4.1 Overview

- Integument — skin — more than a covering that holds your guts in place!

- Integumentary system — complex tissues and cells that play critical roles in maintaining the body’s homeostasis
  - Largest organ system of body
  - Composed of blood vessels, CT structures, glands, hair, nails, nerves, and skin

- Skin is organized according to genetic programming
  - Inherent — inborn features
  - Adaptive - enviromic features
Skin’s adaptations

- Calluses – in response to walking barefeet
  - Protects underlying tissues

- Suntan – skin darkens with regular exposure to sun
  - Prevents sun from damaging sensitive cells underneath

- Stretching – skin stretches as body grows to keep it from tearing
  - Can also shrink…

- Skin prefers temperatures above freezing, not comfortable with too much heat
The Integumentary System

- Also includes mucous membranes (lubricated inner linings that secrete mucus) near the anus, mouth, nose, and reproductive tract
- Starts 4 to 5 weeks after an egg has been fertilized
- Develops from ectoderm and mesoderm
- **Mesenchyme** – embryonic CT composed of star-shaped cells in the gel-like matrix
  - About 8 to 9 weeks
- **Fibroblasts** – cell that secretes proteins that form collagen and elastin fibers
  - Within matrix- develop from mesenchyme cells
- **Lanugo** – temporary, fine body hair on babies
- **Angiogenic factor** – secretion that helps develop blood vessels
  - Angiogenesis - Formation of blood vessels
The Integumentary System, cont.

- Pigmentation – ability to produce skin coloration
- Melanoblasts – cell that develop into a melanocyte and produce pigment
  - Melanocytes – pigment-producing cells
    - Pigments produce a certain color when exposed to light
Skin Structure

- At time of birth, skin matures into 3 distinct layers
  - **Epidermis** – outermost layer
    - Composed of stratified squamous epithelium that continually regenerates itself
    - Derived from embryonic ectoderm layer
  - **Dermis** – true skin layer
    - Formed from mesenchyme cells
  - **Hypodermis**, or subcutaneous layer – innermost layer of skin
    - Last to form, derived from other body regions
Epidermis

- Older cells are nearest outside
  - Inner cells are metabolically active cells usually undergoing mitosis

- Stratum basale – innermost layer of epidermis
  - Aka stratum germinativum
  - Takes 60 to 75 days for cells in this layer to reach the surface

- Dermal papillae – ridged layer of dermis that is tightly bound to the stratum basale

- Malphigian layer – layer of epidermis containing melanocytes
  - Melanocytes secrete a black-to-brown chemical called melanin
    - Melanin – gives skin its color
    - Made from melanosomes
Epidermis, cont.

- **Stratum spinosum**, or prickly layer – appear spiny
  - Contain cells (Langerhans cells) important in fighting skin infections and healing injured skin

- **Stratum granulosum** – middle layer of epidermis
  - Contains keratin – yellow sulfur-rich protein that gives skin its strength
    - Keratocytes – cells that contain keratin
      - Sulfur – gives burning fur, hair, and leather foul smell
      - Also produce waterproofing feature (glycolipid)

- **Stratum compactum** – single layer of waterproofing cells
  - In areas of thick skin, you will find...
    - Stratum lucidum – breakable layer of skin

- **Stratum corneum** – outmost layer of epidermis
  - Composed of dead, flattened cells that regularly shed (desquamation)
Dermis

- Thick layer of CT attached to the stratum germinativum by hemidesmosomes along the dermal papilla
  - Hemidesmosomes – specialized junction between an epithelial cell and the basement membrane
- Areolar CT – binds blood vessels, membranes, muscles, nerves, and skin to other structure
- Fibroblasts – secrete meshwork of protein fibers
  - Involved in body growth, CT maintenance, and wound healing
  - Used for artificial tissues for transplantation (have been grown in cultures)
Subcutaneous Layer (hypodermis)

- Makes up 3rd and innermost layer of skin
- Thickness and composition vary
- Absent or very thin in the eyelids, penis, scrotum, and nipples
  - Responsible for increase in size of females breasts and hips
- Fascia – fibrous tissue covering muscles, the skin, and some organs
- Adipose tissue – fat cells (large amounts)
  - Thickness is measured as indirect indicator of body fat
- Fasciitis – inflammation of the fascia
  - Caused by microbes
4.2 Skin Appendages

- Skin appendages are any complex structure that assists the skin with its functions
  - Some are expelled cells of epidermis, others are modifications of epidermis
  - Most develop from dermis and subcutaneous layers and migrate during embryological development

- Examples
  - Glands,
  - Nerves
  - Nails
  - Hair
Glands

- 3 types
  - Ceruminous glands
  - Sebaceous glands
  - Sweat glands
Ceruminous Glands

- Produce waxy secretion called cerumen
- Large, found in the thin lining of ear canal
- Openings usually surrounded by small hairs
- Produce apocrine secretion called ear wax
Sebaceous Glands

- Are holocrine glands – secrete whole dead cells
- Produce and store an abundance of fat along with membranous organelles
- Once these cells are secreted in gland ducts, they burst open and die
  - This releases fats onto the surface of the skin in an oily secretion called sebum
  - Secrete sebum into hair follicles or hair bulb (inward protrusion of epidermis)
    - Then moves to surface of skin
Sebaceous Gland

- Hair
- Sebum
- Sebaceous gland
- Follicle

Normal Hair Follicle
Sweat Glands

- Categorized into apocrine sweat glands and eccrine sweat glands
- Apocrine = secrete odorous, sweatlike material into hair follicles of armpits, navel, groin region, and areolae
  - Inactive until puberty and taper off in elderly people
  - Secretion contains pheromones, play role in courtship and social behavior
- Eccrine = mostly on skin of armpits, forehead, palms, and soles
  - Composed primarily of salts, organic compounds, and wastes, including urea
  - Microbes feed off eccrine sweat, producing odor
Aprocrine – directly into hair follicle
Eccrine – directly connects to outside of skin
Nerves

- Sensory receptors = specialized nerve cells which are critical for skin to communicate information from environment to body
- Sensory receptors are found in all layers of skin
  - Mostly in innermost regions and in the fascia
- Free nerve endings – pain-sensing nervous found in lower part of epidermis
- Merkel cells – sensitive to gentle physical sensations
  - Most numerous in places of high sensitivity – i.e. fingertips
- Tactile corpuscles, or Meissner’s corpuscles – found in dermal papilla of dermis, respond to touch from pressure
Nerves, cont.

- Lamellated corpuscles, or Pacinian corpuscles – respond to hard pressure, including vibrations
- Ruffini receptors – respond to pressure or constant touch
- Krause end bulbs – found in mouth, respond to touch
Nails

- = keratin secretion

- Grows forward from nail root that lies beneath an area called the skin-nail fold
  - Grows from root..

- Nails will grow back if nail root and skin-nail fold are not severely damaged

- Nail root, or matrix is formed when cells closest to the surface die, flatten, and press tightly together
  - As they accumulate, they push the nail forward

- Lanula – white, half moon shape at base of nail body

- Nail plate – pink area underneath nail body

- Cuticle – outgrowth of skin-nail fold
Nail

- Nail root
- Cuticle
- Nail matrix
- Nail plate
- Hyponychium
- Distal edge of nail plate
- Nail bed
- Distal edge of nail plate
- Nail plate or nail body
- Lanula
- Cuticle
Hair

- Modified stratum corneum formed by an inward protrusion of epidermis called the hair follicle, or hair bulb
  - Each strand grows from an individual follicle buried in subcutaneous layer
- Hair papilla = base of hair follicle
  - Has small blood vessels and a nerve
- Hair shaft = dead, hardened cells protruding from the skin – main part of hair structure
  - Hair shaft is composed of 2 distinct cylindrical regions
    - Hair cortex & hair cuticle
- Hair medulla = inside cortex, inner layer of hair shaft
- Keratin gives a yellowish color to hair
- Melanocytes secrete red, brown, and black pigmentation seen in hair
  - Differences in hair color is due to amount and location of melanin deposited
    - Genetically controlled
Hair Cycle

- Mitosis cycle of hair follicle
- Newly formed hair cells move up in the follicle as newer cells develop beneath them
- Hairs have 2 accessory structures
  - Sebaceous gland
  - Arrector pili muscle – smooth band of muscles that holds hair erect
    - Vellus hair – fine body hair
      - Sensitive tough receptor – goose bumps!
- Terminal hair – hair of the head
- Pubic hair – hair around genitals
- DNA, mitochondria, drugs, and poisons can be found in hair
4.3 Functions of the Integumentary System

- Four functions, in order of magnitude:
  - Protection
  - Heat regulation
  - Sensation
  - Waste excretion
Protection

- Barrier against chemical, mechanical, and microbial damage
  - Chemical – any damage due to any chemical, even water, that breaks down cells
    - Sweat – dilutes potentially hazardous chemicals
    - Cerumen & sebum – act as oily barriers – repel water
      - Also prevents heat from escaping
  - Mechanical – any type of force that can compress, erode, stretch, or tear skin
  - Microbial – produce destructive secretions
    - Commensals – beneficial bacteria found on the skin
Heat Regulation

- Special network of blood vessels in the skin expands or contracts according to internal body temperature
  - Work like an air conditioner - transferring heat from blood to environment
    - Blood flow to skin increases when body is warm
    - Supply diminishes when body is cold to retain heat
- Adipose tissue – natural blanket that keeps body from losing too much heat
Sensation

- Sensory nerves in skin convert stimuli into signals that tell the brain about environmental conditions or hazards.
- Permit skin to detect cold, heat, injury, pressure, stretching, and touch.
- Transducer – nerve cell that converts environmental stimuli into body signals.
Waste Excretion

- Handled primarily by eccrine sweat glands
- Excrete waste, such as urea, organic chemicals, and excess salts
Burns

- Are of the common ways the skin loses its ability to maintain homeostasis locally and for the whole body
  - Exposure to sunlight and cooking accidents make up majority of burns
- Acids, bases, corrosive chemicals, electricity, fires, and steams rooms are other sources of burns
Degrees of Burns

- Based on extent of skin damage
  - First-degree burns
    - Involve superficial damage that causes reddening and swelling of the skin
    - Usually only outer layers of epidermis are damaged
  - Second-degree burns
    - Refers to damage to the stratum spinosum and stratum basale
    - Blisters, reddening, swelling, and fluid buildup are good indicators
  - Third-degree burns
    - Entire epidermis is charred or missing
    - Stratum basale not available to heat open wound
    - Can be fatal – makes you susceptible to dehydration, loss of body heat, and infection.
4.4 Pathologies

- Degenerative
- Genetic
- Infectious
Degenerative

- Solar lentigene — a type of freckling
  - Usually appear in your 30s, people who overexpose skin to sunlight or tanning beds
- Dermatitis — skin inflammation caused by allergic reaction or contact with an irritant
  - Cosmetics, facial cleansers, and toners can produce scaling skin and accelerate skin aging
- Skin cancer — has underlying genetic component
  - Precancerous cells — have potential to become cancerous under certain conditions
    - If damaged, can produce abnormal divisions = cancer
Dermatitis
Degenerative, cont.

- Tumors not associated with cancer
  - Moles — heavily pigmented squamous tumor cells
    - Can lead to skin cancer
  - Skin tags — soft, colored, knob-shaped tumors that grow from skin
    - Usually occur on the neck, armpits, and body, and easily removed by minor surgery
  - Seborrhoeic keratosis — black to brown growth on the face or body
    - Crease a greasy, rough appearance — generally removed for cosmetic reasons
  - Sebaceous hyperplasia — disorder that affects oil glands
  - Syringomas — tumors that form in sweat glands
    - Painless, mostly on cheeks and eyelids
  - Lipomas — tumors in fat cells
Sebaceous hyperplasia

Syringomas

Lipomas

Skin Tag

Seborrhoeic keratosis

Seborrhoeic keratosis
Not this kind of mole, but isn’t it cute?
Moles

- Signs of cancer
  - Asymmetry — one half unlike the other
  - Border irregularity — scalloped edges
  - Color variation — shades of tan, brown, and black
  - Diameter — larger than a pencil
# Skin Cancer

<table>
<thead>
<tr>
<th>Normal Mole</th>
<th>Melanoma</th>
<th>Sign</th>
<th>Characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="Image" alt="Normal Mole Image" /></td>
<td><img src="Image" alt="Melanoma Image" /></td>
<td>Asymmetry</td>
<td>when half of the mole does not match the other half</td>
</tr>
<tr>
<td><img src="Image" alt="Normal Mole Image" /></td>
<td><img src="Image" alt="Melanoma Image" /></td>
<td>Border</td>
<td>when the border (edges) of the mole are ragged or irregular</td>
</tr>
<tr>
<td><img src="Image" alt="Normal Mole Image" /></td>
<td><img src="Image" alt="Melanoma Image" /></td>
<td>Color</td>
<td>when the color of the mole varies throughout</td>
</tr>
<tr>
<td><img src="Image" alt="Normal Mole Image" /></td>
<td><img src="Image" alt="Melanoma Image" /></td>
<td>Diameter</td>
<td>if the mole’s diameter is larger than a pencil’s eraser</td>
</tr>
</tbody>
</table>

*Photographs Used By Permission: National Cancer Institute*
Genetic Skin Disorders

- **Acne** — most common skin disorder that has strong genetic component, overproduction of sebum
  - Consists of cysts, or nodules including blackheads, pimples, red spots, whiteheads, and sometimes lesions

- **Boil, or furuncle** — inflammation of hair follicles resulting in buildup of dead cells and blood components

- **Psoriasis** — inflammatory skin disease accompanied by an increase in skin cell production
  - Causes buildup of thick scales on the skin — it is painful, itchy, and unsightly
Boil, or furuncle

Acne

Psoriasis
Genetic Skin Disorders, cont.

- Birthmark disorders
  - Port wine stains – red – looks like red wine spilled on the skin, affects only 1% of American population
    - Over the years, gets larger and darker – can cause skin disfigurement
  - Spider veins – enlarged blood vessels, doesn’t cause problems, but can be unattractive
  - Strawberry hemangiomas – caused by enlarged blood vessels
    - Grow rapidly after birth. Typically disappears by age 6, produce no complications unless they bleed or around the eyes and mouth
Strawberry Hemangiomas

Spider Veins

Port Wine Staine
Genetic Skin Disorders, cont.

- Vitiligo — results in white patches on the skin
  - made famous by Michael Jackson — no one really knows if he had it
  - Hypopigmentation — decreases in melanin production that causes white spots
  - Could be autoimmune attack on melanocytes

- Albinism — lack of melanin production in the eyes, skin, and hair

- Melasma — results in brown patches on the face
  - Notably on the cheeks, upper lips, nose and chin
Infectious Skin Disorders (bacterial)

Most common bacterial skin infection is caused by *Staphylococcus aureus* (S. aureus)

- Erodes and inflames skin
- Four most common conditions
  - Boils
  - Folliculitis – inflammation of hair follicles
  - Impetigo – rash occurring in childhood
  - Staphylococcal scalded skin syndrome (SSSS) – potentially fatal, shedding and swelling of the skin
Infectious Skin Disorders (fungal)

- *Candida albicans* (C. albicans) – AKA monilia – can spread to skin and nails when immune system is weakened
  - Cause mild to severe inflammation
- Dermatophytes – eat hair, nails, and outer layers of epidermis
  - Causes itching, hair loss, and deformation of the nails
  - Ringworm, or tinea, - usually contracted from furry pets, can spread by bodily contact
    - Related to “jock itch” and “athlete’s foot”
Infectious Skin Disorders (viral)

- Warts – about 60 types
  - Human papilloma virus (HPV) – common skin wart
    - Incurable, treated with a removal strategy
Infectious Skin Disorders (via animals)

- Follicle mice or demodex — arthropod that causes an inflammation of the eyelash follicles
  - Usually live undetected until they accidently contribute to infections of the eyelash
  - Usually not harmful to humans, could kill a dog

- Lice — blood-sucking insects that spread infection as they feed

- Both treated with pesticides