Overview of the Integument

- Largest organ (15% of body weight)
- Surface area of 1.5-2 m²
- Composed of 2 layers
  - Epidermis - keratinized stratified squamous epithelium
  - Dermis - connective tissue layer
- Hypodermis - lies beneath skin
- Thickness variable, normally 1-2 mm
  - dermis may thicken, up to 6 mm

Functions of the Skin

- Protection against trauma, fluid loss, chemical attack, ultraviolet light, and infection
  - packed with keratin and linked by desmosomes
  - acid mantle (pH 4-6) - keeps bacteria in check
- Sensory receptor - detects touch, pressure, pain, temperature stimuli
- Maintenance of normal body temperature through insulation or evaporative cooling, as needed
- Synthesis of vitamin D3; converted to calcitriol, a hormone important to maintaining Ca²⁺ balance
- Excretion of salts, water, organic wastes
- Nonverbal communication - facial expressions
The Epidermis

- A keratinized stratified squamous epithelium
- Avascular; nourished by diffusion of nutrients from dermis
- Cells found in the epidermis include
  - Stem cells
    - undifferentiated cells in deepest layers
  - Keratinocytes — majority of the epidermal cells
  - Melanocytes
    - Synthesize pigment melanin that shields against UV
  - Tactile (Merkel) cells
    - receptor cells; detect light touch
  - Dendritic (Langerhans) cells
    - macrophages guard against pathogens

Layers of the Epidermis

- Stratum basale (stratum germinativum)
- Stratum spinosum
- Stratum granulosum
- Stratum lucidum (only in thick skin)
- Stratum corneum

Cell and Layers of the Epidermis

Stratum Basale = S. germinativum

- Deepest layer; single layer cells resting on basement membrane; attached to underlying dermis
- Cell types in this layer
  - Stem cells
    - Undergo mitosis to produce keratinocytes
  - Keratinocytes
    - Migrate toward skin surface and replace lost epidermal cells
  - Melanocytes
    - Synthesize and distribute melanin among keratinocytes
    - Keratinocytes accumulate melanin on their “sunny side”
    - Equal numbers in all races
      - Differences in skin color due to differences in rate of production and how clumped or spread out melanin is
  - Merkel cells are touch receptors
<table>
<thead>
<tr>
<th>Stratum Spinosum</th>
<th>Stratum Granulosum</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Several layers of keratinocytes (8-10 layers)</td>
<td>• 3 to 5 layers of flat keratinocytes; have stopped dividing</td>
</tr>
<tr>
<td>– appear ‘spiny’ due to shrinkage during histological preparation</td>
<td>• Contain keratinohyalin granules (hence its name)</td>
</tr>
<tr>
<td>– Begin to synthesize protein keratin which cause cells to flatten</td>
<td>– combine with filaments of cytoskeleton to form keratin (a tough fibrous protein)</td>
</tr>
<tr>
<td>– Bound to each other by desmosomes and tight junctions</td>
<td>• Major component of hair and nails</td>
</tr>
<tr>
<td>• Contains star-shaped Langerhans cells</td>
<td>• Keratinocytes also produce lipid-filled vesicles that release a glycolipid by exocytosis to waterproof the skin</td>
</tr>
<tr>
<td>– macrophages from bone marrow that migrate to the epidermis</td>
<td>– Glycolipid also forms a barrier between surface cells and deeper layers of the epidermis</td>
</tr>
<tr>
<td></td>
<td>• cuts off surface strata from nutrient supply; thus, upper layer cells quickly die</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stratum Lucidum</th>
<th>Stratum Corneum</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Thin translucent zone seen only in thick skin</td>
<td>• Up to 15-30 layers of dead, scaly, keratinized cells</td>
</tr>
<tr>
<td>• Keratinocytes are packed with keratin</td>
<td>– Keratinization (cornification) - formation of protective, superficial layers of cells filled with keratin</td>
</tr>
<tr>
<td>• Cells have no nucleus or organelles</td>
<td>– Occurs on all exposed skin surfaces except anterior surface of eyes</td>
</tr>
<tr>
<td></td>
<td>– Surface cells flake off (exfoliate/desquamate) in sheets because they are tightly interconnected by desmosomes</td>
</tr>
<tr>
<td></td>
<td>– 15-35 days required for a cell to move from S. basale to S. corneum</td>
</tr>
</tbody>
</table>
Stratum Corneum and Body Water

- S. corneum is water resistant but not waterproof
- Water from interstitial fluids penetrates the surface and evaporates into the air
  - known as *insensible perspiration* (500 ml/day = 1 pt.)
  - damage that breaks connections between superficial and deeper layers allows fluid to accumulate = blister
  - severe burns increase rate of insensible perspiration and lead to dangerous loss of excess fluid
- *Sensible perspiration* (that which you are aware of) produced by sweat glands.
- Immersion of skin in water (bath) may move water into or out of the epithelium
  - in salt water, water leaves, accelerating dehydration in those shipwrecked and in the water

Sensible perspiration

Epidermal Layers and Keratinization

Dermis

- Second major layer of the skin
  - A strong, flexible connective tissue
- Richly supplied with blood vessels and nerves
- Thickness varies = 0.6mm to 3mm
- Composition
  - Collagen, elastic and reticular fibers, fibroblasts
  - Give structural strength to skin
- Dermal papillae - extensions of the dermis into the epidermis
  - form the ridges of the fingerprints
- Layers - see next slide
  - Papillary layer - superficial layer; includes dermal papillae
  - Reticular layer - thicker (80%), deeper part of dermis

Thick and Thin Skin

- Thick skin
  - Has all 5 epithelial strata
  - Found in areas subject to pressure or friction
    - Palms of hands, fingertips, soles of feet
  - Fingerprints and footprints. Papillae of underlying dermis in parallel rows
- Thin skin
  - More flexible than thick skin
  - Covers rest of body
- Callus - increase in number of layers in stratum corneum. When this occurs over a bony prominence, a *corn* forms.
Dermis

- Two layers of the dermis
  - Papillary - Superficial layer; 20% of dermis
  - Areolar tissue with lots of elastic fibers.
  - Dermal papillae - Fingerlike extensions of dermis
    - Form ridges of the fingerprint
  - Capillary beds.
  - Touch receptors (Meissner’s), free nerve endings sensing pain
- Reticular: Deeper layer; 80% of dermis
  - Composed of dense irregular C.T.
  - Collagen and elastic fibers.
  - Stretching of skin (obesity, pregnancy) can tear collage fibers
    and produce striae (stretch marks)
  - Hair follicles, nerves, oil glands, ducts of sweat glands, other
    sensory receptors found here

Hypodermis

- Aka subcutaneous tissue, superficial fascia
- Mostly adipose tissue (some areolar)
  - Obesity due to accumulation of subcutaneous fat
  - About 8% thicker in women than men
- Functions:
  - Binds skin to underlying tissue
  - Energy reservoir (fat)
  - Thermal insulation
  - Padding/cushioning
- Hypodermic injections (subQ)
  - Highly vascular

Skin Color: Pigments

Determined by 3 factors:
1) pigments (melanin, Hb, carotene)
2) blood circulating through the skin
3) thickness of stratum corneum

- Pigments
  - Carotene: yellow pigment. Acquired from egg yolks and yellow and
    orange vegetables. Accumulates in stratum corneum, in adipose
    cells of dermis, and in hypodermis.
  - Melanin: provides for protection against UV light.
    - produced by melanocytes
    - derived from the amino acid tyrosine.
    - accumulates over nuclei of keratinocytes
    - amount in skin determined by heredity and light exposure
    - differences in pigmentation among individuals reflects levels of
      synthetic activity and NOT numbers of melanocytes
      - Even albinos have same number but no activity
    - Stimulated by UV exposure but not rapidly enough to protect against
      sunburn on first day

Abnormal Skin Colors

- Cyanosis = blueness from deficiency of oxygen in the
  circulating blood (cold weather)
- Erythema = redness due to dilated cutaneous vessels
  (anger, sunburn, embarrassment)
- Jaundice = yellowing of skin and sclera due to excess of
  bilirubin in blood (liver disease)
- Bronzing = golden-brown color of Addison disease
  (deficiency of glucocorticoid hormone)
- Pallor = pale color from lack of blood flow
- Albinism = a genetic lack of melanin
- Hematoma = a bruise (visible clotted blood)
Sebaceous (Oil) Glands

- Occur over entire body, except palms and soles
- Oily secretion (sebum)
  - Lanolin in skin creams is sheep sebum
  - Holocrine secretion – entire cell breaks up to form secretion
- Functions to collect dirt, soften and lubricate hair and skin
- Most empty into hair follicle
  - Exceptions: lips, meibomian glands of eyelids, genitalia

Sudoriferous (Sweat) Glands

- Widely distributed on body
- Sweat is a filtrate of plasma and some waste products
  - 500 ml of insensible perspiration/day
  - Sweating with visible wetness is diaphoresis
- Two major types
  - Merocrine or eccrine. Most common.
    - Open directly onto surface of skin. Have own pores.
    - Coiled part in dermis, duct exiting through epidermis.
    - Numerous in palms and soles. Absent from margin of lips, labia minora, tips of penis, and clitoris.
  - Apocrine glands produce sweat containing fatty acids
    - Confined to axillae, genitalia (external labia, scrotum), around anus.
    - Respond to stress and sex
    - Secretion: organic compounds that are odorless but, when acted upon by bacteria, may become odiferous.

Other Integumentary Glands

- Ceruminous glands: modified merocrine sweat glands
  - Located in external auditory meatus.
  - Ear wax (cerumen). Composed of a combination of sebum and secretion from ceruminous.
  - Function: In combination with hairs, prevent dirt and insects from entry. Also keep eardrum supple.
Mammary Glands

- Breasts and mammary glands not the same
  - Both sexes have breasts
  - In females, breasts are a secondary sexual characteristic
- Mammary gland is a milk-producing gland within the breast and only during lactation and pregnancy
- Mammary glands - is a modified apocrine sweat gland.
- Mammary ridges or milk lines
  - 2 rows of mammary glands in most mammals
  - Primates kept only anteriormost glands
- Additional nipples (polythelia - a sign of “witches”) may develop along milk line inferior to 1st mammae
- Gynecomastia - partial development in males

Characteristics of Human Hair

- Hair (composed of hard keratin)
  - HK is more compact than soft keratin (SK) which is type found in S. corneum
- Hair found almost everywhere
  - Lacking on soles, palms, toes, fingers, lips, nipples, parts of ext. genitalia, distal segment of fingers
  - 75% of the 2.5 million are on body surface, not head
- 3 different body hair types
  - Lanugo -- fine, unpigmented fetal hair
  - Vellus -- fine, unpigmented hair of children and women
  - Terminal hair -- coarser, longer, pigmented hair of scalp, eyebrows, axillary, and pubic regions

Structure of Hair and Follicle

- Hair is filament of keratinized cells; 3 zones
  - Bulb - swelling at base in dermis
  - Root - remainder of hair with follicle
  - Shaft - exposed portion above skin surface
- In cross section
  - Medulla - core of loosely arranged cells and air spaces
  - Cortex (bulk of hair) - densely packed keratinized cells
  - Cuticle (surface of hair) - single layer of scaly cells
- Follicle - an diagonal tube within the skin
  - Inner layer is an extension of the epidermis
  - Outer layer derived from dermis
  - Nerve fibers (hair receptors) encircle follicle; detect motion
  - Arrector pili muscles stimulate piloerection (goose bumps)
  - Bulb is where hair originates
  - Vascular tissue (papilla) in bulb provides nutrients
Hair Growth and Loss

- Hair growth
  - Due to mitosis of S. basale cells in epithelial root sheath
  - Scalp hair - grows 1 mm every 3 days (10-18 cm/yr)
    - Grows for 2-4 yrs, enters dormant stage (3-4 months)
    - Pushed out by new hair growing beneath it
    - Hairs of eyebrows and eyelashes grow for only 3-4 months
- Thinning or baldness = alopecia
- Pattern baldness - the loss of hair from only some regions of the scalp rather than thinning uniformly
  - genetic and hormonal
  - sex-influenced trait (dominant in males, recessive in females); expressed only with high testosterone levels
- Hirsutism = excessive hair growth in areas not normally hairy
  - hormone imbalance (ovary or adrenal cortex problem)

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 (in some guys, that is) 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

White hair = air in medulla and lack of pigment in cortex. Gray hair is a mixture of white and pigmented hairs. And frequently a sign of great wisdom!! :)

Hair Color and Texture, Gray and White
Fingernail Structure

Nails

- Derivative of stratum corneum
  - densely packed cells filled with hard keratin
- Flat nails allow for 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

Skin Cancer

- The three major types of skin cancer are:
  - Basal cell carcinoma
  - Squamous cell carcinoma
  - Melanoma

Basal Cell Carcinoma

- Least malignant and most common skin cancer
- Stratum basale cells proliferate and invade the dermis and hypodermis
- Slow growing and do not often metastasize
- Can be cured by surgical excision in 99% of the cases
Squamous Cell Carcinoma

- Arises from keratinocytes of stratum spinosum
- Arise most often on scalp, ears, and lower lip
- Grows rapidly and metastasizes if not removed; if to lymph nodes, can be fatal
- Prognosis is good if treated by radiation therapy or removed surgically

Melanoma

- Cancer of melanocytes is the most dangerous type of skin cancer because it is:
  - Highly metastatic
  - Resistant to chemotherapy
  - Result of oncogene BRAF in men
- ABCD - asymmetry, border irregular, color mixed, and diameter over 6 mm

Melanoma

- Melanomas have the following characteristics (ABCD rule)
  - A: Asymmetry; the two sides of the pigmented area do not match
  - B: Border is irregular and exhibits indentations
  - C: Color (pigmented area) is black, brown, tan, and sometimes red or blue
  - D: Diameter is larger than 6 mm (size of a pencil eraser)

Melanoma

- Treated by wide surgical excision accompanied by immunotherapy
- Chance of survival is poor if the lesion is over 4 mm thick
Burns

- First-degree – only the epidermis is damaged
  - Symptoms include localized redness, swelling, and pain
- Second-degree – epidermis and upper regions of dermis are damaged
  - Symptoms mimic first degree burns, but blisters also appear
- Third-degree – entire thickness of the skin is damaged
  - Burned area appears gray-white, cherry red, or black; there is no initial edema or pain (since nerve endings are destroyed)
- Treatment - IV nutrition and fluid replacement, debridement, and infection control

Rule of Nines

- Estimates the severity of burns
- Burns considered critical if:
  - Over 25% of the body has second-degree burns
  - Over 10% of the body has third-degree burns
  - There are third-degree burns on face, hands, or feet

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

Rule of Nines
Developmental Aspects of the Integument: Old Age

- Epidermal replacement of cells slows and skin becomes thinner
- Skin becomes dry and itchy
- Subcutaneous fat layer diminishes, leading to intolerance of cold
- Decreased elasticity and loss of subcutaneous tissue leads to wrinkles
- Decreased numbers of melanocytes and Langerhans’ cells increase the risk of skin cancer
- Decrease in blood supply causes poor ability to regulate body temperature
- Functioning melanocytes decrease or increase; age spots