Chapter 5
The Integumentary System

• Skin and its accessory structures
  - structure
  - function
  - growth and repair
  - development
  - aging
  - disorders

General Anatomy

• A large organ composed of all 4 tissue types
• 22 square feet
• 1-2 mm thick
• Weight 10 lbs.

Overview

• 2 Major layers of skin
  - epidermis is epithelial tissue only
  - dermis is layer of connective tissue, nerve & muscle
• Subcutaneous tissue (subQ or hypodermis) is layer of adipose & areolar tissue
  - subQ = subcutaneous injection
  - intradermal = within the skin layer
Overview of Epidermis

- Stratified squamous epithelium
- Contains no blood vessels
- 4 types of cells
- 5 distinct strata (layers) of cells

Cell types of the Epidermis

- Keratinocytes—90%
  - produce keratin
- Melanocytes—8%
  - produce melanin pigment
  - melanin transferred to other cells with long cell processes
- Langerhan cells
  - from bone marrow
  - provide immunity
- Merkel cells
  - in deepest layer
  - form touch receptor with sensory neuron

Layers (Strata) of the Epidermis

- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basale
**Stratum Basale**
- Deepest single layer of cells
- Called stratum germinativum
- Combination of merkel cells, melanocytes, keratinocytes & stem cells that divide repeatedly
- Cells attached to each other & to basement membrane by desmosomes & hemidesmosomes

**Stratum Spinosum**
- 8 to 10 cell layers held together by desmosomes
- During slide preparation, cells shrink and look spiny
- Melanin taken in by phagocytosis from nearby melanocytes

**Stratum Granulosum**
- 3 - 5 layers of flat dying cells
- Show nuclear degeneration
- Contain dark-staining keratohyalin granules
- Contain lamellar granules that release lipid that repels water
Stratum Lucidum

- Seen in thick skin on palms & soles of feet
- Three to five layers of clear, flat, dead cells
- Contains precursor of keratin

Stratum Corneum

- 25 to 30 layers of flat dead cells filled with keratin and surrounded by lipids
- Continuously shed
- Barrier to light, heat, water, chemicals & bacteria
- Friction stimulates callus formation
Dermis

- Connective tissue layer composed of collagen & elastic fibers, fibroblasts, macrophages & fat cells
- Contains hair follicles, glands, nerves & blood vessels
- Major regions of dermis
  - papillary region
  - reticular region

Papillary Region

- Top 20% of dermis
- Composed of loose CT & elastic fibers
- Finger like projections called dermal papillae
- Functions
  - anchors epidermis to dermis
  - contains capillaries that feed epidermis
  - contains Meissner’s corpuscles (touch) & free nerve endings (pain and temperature)
Reticular Region

• Dense irregular connective tissue
• Contains interlacing collagen and elastic fibers
• Packed with oil glands, sweat gland ducts, fat & hair follicles
• Provides strength, extensibility & elasticity to skin
  – stretch marks are dermal tears from extreme stretching
• Epidermal ridges form in fetus as epidermis conforms to dermal papillae
  – fingerprints are left by sweat glands open on ridges
  – increase grip of hand

Skin Color Pigments (1)

• Melanin produced in epidermis by melanocytes
  – same number of melanocytes in everyone, but differing amounts of pigment produced
  – results vary from yellow to tan to black color
  – melanocytes convert tyrosine to melanin
  • UV in sunlight increases melanin production
• Clinical observations
  – freckles or liver spots = melanocytes in a patch
  – albinism = inherited lack of tyrosinase; no pigment
  – vitiligo = autoimmune loss of melanocytes in areas of the skin produces white patches

Skin Color Pigments (2)

• Carotene in dermis
  – yellow-orange pigment (precursor of vitamin A)
  – found in stratum corneum & dermis
• Hemoglobin
  – red, oxygen-carrying pigment in blood cells
  – if other pigments are not present, epidermis is translucent so pinkness will be evident
Skin Color as Diagnostic Clue

- **Jaundice**
  - yellowish color to skin and whites of eyes
  - buildup of yellow bilirubin in blood from liver disease
- **Cyanotic**
  - bluish color to nail beds and skin
  - hemoglobin depleted of oxygen looks purple-blue
- **Erythema**
  - redness of skin due to enlargement of capillaries in dermis
  - during inflammation, infection, allergy or burns

Accessory Structures of Skin

- **Epidermal derivatives**
- Cells sink inward during development to form:
  - hair
  - oil glands
  - sweat glands
  - nails

Structure of Hair

- **Shaft** — visible
  - medulla, cortex & cuticle
  - CS round in straight hair
  - CS oval in wavy hair
- **Root** — below the surface
- **Follicle surrounds root**
  - external root sheath
  - internal root sheath
  - base of follicle is bulb
  - blood vessels
  - germinal cell layer
Hair Related Structures

- **Arrector pili**
  - smooth muscle in dermis contracts with cold or fear.
  - forms goosebumps as hair is pulled vertically
- **Hair root plexus**
  - detect hair movement
Hair Growth

- Growth cycle = growth stage & resting stage
- Growth stage
  - lasts for 2 to 6 years
  - matrix cells at base of hair root producing length
- Resting stage
  - lasts for 3 months
  - matrix cells inactive & follicle atrophies
- Old hair falls out as growth stage begins again
  - normal hair loss is 70 to 100 hairs per day
Scalp - 2 to 6 years
(25 years some)

Trunk, Eyebrows & extremities - 6 mos.
Hair Color
- Result of melanin produced in melanocytes in hair bulb
- Dark hair contains true melanin
- Blond and red hair contain melanin with iron and sulfur added
- Graying hair is result of decline in melanin production
- White hair has air bubbles in the medullary shaft

Glands of the Skin
- Specialized exocrine glands found in dermis
- Sebaceous (oil) glands
- Sudiferous (sweat) glands
- Ceruminous (wax) glands
- Mammary (milk) glands
Sebaceous (oil) glands

- Secretory portion in the dermis
- Most open onto hair shafts
- Sebum
  - combination of cholesterol, proteins, fats & salts
  - keeps hair and skin from soft & pliable
  - inhibits growth of bacteria & fungi (ringworm)
- Acne
  - bacterial inflammation of glands
  - secretions stimulated by hormones at puberty

Sudoriferous (sweat) glands

- Eccrine (sweat) glands
  - most areas of skin
  - secretory portion in dermis with duct to surface
  - regulate body temperature with perspiration
- Apocrine (sweat) glands
  - armpit and pubic region
  - secretory portion in dermis with duct that opens onto hair follicle
  - secretions more viscous

Ceruminous glands

- Modified sweat glands produce waxy secretion in ear canal
- Cerumin contains secretions of oil and wax glands
- Helps form barrier for entrance of foreign bodies
- Impacted cerumen may reduce hearing
Nails

- Tightly packed, keratinized cells
- Nail body is pink due to underlying capillaries
- Lunula appears white due to thickened stratum basale in that area
- Cuticle (eponychium) is stratum corneum
- Nail matrix deep to the nail root is the region from which the nail growth occurs
- Growth is 1mm per week--faster in summer & on most-used hand

Structure of Nails

- Tightly packed keratinized cells
- Nail body
  - visible portion pink due to underlying capillaries
  - free edge appears white
- Nail root
  - buried under skin layers
  - lunula is white due to thickened stratum basale
- Eponychium (cuticle)
  - stratum corneum layer

Nail Growth

- Nail matrix below nail root produces growth
- Cells transformed into tightly packed keratinized cells
- 1 mm per week
Types of Skin

- Thin skin
  - covers most of body
  - thin epidermis (.1 to .15 mm.) that lacks stratum lucidum
  - lacks epidermal ridges, has fewer sweat glands and sensory receptors
- Thick skin
  - only on palms and soles
  - thick epidermis (.6 to 4.5 mm.) with distinct stratum lucidum & thick stratum corneum
  - lacks hair follicles and sebaceous glands

General Functions of the Skin

- Regulation of body temperature
- Protection as physical barrier
- Sensory receptors
- Excretion and absorption
- Synthesis of vitamin

Thermoregulation

- Releasing of sweat onto the skin
  - perspiration & its evaporation lowers body temperature
- Adjusting flow of blood to the body surface
  - in moderate exercise, more blood brought to surface helps lower temperature
  - with extreme exercise, blood is shunted to muscles and body temperature rises
- Shivering and constriction of surface vessels
  - raise internal body temperature as needed
Protection

- Physical, chemical and biological barrier
  - tight cell junctions prevent bacterial invasion
  - lipids released retard evaporation
  - pigment protects somewhat against UV light
  - langerhans cells alert immune system

Cutaneous Sensations

- Touch, temperature, pressure, vibration, tickling and some pain sensations arise from the skin.

Excretion and Absorption

- Only a minor role is played by the skin
- 400 mL of water evaporates from it daily
- Small amounts salt, CO2, ammonia and urea are excreted
- Lipid soluble substances can be absorbed through the skin
  - vitamins A, D, E and K, Oxygen and CO2
  - acetone and dry-cleaning fluid, lead, mercury, arsenic, poisons in poison ivy and oak
Transdermal Drug Administration

- Method by which drugs in a patch enter the body
- Drug absorption most rapid in areas where skin is thin (scrotum, face and scalp)
- Examples
  - nitroglycerin (prevention of chest pain from coronary artery disease)
  - scopolamine (motion sickness)
  - nicotine (stop smoking alternative)

Synthesis of Vitamin D

- Sunlight activates a precursor to vitamin D
- Enzymes in the liver and kidneys transform that molecule into calcitriol (most active form of vitamin D)
- Necessary vitamin for absorption of calcium from food in the gastrointestinal tract

Development of the Skin

- Epidermis develops from ectodermal germ layer
- Dermis develops from mesodermal germ layer
  - at 8 weeks, fetal “skin” is simple cuboidal epithelium
  - nails begin to form at 10 weeks, but do not reach the fingertip until the 9th month
  - dermis forms from mesoderm by 11 weeks
  - by 16 weeks, all layers of the epidermis are present
  - oil and sweat glands form in 4th and 5th month
  - by 6th months, delicate fetal hair (lanugo) has formed
- Slippery coating of oil and sloughed off skin called vernix caseosa is present at birth
Age Related Structural Changes

- Collagen fibers decrease in number & stiffen
- Elastic fibers become less elastic
- Fibroblasts decrease in number
- Langerhans cells and macrophages decrease in number and become less-efficient phagocytes
- Oil glands shrink and the skin becomes dry
- Walls of blood vessels in dermis thicken so decreased nutrient availability leads to thinner skin as subcutaneous fat is lost

Photodamage

- Ultraviolet light (UVA and UVB) both damage the skin
- Acute overexposure causes sunburn
- DNA damage in epidermal cells can lead to skin cancer
- UVA produces oxygen free radicals that damage collagen and elastic fibers and lead to wrinkling of the skin

Skin Cancer

- 1 million cases diagnosed per year
- 3 common forms of skin cancer
  - basal cell carcinoma (rarely metastasize)
  - squamous cell carcinoma (may metastasize)
  - malignant melanomas (metastasize rapidly)
    - most common cancer in young women
    - arise from melanocytes — life threatening
    - key to treatment is early detection watch for changes in symmetry, border, color and size
    - risks factors include— skin color, sun exposure, family history, age and immunological status
**Burns**

- Destruction of proteins of the skin
  - chemicals, electricity, heat
- Problems that result
  - shock due to water, plasma and plasma protein loss
  - circulatory & kidney problems from loss of plasma
  - bacterial infection

**Types of Burns**

- First-degree
  - only epidermis (sunburn)
- Second-degree burn
  - destroys entire epidermis & part of dermis
  - fluid-filled blisters separate epidermis & dermis
  - epidermal derivatives are not damaged
  - heals without grafting in 3 to 4 weeks & may scar
- Third-degree or full-thickness
  - destroy epidermis, dermis & epidermal derivatives
  - damaged area is numb due to loss of sensory nerves

**Pressure Sores**

- Decubitus ulcers
- Caused by constant deficiency of blood flow to tissue
- Areas affected is skin over bony prominence in bedridden patients
- Preventable with proper care