An Introduction to the Integumentary System

• Learning Outcomes

• 5-1 Describe the main structural features of the epidermis, and explain the functional significance of each.

• 5-2 Explain what accounts for individual differences in skin color, and discuss the response of melanocytes to sunlight exposure.

• 5-3 Describe the interaction between sunlight and vitamin D₃ production.

• 5-4 Describe the roles of epidermal growth factor.
An Introduction to the Integumentary System

• Learning Outcomes
  • 5-5 Describe the structure and functions of the dermis.
  • 5-6 Describe the structure and functions of the hypodermis.
  • 5-7 Describe the mechanisms that produce hair, and explain the structural basis for hair texture and color.
An Introduction to the Integumentary System

• Learning Outcomes
  • **5-8** Discuss the various kinds of glands in the skin, and list the secretions of those glands.
  • **5-9** Describe the anatomical structure of nails, and explain how they are formed.
  • **5-10** Explain how the skin responds to injury and repairs itself.
  • **5-11** Summarize the effects of aging on the skin.
An Introduction to the Integumentary System

• **The Integument**
  
  • Is the largest system of the body
    
    • 16% of body weight
    
    • 1.5 to 2 m² in area
    
    • The integument is made up of two parts
      1. **Cutaneous membrane** (skin)
      2. **Accessory structures**
An Introduction to the Integumentary System

• Two Components of the Cutaneous Membrane

1. Outer **epidermis**
   - Superficial epithelium (epithelial tissues)

2. Inner **dermis**
   - Connective tissues
Accessory Structures

- Originate in the dermis
- Extend through the epidermis to skin surface
  - Hair
  - Nails
  - Multicellular exocrine glands
An Introduction to the Integumentary System

- Connections
  - Cardiovascular system
    - Blood vessels in the dermis
  - Nervous system
    - Sensory receptors for pain, touch, and temperature
An Introduction to the Integumentary System

- **Hypodermis** (Superficial Fascia or *Subcutaneous Layer*)
  - Loose connective tissue
  - Below the dermis
  - Location of hypodermic injections
Figure 5-1  The Components of the Integumentary System

- Cutaneous Membrane
  - Epidermis
  - Dermis
    - Papillary layer
    - Reticular layer
  - Hypodermis

- Accessory Structures
  - Hair shaft
  - Pore of sweat gland duct
  - Tactile corpuscle
  - Sebaceous gland
  - Arrector pili muscle
  - Sweat gland duct
  - Hair follicle
  - Lamellated corpuscle
  - Nerve fibers
  - Sweat gland
  - Artery
  - Vein
  - Cutaneous plexus
  - Fat
Figure 5-1 The Components of the Integumentary System

Cutaneous Membrane

<table>
<thead>
<tr>
<th>Dermis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Papillary layer</td>
</tr>
<tr>
<td>Reticular layer</td>
</tr>
</tbody>
</table>

| Epidermis |

Hypodermis
Figure 5-1  The Components of the Integumentary System

**Accessory Structures**

- Hair shaft
- Pore of sweat gland duct
- Tactile corpuscle
- Sebaceous gland
- Arrector pili muscle
- Sweat gland duct
- Hair follicle
- Lamellated corpuscle
- Nerve fibers
- Sweat gland
- Artery
- Vein
- Fat
- Cutaneous plexus
An Introduction to the Integumentary System

- Functions of Skin
  - *Protection* of underlying tissues and organs
  - *Excretion* of salts, water, and organic wastes (glands)
  - *Maintenance* of body temperature (insulation and evaporation)
  - *Production* of melanin
An Introduction to the Integumentary System

- Functions of Skin
  - Production of keratin
  - Synthesis of vitamin D₃
  - Storage of lipids
  - Detection of touch, pressure, pain, and temperature
5-1 Epidermis

- The Epidermis
  - Is avascular stratified squamous epithelium
    - Nutrients and oxygen diffuse from capillaries in the dermis
Figure 5-2 The Basic Organization of the Epidermis

- **Epidermis**
- **Epidermal ridge**
- **Dermal papilla**
- **Dermis**

**Thin skin** (LM × 154)
- **Basement membrane**
- **Dermis**
- **Epidermal ridge**

**Thick skin** (LM × 154)
- **Stratum corneum**
- **Stratum lucidum**
- **Dermal papilla**
The structural relationship and interface between the epidermis and underlying dermis. The proportions of the various layers differ with the location sampled.
5-1 Epidermis

- Cells of the Epidermis
  - Keratinocytes
    - Contain large amounts of keratin
    - Are the most abundant cells in the epidermis
5-1 Epidermis

- **Thin Skin**
  - Covers most of the body
  - Has four layers of keratinocytes

- **Thick Skin**
  - Covers the palms of the hands and soles of the feet
  - Has five layers of keratinocytes
Figure 5-2b The Basic Organization of the Epidermis

A micrograph of thin skin, which covers most of the exposed body surface.
Figure 5-2c The Basic Organization of the Epidermis

A micrograph of thick skin, which covers the surface of the palms and the soles of the feet.
5-1 Epidermis

- Structures of the Epidermis
  - The five *strata* of keratinocytes in thick skin
  - From basal lamina to free surface
    1. Stratum basale
    2. Stratum spinosum
    3. Stratum granulosum
    4. Stratum lucidum
    5. Stratum corneum
Figure 5-3  The Structure of the Epidermis

- **Surface**
- **Stratum corneum**
- **Stratum lucidum**
- **Stratum granulosum**
- **Stratum spinosum**
- **Stratum basale**
- **Basement membrane**
- **Dermis**
- **Papillary layer of dermis**
- **Thick skin**
- **LM × 210**
5-1 Epidermis

- **Stratum Basale**
  - Is attached to basement membrane by hemidesmosomes
  - Forms a strong bond between epidermis and dermis
  - Forms *epidermal ridges* (e.g., fingerprints)
  - **Dermal papillae** (tiny mounds)
    - Increase the area of basement membrane
    - Strengthen attachment between epidermis and dermis
  - Has many *basal cells* or *germinative cells*
Figure 5-4  The Epidermal Ridges of Thick Skin

- Pores of sweat gland ducts
- Epidermal ridge

Thick skin  SEM x 25
5-1 Epidermis

• Specialized Cells of Stratum Basale
  • *Merkel cells*
    • Found in hairless skin
    • Respond to touch (trigger nervous system)
  • *Melanocytes*
    • Contain the pigment melanin
    • Scattered throughout stratum basale
5-1 Epidermis

- **Stratum Spinosum** — the “spiny layer”
  - Produced by division of stratum basale
  - Eight to ten layers of keratinocytes bound by desmosomes
  - Cells shrink until cytoskeletons stick out (spiny)
  - Continue to divide, increasing thickness of epithelium
  - Contain *dendritic (Langerhans) cells*, active in immune response
5-1 Epidermis

• **Stratum Granulosum** — the “grainy layer”
  - Stops dividing, starts producing
    - **Keratin**
      - A tough, fibrous protein
      - Makes up hair and nails
    - **Keratohyalin**
      - Dense granules
      - Cross-link keratin fibers
5-1 Epidermis

• Cells of Stratum Granulosum
  • Produce protein fibers
  • Dehydrate and die
  • Create tightly interlocked layer of keratin surrounded by keratohyalin
5-1 Epidermis

- **Stratum Lucidum** — the “clear layer”
  - Found only in thick skin
  - Covers stratum granulosum
5-1 Epidermis

- **Stratum Corneum** — the “horn layer”
  - Exposed surface of skin
  - 15 to 30 layers of keratinized cells
  - Water resistant
  - Shed and replaced every 2 weeks
5-1 Epidermis

- **Keratinization**
  - The formation of a layer of dead, protective cells filled with keratin
  - Occurs on all exposed skin surfaces except eyes
  - Skin life cycle
  - It takes 15–30 days for a cell to move from stratum basale to stratum corneum
5-1 Epidermis

• Perspiration
  • **Insensible perspiration**
    • Interstitial fluid lost by evaporation through the stratum corneum
  • **Sensible perspiration**
    • Water excreted by sweat glands
    • Dehydration results:
      • From damage to stratum corneum (e.g., burns and blisters [insensible perspiration])
      • From immersion in hypertonic solution (e.g., seawater [osmosis])
5-1 Epidermis

- **Hydration**
  - Results from immersion in hypotonic solution (e.g., freshwater [osmosis])
  - Causes swelling of epithelial cells, evident on the palms and soles
5-2 Skin Color

• Skin Color is Influenced by Two Pigments

1. Carotene

2. Melanin

• Blood circulation (red blood cells)
5-2 Skin Color

• **Carotene**
  - Orange-yellow pigment
  - Found in orange vegetables
  - Accumulates in epidermal cells and fatty tissues of the dermis
  - Can be converted to vitamin A
5-2 Skin Color

- **Melanin**
  - Yellow-brown or black pigment
  - Produced by *melanocytes* in stratum basale
  - Stored in transport vesicles (*melanosomes*)
  - Transferred to keratinocytes
Figure 5-5 Melanocytes

Melanocytes in stratum basale
Melanin pigment
Basement membrane

Melanocytes LM × 600
Figure 5-5 Melanocytes

- Melanosome
- Keratinocyte
- Melanin pigment
- Melanocyte
- Basement membrane

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Figure 5-6 Skin Cancers

a Basal cell carcinoma

b Melanoma
5-2 Skin Color

• Function of Melanocytes
  • Melanin protects skin from sun damage

• Ultraviolet (UV) radiation
  • Causes DNA mutations and burns that lead to cancer and wrinkles
  • Skin color depends on melanin production, not number of melanocytes
5-2 Skin Color

- Capillaries and Skin Color
  - Oxygenated red blood contributes to skin color
    - Blood vessels dilate from heat, skin reddens
    - Blood flow decreases, skin pales
  - Cyanosis
    - Bluish skin tint
    - Caused by severe reduction in blood flow or oxygenation
5-2 Skin Color

- Illness and Skin Color
  - Jaundice
    - Buildup of bile produced by liver
    - Yellow color
  - Pituitary tumor
    - Excess MSH
  - Addison’s disease
    - A disease of the pituitary gland
    - Skin darkening
  - Vitiligo
    - Loss of melanocytes
    - Loss of color
5-3 Vitamin D₃

• **Vitamin D₃**
  - Epidermal cells produce *cholecalciferol* (vitamin D₃)
    - In the presence of UV radiation
  - Liver and kidneys convert vitamin D₃ into *calcitriol*
    - Aids absorption of calcium and phosphorus
  - Insufficient vitamin D₃
    - Can cause *rickets*
Figure 5-7  Rickets
5-4 Epidermal Growth Factor (EGF)

- **Epidermal Growth Factor (EGF)**
  - Powerful peptide growth factor
  - Produced by glands (salivary and duodenum)
  - Used in laboratories to grow skin grafts

- **Functions of EGF**
  - Promotes division of germinative cells
  - Accelerates keratin production
  - Stimulates epidermal repair
  - Stimulates glandular secretion
5-5 The Dermis

- The Dermis
  - Located between epidermis and subcutaneous layer
  - Anchors epidermal accessory structures (hair follicles, sweat glands)
  - Two components
    1. Outer **papillary layer**
    2. Deep **reticular layer**
5-5 The Dermis

- **The Papillary Layer**
  - Consists of areolar tissue
  - Contains smaller capillaries, lymphatics, and sensory neurons
  - Has dermal papillae projecting between epidermal ridges
5-5 The Dermis

- The **Reticular Layer**
  - Consists of dense irregular connective tissue
  - Contains larger blood vessels, lymphatic vessels, and nerve fibers
  - Contains collagen and elastic fibers
  - Contains connective tissue proper
5-5 The Dermis

• Dermatitis
  • An inflammation of the papillary layer
  • Caused by infection, radiation, mechanical irritation, or chemicals (e.g., poison ivy)
  • Characterized by itch or pain
5-5 The Dermis

- Dermal Strength and Elasticity
  - Presence of two types of fibers
    1. Collagen fibers
       - Very strong, resist stretching but bend easily
       - Provide flexibility
    2. Elastic fibers
       - Permit stretching and then recoil to original length
       - Limit the flexibility of collagen fibers to prevent damage to tissue

- Skin turgor
  - Properties of flexibility and resilience
Skin Damage

Sagging and wrinkles (reduced skin elasticity) are caused by:

- Dehydration
- Age
- Hormonal changes
- UV exposure
5-5 The Dermis

- **Skin Damage**
  
  - **Stretch marks**
    
    - Thickened tissue resulting from excessive stretching of skin due to:
      
      - Pregnancy
      
      - Weight gain
5-5 The Dermis

- **Cleavage Lines**
  - Collagen and elastic fibers in the dermis
    - Arranged in parallel bundles
    - Resist force in a specific direction
  - **Cleavage (tension) lines** establish important patterns
    - A parallel cut remains shut, heals well
    - A cut across (right angle) pulls open and scars
Figure 5-8  Cleavage Lines of the Skin
5-5 The Dermis

- The Dermal Blood Supply
  - *Cutaneous plexus*
    - A network of arteries along the reticular layer
  - *Papillary plexus*
    - Capillary network from small arteries in papillary layer
  - *Venous plexus*
    - Capillary return deep to the papillary plexus
  - *Contusion*
    - Damage to blood vessels resulting in “black-and-blue” bruising
Figure 5-9 Dermal Circulation

- Hair
- Papillary layer
- Reticular layer
- Cutaneous plexus
- Epidermal ridges
- Papillary plexus
- Dermal papillae
- Capillary loop of papillary plexus
5-5 The Dermis

- Innervation of the Skin
  - Nerve fibers in skin control:
    - Blood flow
    - Gland secretions
    - Sensory receptors
      - Light touch—*tactile corpuscles*, located in dermal papillae
      - Deep pressure and vibration—*lamellated corpuscles*, in the reticular layer
The Hypodermis (Subcutaneous Layer)

- Lies below the integument
- Stabilizes the skin
- Allows separate movement
- Made of elastic areolar and adipose tissues
- Connected to the reticular layer of integument by connective tissue fibers
- Few capillaries and no vital organs
- The site of subcutaneous injections using hypodermic needles
5-6 The Hypodermis

- Deposits of Subcutaneous Fat
  - Distribution patterns determined by hormones
  - Reduced by cosmetic liposuction (lipoplasty)
5-7 Hair

• Hair, Hair Follicles, Sebaceous Glands, Sweat Glands, and Nails
  • Integumentary accessory structures
  • Derived from embryonic epidermis
  • Located in dermis
  • Project through the skin surface
• Human Body
  • The human body is covered with hair, *except*:
    • Palms
    • Soles
    • Lips
    • Portions of external genitalia
5-7 Hair

• Functions of Hair
  • Protects and insulates
  • Guards openings against particles and insects
  • Is sensitive to very light touch
5-7 Hair

- The Hair Follicle
  - Located deep in dermis
  - Produces nonliving hairs
  - Wrapped in a dense connective tissue sheath
  - Base is surrounded by sensory nerves (root hair plexus)
5-7 Hair

• Accessory Structures of Hair
  • Arrector pili
    • Involuntary smooth muscle
    • Causes hairs to stand up
    • Produces “goose bumps”
  • Sebaceous glands
    • Lubricate the hair
    • Control bacteria
5-7 Hair

- Regions of the Hair
  - Hair root
    - Lower part of the hair
    - Attached to the integument
  - Hair shaft
    - Upper part of the hair
    - Not attached to the integument
Figure 5-10a Hair Follicles and Hairs

Single hair follicle, showing the associated accessory structures; a superficial view of the deeper portions of the follicle illustrates the connective tissue sheath and the root hair plexus.
### Hair Structure

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The medulla, or core, of</td>
<td>The medulla, or the core of the hair contains a flexible, soft keratin.</td>
</tr>
<tr>
<td>the hair</td>
<td></td>
</tr>
<tr>
<td>contains a flexible</td>
<td></td>
</tr>
<tr>
<td>soft keratin</td>
<td></td>
</tr>
<tr>
<td>The cortex</td>
<td>The cortex contains thick layers of hard keratin, which give the hair its</td>
</tr>
<tr>
<td>contains thick layers of</td>
<td>stiffness.</td>
</tr>
<tr>
<td>hard keratin</td>
<td></td>
</tr>
<tr>
<td>The cuticle</td>
<td>The cuticle, although thin, is very tough, and it contains hard keratin.</td>
</tr>
</tbody>
</table>

### Follicle Structure

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The internal root sheath</td>
<td>The internal root sheath surrounds the hair root and the deeper portion of</td>
</tr>
<tr>
<td>surrounds the hair</td>
<td>the shaft. The cells of this sheath disintegrate quickly, and this layer</td>
</tr>
<tr>
<td>root and the deeper</td>
<td>does not extend the entire length of the hair follicle.</td>
</tr>
<tr>
<td>portion of the shaft</td>
<td></td>
</tr>
<tr>
<td>The external root sheath</td>
<td>The external root sheath extends from the skin surface to the hair matrix.</td>
</tr>
<tr>
<td>extends</td>
<td></td>
</tr>
<tr>
<td>from the skin surface</td>
<td></td>
</tr>
<tr>
<td>to the hair matrix</td>
<td></td>
</tr>
<tr>
<td>The glassy membrane</td>
<td>The glassy membrane is a thickened, clear layer wrapped in the dense</td>
</tr>
<tr>
<td>is a thickened, clear</td>
<td>connective tissue sheath of the follicle as a whole.</td>
</tr>
<tr>
<td>layer</td>
<td></td>
</tr>
<tr>
<td>Connective tissue sheath</td>
<td></td>
</tr>
</tbody>
</table>
Figure 5-10c  Hair Follicles and Hairs

Diagrammatic sectional view along the long axis of a hair follicle.
Figure 5-10d Hair Follicles and Hairs

Longitudinal section through two hair follicles, showing the base of the follicle and the matrix and papilla at the root of the hair.
5-7 Hair

- Hair Production

  - Begins at the base of a hair follicle, deep in the dermis
    - The **hair papilla** contains capillaries and nerves
    - The **hair bulb** produces **hair matrix**
      - A layer of dividing basal cells
      - Produces hair structure
      - Pushes hair up and out of skin
5-7 Hair

- Hair Shaft Structure
  - Medulla
    - The central core
  - Cortex
    - The middle layer
  - Cuticle
    - The surface layer
5-7 Hair

• Keratin
  • As hair is produced, it is keratinized
    • Medulla contains flexible soft keratin
    • Cortex and cuticle contain stiff hard keratin
5-7 Hair

- Layers in the Follicle
  - **Internal root sheath**
    - The inner layer
    - Contacts the cuticle in lower hair root
  - **External root sheath**
    - Extends from skin surface to hair matrix
  - **Glassy membrane**
    - A dense connective tissue sheath
    - Contacts connective tissues of dermis
5-7 Hair

• **Hair Growth Cycle**
  
  • Growing hair
    
    • Is firmly attached to matrix
  
  • **Club hair**
    
    • Is not growing
    
    • Is attached to an inactive follicle
5-7 Hair

- Hair Growth Cycle
  - New hair growth cycle
    - Follicle becomes active
    - Produces new hair
    - Club hair is shed
5-7 Hair

- **Types of Hairs**
  - **Vellus hairs**
    - Soft, fine
    - Cover body surface
  - **Terminal hairs**
    - Heavy, pigmented
    - Head, eyebrows, and eyelashes
    - Other parts of body after puberty
5-7 Hair

- Hair Color
  - Produced by melanocytes at the hair papilla
  - Determined by genes
5-8 Sebaceous Glands and Sweat Glands

- Exocrine Glands in Skin
  - **Sebaceous Glands** (oil glands)
    - Holocrine glands
    - Secrete sebum
  - Two Types of **Sweat Glands**
    1. Apocrine glands
    2. Merocrine (eccrine) glands
      - Watery secretions
Types of **Sebaceous (Oil) Glands**

- Simple branched alveolar glands
  - Associated with hair follicles

**Sebaceous follicles**

- Discharge directly onto skin surface

**Sebum**

- Contains lipids and other ingredients
- Lubricates and protects the epidermis
- Inhibits bacteria
Figure 5-11  The Structure of Sebaceous Glands and Sebaceous Follicles

- Epidermis
- Dermis
- Subcutaneous layer
- Sebaceous follicle
- Sebaceous gland
- Lumen (hair removed)
- Wall of hair follicle
- Basement membrane
- Discharge of sebum
- Lumen
- Breakdown of cell membranes
- Mitosis and growth
- Basal cells

LM × 150
Figure 5-11  The Structure of Sebaceous Glands and Sebaceous Follicles
Figure 5-11  The Structure of Sebaceous Glands and Sebaceous Follicles

- Lumen (hair removed)
- Wall of hair follicle
- Basement membrane
- Discharge of sebum
- Lumen
- Breakdown of cell membranes
- Mitosis and growth
- Basal cells
Figure 5-11 The Structure of Sebaceous Glands and Sebaceous Follicles

- Lumen (hair removed)
- Wall of hair follicle
- Basement membrane
- Basal cells

Sebaceous gland  LM x 150
5-8 Sebaceous Glands and Sweat Glands

- **Apocrine Sweat Glands**
  - Found in armpits, around nipples, and groin
  - Secrete products into hair follicles
  - Produce sticky, cloudy secretions
  - Break down and cause odors
  - Surrounded by myoepithelial cells
    - Squeeze apocrine gland secretions onto skin surface
    - In response to hormonal or nervous signal
Figure 5-12a  Sweat Glands

Apocrine sweat glands secrete a thick, odorous fluid into hair follicles.
5-8 Sebaceous Glands and Sweat Glands

- **Merocrine (Eccrine) Sweat Glands**
  - Widely distributed on body surface
  - Especially on palms and soles
  - Coiled, tubular glands
  - Discharge directly onto skin surface
  - Sensible perspiration
  - Water, salts, and organic compounds
  - Functions of merocrine sweat gland activity
    - Cools skin
    - Excretes water and electrolytes
    -Flushes microorganisms and harmful chemicals from skin
Merocrine sweat glands discharge a watery fluid onto the surface of the skin.
Other Integumentary Glands

1. Mammary glands
   - Produce milk

2. Ceruminous glands
   - Produce cerumen (earwax)
   - Protect the eardrum
5-8 Sebaceous Glands and Sweat Glands

• Control of Glands
  • Autonomic nervous system (ANS)
    • Controls sebaceous and apocrine sweat glands
    • Works simultaneously over entire body
  • Merocrine sweat glands
    • Controlled independently
    • Sweating occurs locally
  • Thermoregulation
    • The main function of sensible perspiration
    • Works with cardiovascular system
    • Regulates body temperature
5-9 Nails

- **Nails**
  - Protect fingers and toes
  - Made of dead cells packed with keratin
  - Metabolic disorders can change nail structure

- **Nail Production**
  - Occurs in a deep epidermal fold near the bone called the **nail root**
5-9 Nails

- **Structure of a Nail**
  - **Nail body**
    - The visible portion of the nail
    - Covers the **nail bed**
  - **Lunula**
    - The pale crescent at the base of the nail
  - **Sides of nails**
    - Lie in **lateral nail grooves**
    - Surrounded by **lateral nail folds**
5-9 Nails

• Structure of a Nail
  • Skin beneath the distal free edge of the nail
    • Is the hyponychium (onyx = nail)
  • Visible nail emerges:
    • From the eponychium (cuticle)
    • At the tip of the proximal nail fold
Figure 5-13 The Structure of a Nail

(a) A superficial view

(b) A cross-sectional view

(c) A longitudinal section
Figure 5-13a The Structure of a Nail

- Direction of growth
- Free edge
- Lateral nail fold
- Nail body
- Lunula
- Proximal nail fold
- Eponychium

A superficial view
Figure 5-13b  The Structure of a Nail

- Lateral nail fold
- Lateral nail groove
- Nail bed
- Phalanx (bone of fingertip)
- Nail body

A cross-sectional view
Figure 5-13c The Structure of a Nail

- Eponychium
- Proximal nail fold
- Nail root
- Lunula
- Nail body
- Epidermis
- Dermis
- Phalanx
- Hyponychium

A longitudinal section
5-10 Repair of the Integument

- Repair of the Integument Following an Injury
  - Bleeding occurs
  - Mast cells trigger inflammatory response
  - A scab stabilizes and protects the area
  - Germinative cells migrate around the wound
  - Macrophages clean the area
  - Fibroblasts and endothelial cells move in, producing granulation tissue
Bleeding occurs at the site of injury immediately after the injury, and mast cells in the region trigger an inflammatory response.
After several hours, a scab has formed and cells of the stratum basale are migrating along the edges of the wound. Phagocytic cells are removing debris, and more of these cells are arriving via the enhanced circulation in the area. Clotting around the edges of the affected area partially isolates the region.
One week after the injury, the scab has been undermined by epidermal cells migrating over the meshwork produced by fibroblast activity. Phagocytic activity around the site has almost ended, and the fibrin clot is breaking up.
After several weeks, the scab has been shed, and the epidermis is complete. A shallow depression marks the injury site, but fibroblasts in the dermis continue to create scar tissue that will gradually elevate the overlying epidermis.
5-10 Repair of the Integument

- Repair of the Integument Following an Injury
  - Fibroblasts produce **scar tissue**
    - Inflammation decreases, clot disintegrates
    - Fibroblasts strengthen scar tissue
    - A raised **keloid** may form
Figure 5-15  A Keloid
Figure 5-16 A Quick Method of Estimating the Percentage of Surface Area Affected by Burns

ADULT

Head 9%
Upper limb 9% each
Trunk 36% (front and back)
Genitalia 1%
Lower limb 18% each

CHILD (5-year-old)

Head 15%
Trunk 32% (front and back)
Upper limb 9% each
Genitalia 1%
Lower limb 17% each
5-11 Effects of Aging on the Integumentary System

- Effects of Aging
  - Epidermal thinning
  - Decreased numbers of dendritic (Langerhans) cells
  - Decreased vitamin D$_3$ production
  - Decreased melanocyte activity
  - Decreased glandular activity (sweat and oil glands)
5-11 Effects of Aging on the Integumentary System

- Effects of Aging
  - Reduced blood supply
  - Decreased function of hair follicles
  - Reduction of elastic fibers
  - Decreased hormone levels
  - Slower repair rate
Importance of the Integumentary System

- Protects and interacts with all organ systems
- Changes in skin appearance are used to diagnose disorders in other systems
Figure 5-17 System Integrator: The Integumentary System

The INTEGUMENTARY System

The integumentary system provides mechanical protection against environmental hazards. It forms the external surface of the body and provides protection from dehydration, environmental chemicals, and external forces. The integument (skin) is separated and insulated from the rest of the body by the subcutaneous layer, but it is interconnected with the rest of the body by an extensive circulatory network of blood and lymphatic vessels. As a result, although the protective mechanical functions of the skin can be discussed independently, its physiological activities are always closely integrated with those of other systems.

ABOUT THE SYSTEM INTEGRATORS
Since each body system interacts with every other body system, no one system can be completely understood in isolation. The integration of the various systems allows the human body to function seamlessly, and when disease or injury strikes, multiple systems must respond to heal the body.

These charts will introduce the body systems one by one and show how each influences the others to make them function more effectively, and in turn how other body systems influence the system you are studying. As we progress through the organ system, the complementary nature of these interactions will become clear. Homeostasis depends on the thorough integration of all the body systems working as one.