Chapter 6
Integumentary System
Skin
The Integumentary System

• Functions of the skin and subcutaneous tissue
  – epidermis and dermis
  – hypodermis
  – thick and thin skin
  – skin color
  – skin markings
• Hair and nails
• Cutaneous glands
Overview

• Largest organ (15% of body weight)
• Epidermis
  – keratinized stratified squamous epithelium
• Dermis
  – connective tissue layer
• Hypodermis
  – Superficial fascia
• Thickness variable, normally 1-2 mm
Structure of the Skin
Functions of the Skin

- Resistance to infection, water loss-gain, ultraviolet light
- Vitamin D synthesis
- Sensory receptors
- Temperature regulation
- Nonverbal communication
Cell and Layers of the Epidermis

(a) Diagram showing different cells and structures in the epidermis:
- Exfoliating keratinocytes
- Dead keratinocytes
- Living keratinocytes
- Dendritic cell
- Tactile cell
- Stem cell
- Melanocyte
- Sensory nerve ending

(b) Micrograph of the epidermis showing:
- Friction ridges
- Stratum corneum
- Stratum lucidum
- Stratum granulosum
- Stratum spinosum
- Stratum basale
- Dermis
- Dermal papilla
Stratum Basale

- Single layer cells on basement membrane
- Cell types in this layer
  - keratinocytes
    - undergo mitosis to replace epidermis
  - melanocytes
    - distribute melanin through cell processes
    - melanin picked up by keratinocytes
  - merkel cells are touch receptors
    - form Merkel disc
Stratum Spinosum

• keratinocytes
  – appear spiny due to shrinkage during histological preparation
• dendritic (Langerhans) cells
  – macrophages from bone marrow that migrate to the epidermis
  – 800 cells/millimeter²
  – help protect body against pathogens by “presenting” them to the immune system
Stratum Granulosum

- 3 to 5 layers Flat keratinocytes
- Contain keratinohyalin granules
  - combine with filaments of cytoskeleton to form keratin
- Produces lipid-filled vesicles that release a glycolipid by exocytosis to waterproof the skin
  - forms a barrier between surface cells and deeper layers of the epidermis
  - cuts off surface strata from nutrient supply
Stratum Lucidum

- Thin translucent zone seen only in thick skin
- Keratinocytes are packed with eleidin, a precursor to keratin
  - does not stain well
- Cells have no nucleus or organelles
Stratum Corneum

- Up to 30 layers of dead, scaly, keratinized cells
  - surface cells flake off (exfoliate)
Life History of Keratinocytes

- Produced by stem cells in stratum basale
- New cells push others toward surface
  - cells grow flat and fill with vesicles
- Cells filled with keratin
  - forms water barrier
- Cells die and exfoliate
Dermis

- Thickness = 0.6mm to 3mm
- Composition
  - collagen, elastic and reticular fibers, fibroblasts
- Dermal papillae - extensions of the dermis into the epidermis
  - forming the ridges of the fingerprints
- Layers
  - papillary layer
  - reticular layer is deeper part of dermis
**Hypodermis**

- Subcutaneous tissue/ superficial fascia
- Mostly adipose
- Functions
  - energy reservoir
  - thermal insulation
- Hypodermic injections (subQ)
  - highly vascular
Skin Colors (Pigmentation)

- Hemoglobin = red pigment of red blood cells
- Carotene = yellow pigment
  - concentrates in stratum corneum and fat
- Melanin = yellow, brown, and black hues
  - pigment synthesis stimulated by UV radiation
Skin Markings

• Hemangiomas (birthmarks)
  – discolored skin caused by benign tumors of dermal blood capillaries (strawberry birthmarks disappear in childhood -- port wine birthmarks last for life)

• Freckles and moles = aggregations of melanocytes
  – freckles are flat; moles are elevated

• Friction ridges leave oily fingerprints on touched surfaces
  – unique pattern formed during fetal development

• Flexion creases form after birth by repeated closing of the hand

• Flexion lines form in wrist and elbow areas
Hair

• Hair (composed of hard keratin)
  – disulfide bridges between molecules

• Hair found everywhere except contact surfaces (hands, feet, genitals, nipples)
  – differences between sexes or individuals is difference in texture and color of hair

• 3 different body hair types
  – lanugo -- fine, unpigmented fetal hair
  – vellus -- fine, unpigmented hair of children and women
  – terminal hair -- coarse, long, pigmented hair of scalp
Structure of Hair and Follicle

- **Hair is filament of keratinized cells**
  - shaft = above skin; root = within follicle
  - in cross section: medulla, cortex and cuticle

- **Follicle is oblique tube within the skin**
  - bulb is where hair originates
  - vascular tissue (papilla) in bulb provides nutrients

- **Texture and shape of hair**
  - straight hair = round, wavy = oval

- **Hair color = pigment in cells of cortex**
Structure of Hair Follicle

- Epithelial root sheath
- Connective tissue root sheath
- Hair receptors entwine each follicle
- Piloerector muscle
  - goose bumps
Variations of Hair Follicle Size and Distribution in Different Body Sites

Nina Otberg, Heike Richter, Hans Schaefer, Ulrike Blume-Peytavi, Wolfram Sterry and Jürgen Lademann

*Journal of Investigative Dermatology* (2004) 122, 14–19
Hair Growth and Loss

• Hair cycle = 3 repeating cycles
  – anagen is growth stage (90% of scalp follicles)
    • lasts 6-8 years in young adult (sometimes longer)
    • Shorter (months) for other parts of body
  – catagen is shrinking follicle (lasts 2-3 weeks)
  – telogen is resting stage (lasts 1-3 months)

• Thinning or baldness = alopecia

• Pattern baldness = genetic and hormonal
  – sex-influenced trait (dominant in males, recessive in females); expressed only with high testosterone levels
Functions of Hair

• Body hair (too thin to provide warmth)
  – alert us to parasites crawling on skin
• Scalp hair
  – heat retention and sunburn cover
• Beard, pubic and axillary hair indicate sexual maturity and help distribute sexual scents
• Guard hairs and eyelashes
  – prevent foreign objects from getting into nostrils, ear canals or eyes
• Expression of emotions with eyebrows
Hair Color

- More eumelanin = darker
- More pheomelanin = lighter

Round = straight
Oval = curly
Nails

• Derivative of stratum corneum
  – densely packed cells filled with hard keratin
• Flat nails protect fleshy, sensitive fingertips
• Growth rate is 1 mm per week
  – new cells added by mitosis in the nail matrix
  – nail plate is visible part of nail
    • medical diagnosis of iron deficiency = concave nails
Nail bed  The skin on which the nail plate rests
Nail plate  The clear, keratinized portion of the nail
Root  The proximal end of a nail, underlying the nail fold
Body  The major portion of the nail plate, overlying the nail bed
Free edge  The portion of the nail plate that extends beyond the end of the digit
Hyponychiuma  The epithelium of the nail bed
Nail fold  The fold of skin around the margins of the nail plate
Nail groove  The groove where the nail fold meets the nail plate
Eponychiumb  Dead epidermis that covers the proximal end of the nail; commonly called the cuticle
Nail matrix  The growth zone (mitotic tissue) at the proximal end of the nail; corresponding to the stratum basale of the epidermis
Lunulec  The region at the base of the nail that appears as a small white crescent because it overlies a thick stratum basale that obscures dermal blood vessels from view

a hypo = under + onych = nail
b ep = above + onych = nail
c lun = moon + ule = little
(a) Apocrine
(b) Merocrine
(c) Sebaceous
Sweat Glands

• Filtrate of plasma and some waste products
  – 500 ml of insensible perspiration/day
  – sweating with visible wetness is diaphoresis

• Merocrine glands - simple tubular gland
  – millions of them help cool the body

• Apocrine glands produce sweat containing fatty acids
  – found only near hair follicles and respond to stress and sex
  – bromhidrosis is body odor produced by bacterial action on fatty acids
Sebaceous Glands

- Oily secretion called sebum that contains broken-down cells
  - lanolin in skin creams is sheep sebum
- Flask-shaped gland with duct that opens into hair follicle
Ceruminous Glands

• Found only in external ear canal
• Their secretion combines with sebum to produce earwax
  – waterproof keeps eardrum flexible
  – bitterness repel mites and other pests
Mammary Glands

• Breasts of both sexes rarely contain glands
  – secondary sexual characteristic of females
    • found only during lactation and pregnancy
      – modified apocrine sweat gland
      – thicker secretion released by ducts open on the nipple

• Mammary ridges or milk lines
  – 2 rows of mammary glands in most mammals
  – primates kept only anteriormost glands

• Additional nipples (polythelia)
  – may develop along milk line
Burns

• Hot water, sunlight, radiation, electric shock or acids and bases
• Death from fluid loss and infection
• Degrees of burns
  – 1st-degree = only the epidermis (red, painful and edema)
  – 2nd-degree = epidermis and part of dermis (blistered)
    • epidermis regenerates from hair follicles and sweat glands
  – 3rd-degree = epidermis, dermis and more is destroyed
    • often requires grafts or fibrosis and disfigurement may occur
UVA, UVB and Sunscreens

• UVA and UVB are improperly called “tanning rays” and “burning rays”
• Both thought to initiate skin cancer
• As sale of sunscreens has risen so has skin cancer
  – those who use have higher incidence of basal cell
  – chemical in sunscreen damage DNA and generate harmful free radicals
    • PABA, zinc oxide and titanium dioxide