Chapter 5
Integumentary System
Lecture 12

Lecture Overview

• Functions of the Integumentary System
• Overview of the skin
• The epidermis
• The dermis
• The hypodermis (subcutaneous layer)
• Accessory structures of the integumentary system
• Injury and Repair
• Aging and the integumentary system

Where are We in Our Organizational Scheme?
**Some Questions…**

Skin is composed of an epithelial layer and a connective tissue layer. Is skin a membrane? Yes. A cutaneous membrane

What is a membrane? Combination of ET and CT tissues combine to protect/cover other tissues

Is there a difference between the skin (integument) and the integumentary system?

Yes. Skin is the cutaneous membrane consisting of an epithelium (epidermis) and a dermis (CT). The integumentary system (IS) includes the skin, hair, nails, and glands (accessory structures).

How does the structure of the integument enable it to perform its functions of protection, temperature regulation, etc.?

That is the subject of this lecture…

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**Introduction to the Integumentary System**

- The integument constitutes 16% of our body weight and has a surface area of about 1.5 – 2.0 m² (15 – 20 ft²)

- **Functions of the integument**
  - Protection (from mechanical/chemical/bacterial damage, UV radiation)
  - Temperature regulation (extreme heat, extreme cold) and Fluid conservation
  - Excretion
  - Vitamin D production
  - Sensation (touch, pressure)

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**Overview of the Integument**

Epidermis = protection; Dermis = nourishment of epidermis; SubQ = insulation

Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001
Layer of the Epidermis - Overview

Cells of the Epidermis

- **Epidermis of the skin is classified as a keratinized stratified squamous epithelium.**
- **Cells of the epidermis include**
  - Keratinocytes (90%)
    - Keratin – a tough, fibrous intracellular protein (protection)
    - Lamellar granules (waterproofing, extracellular)
  - Melanocytes (8%)
    - Produce melanin (protection from UV radiation)
  - Langerhans cells (1-2%)
    - Migrate to skin from bone marrow
    - Participate in skin’s immune response (dendritic cells)
  - Merkel cells (< 1%)
    - Least numerous; specialized epithelial cells
    - Function in sensation of touch

Thick and Thin Skin

- **Thick skin** - palms of hands, soles of feet; **five epidermal layers**
- **Thin skin** - everywhere else; **four epidermal layers (no s. lucidum)**
Layers of the Epidermis

**Stratum basale (Bottom)** (germinativum)
- lowest layer
- single layer of dividing cells that continually replace more superficial epithelial cells
- contains Merkel cells (touch) and melanocytes (pigment)
- attached by hemidesmosomes to underlying basal lamina
- epidermal ridges; contours of skin follow ridges = fingerprints

Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001

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Layers of the Epidermis

**Stratum spinosum (spiny)**
- 8-10 layers of rounded cells with large nuclei
- held together by desmosomes
- cells continue to divide
- Langerhans (immune) cells found here

Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001

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“Bare Skin Gets Lots of Cuts”

Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001
Layers of the Epidermis

**Stratum granulosum (granular)**
- 3-5 layers of keratinocytes
- most no longer divide
- begin making lots of keratin and keratohyalin (KH)
  - * cells flatten and harden
  - * cell membranes thicken
  - * KH promotes dehydration and cross-linking of keratin fibers
  - * nuclei begin to disintegrate and cells die

*Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001*

**Stratum lucidum (clear)**
- ONLY in THICK SKIN
- flattened, densely packed, and filled with keratin (eleidin)
- separates the s. corneum from the s. granulosum
- Water resistant boundary layer of keratinized skin

*Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001*

**Stratum corneum (horny)**
- 15-30 layers of dead keratinized cells (dander)
- exposed to outside
- tightly connected by desmosomes
- remain for about 2 weeks
- water-resistant
  - interstitial fluids slowly permeate and evaporate (insensible perspiration)
  - damage to epidermis greatly increases this water loss
  - fluid collection between cells creates blisters

*Figure from: Martini, Anatomy & Physiology, Prentice Hall, 2001*
### Skin Color

#### Genetic Factors
- varying amounts and type of melanin
- varying size/number of melanin granules
- albinos lack melanin (but not melanocytes!)

#### Physiological Factors
- dilation of dermal blood vessels (erythema)
- constriction of dermal blood vessels (less pink, pale = pallor)
- level of oxygenation of blood
  * normal = pink (fair-skinned)
  * low = bluish (cyanosis)
- carotene -> Vit A (yellow)
- jaundice (yellow)

#### Environmental Factors
- sunlight
- UV light from sunlamps
- X rays

### Skin Color and Melanin

**Melanocytes and melanin facts**
- tyrosine (aa) → melanin
- UV radiation up-regulates production of melanin
- Caucasian vs. dark-skinned
  * number vs. activity
  * layer of epidermis
Other Epidermal Facts

- Vitamin D₃ ("sunshine vitamin")
  - After UV irradiation epidermal cells in s. spinosum and s. basale convert a cholesterol-related steroid to Vit D₃ (cholecalciferol)
  - Vit D₃ → ↑ absorption of calcium and phosphorus by small intestine

- Epidermal Growth Factor (EGF)
  - Produced in salivary glands and duodenum
  - Widespread effects on epithelia
    - ↑ cell division in s. basale and s. spinosum
    - ↑ production of keratin
    - ↑ epidermal development and repair
    - ↑ synthetic activity and secretion by epithelial glands

Dermis

Papillary layer (contains papillae)
- areolar connective tissue (CT)
- capillaries and sensory neurons
- dermal papillae
- fingerprints (with epi. ridges)

Reticular layer (contains fibers)
- dense, irregular CT
- collagen fiber bundles extend upward and downward
- also contains elastic fibers and cells of CT proper
- accessory organs of integumentary system (from epi.)
- cleavage or tension lines
- flexure lines

Dermis

Circulation
- cutaneous plexus (CP)
- branches of CP supply hair follicles, glands, other structures
- form papillary plexus

Nerves
- control blood flow
- regulate gland secretion
- monitor sensory reception
- light touch (Meissner’s)
- deep touch/pressure (Pacinian or lamellated corpuscles)
- naked nerve endings to epithelium (pain, temperature)
Subcutaneous Layer

- Stabilization of dermis
- Insulation
- Areolar and adipose tissue
- Effect of hormones
- Reservoir of blood

Also called 'hypodermis'. This is the superficial fascia.

Hair (pilo-)

- Epidermal cells
- Tube-like depression
- Extends into dermis
- Hair root (in dermis)
- Hair shaft (outer 1/3)
- Hair papilla
- Dead epidermal cells
- Melanin
- Arrector pili muscle

A hair in the scalp grows for 2-5 years, about 0.33mm/day

Hair Follicles

Types of hair:
1. Lanugo – long, blond, fine (fetal, anorexia nervosa)
2. Vellus – short, blond (children, adult females)
3. Terminal – course, pigmented (adults)
Hairs Emerging from Follicles


Hair Color and Texture

Figure from: Saladin, Anatomy & Physiology, McGraw Hill, 2007

Sebaceous (Oil) Glands

- usually associated with hair follicles
- holocrine glands
- secrete sebum, a waxy, oily material
- absent on palms and soles
- inhibits growth of bacteria
- lubricates and protects keratin of hair shaft, and conditions skin

Sebaceous follicles – not associated with hair. Discharge directly on to skin. On face, back, chest, nipples and male sex organs.
Sweat Glands

- Also called sudoriferous glands
- Apocrine (merocrine secretion) glands
  - Associated with hair follicles
  - Thick, odorous secretion
- Eccrine (merocrine secretion) glands
  - Most numerous
  - Palms, soles, forehead, neck, back
  - Directly on to surface
  - Watery secretion
  - For thermoregulation
- Ceruminous glands
- Mammary glands

Sweating (usu excessive) with visible wetness = diaphoresis

Nails

- Know these terms – be able to label a diagram of the nail

Regulation of Body Temperature

Hyperthermia – Abnormally high body temperature

May be caused by
- Environment (heat, humidity)
- Illness (fever [>=37.2°C], pyrexia)
- Anesthesia (malignant h.)

Corrected by loss of heat by radiation, convection, conduction, evaporation

Heat exhaustion (prostration)
- Fatigue
- Dizziness
- Headache
- Muscle cramps
- Nausea
- May lead to heat stroke
Regulation of Body Temperature

Hypothermia – Abnormally low body temperature (at least 2°C below normal body temp)

May be caused by:
- exposure to cold (primary)
- illness (secondary)
- surgical induction (clinical)

Cardiac arrest is likely if temperature falls below 28°C (82°F)

Corrected by mechanisms to retain body heat (see left)

Healing of Cuts

1. Bleeding/clotting
2. Scab formation
3. Epidermal cell migration and collagen production
4. Shedding of scab; covering of wound with epithelium

Types of Burns

1) Partial-thickness burns
2) Full-thickness burns

Figure from: Saladin, Anatomy & Physiology, McGraw Hill, 2007
Life Span Changes

- Scaly skin as sebaceous glands secrete less oil
- Age spots
- Dermis becomes reduced
- Loss of fat
- Wrinkles
- Sagging
- Melanin production slows
- Hair thins
- Number of hair follicles decrease
- Impaired nail growth
- Sensory receptors decline
- Inability to control body temperature
- Less vitamin D production

Review

- The Integumentary System has numerous functions that are related to its composition and structure
  - Protection
  - Temperature regulation (sweat, blood vessels)
  - Excretion
  - Vitamin D production
  - Sensation (touch, pressure)
- The epidermis – the outer, protective layer
  - S. basale, s. spinosum, s. granulosum, s. lucidum (thick skin only), s. corneum

Review

- The dermis – the lower, nutritive layer
  - Papillary dermis
  - Reticular dermis
  - Dermis contains accessory organs of skin

- The hypodermis (subcutaneous) – insulates
  - The superficial fascia
  - ‘baby fat’
  - reservoir of blood
  - NOT part of the skin
Review

• Accessory structures of the integumentary system
  – Hair
  – Nails (parts of nails)
  – Sweat glands
    • Apocrine (merocrine)
    • Eccrine (merocrine)
    • Modified (mammary, ceruminous)
  – Sebaceous glands and sebaceous follicles
  – These structures are vital for skin repair since they act as a source of epithelial cells

Review

• Skin color is due to many factors
  – Genetic (melanin)
  – Environmental (UV irradiation)
  – Physiologic
    • Dilation of dermal blood vessels – erythema
    • Poor oxygenation of blood – cyanosis
    • Constriction of dermal blood vessels – pale skin
    • Carotene, jaundice (yellow skin)

Review

• Temperature regulation is an important function of the integumentary system
  – Body can lose heat by
    • Radiation
    • Evaporation
    • Convection
    • Conduction
  – Hyperthermia (ABOVE normal core temperature)
    • Dilation of dermal blood vessels
    • Increased sweat gland secretion
  – Hypothermia (BELOW normal core temperature)
    • Constriction of dermal blood vessels
    • Decrease in sweat gland secretion
Review

• Stem cells in the epithelium and dermis are crucial to repair after injury
  – Wound healing and regeneration
  – Burns

• Numerous changes occur in the integumentary system with age (Ugh!)