THE INTEGUMENTARY SYSTEM

Epidermis

Dermis

Hypodermis
• How many times have you looked in the mirror only to see a pimple, rash, wrinkle, or unwanted hair?

• No other organ in the body is so scrutinized, scrubbed, lifted, and painted over as the skin.

• Yet, year after year, the skin withstands the effects of harsh weather, burning rays of the sun, constant bathing, friction, injury, and microorganisms that are constantly trying to penetrate its surface.
Integumentary System

- The skin and the accessory structures (sweat glands, hair, nails) form the **INTEGUMENTARY SYSTEM**

- The integumentary system performs many roles, most of which protect the body from harm or act as a barrier against the external environment.
Basic Functions

1. Protection
   - Mechanical damage
   - Chemical damage
   - Thermal damage
   - UV damage
Functions cont.

2. Heat loss or retention
   – Loss: activates sweat glands and dilates capillaries
   – Retention: not allowing blood to flow to skin capillaries

3. Excretion
   – uric acid and urea
   – Salts and water
Basic Functions cont.

4. Vitamin D
   - Cholesterol plus sunlight
   - Lack of vitamin D effects bones and moods (depression)
New recommendations

15 minutes of unprotected sun per day
5. Dessication
   – Waterproofing
   – Drying out
Structures of the Skin

• The skin is the **CUTANEOUS MEMBRANE**

• It is considered an ORGAN (remember…an organ is 2 or more kinds of tissues grouped together to perform a particular function)

• The skin has 3 layers of tissue:
  – **EPIDERMIS**
  – **DERMIS**
  – **HYPODERMIS**
Epidermis

- The thin outer layer of the skin
- Composed of stratified squamous epithelium
Stratified Squamous Epithelium
Epidermis con’t

- Avascular (it has NO blood supply)
- Oxygen and nutrients supplied from the dermis underneath
- 5 layers called strata (stratums)
  - Stratum basale
    - Deepest layer
    - Only layer that receives nourishment from dermis
    - Daughter cells pushed upward
Strata cont.

- Stratum spinosum
- Stratum granulosum
- Stratum lucidum
  - Occurs only where skin is hairless & extra thick
  - Palms and soles of feet
- Stratum corneum

- Each layer the cells get flatter and more filled with keratin. As cells fill with keratin, they die.
Stratum corneum

- Top 20-30 layers
- *Cornified* or *horny* cells filled with keratin
- Shingled dead cells
- New epidermis every 25-45 days
Keratinocytes: produce keratin

- Keratin hardens and flattens cells as they move toward the outer surface of the skin.
- It waterproofs the skin so that it neither absorbs nor loses much water.
Melanocytes: cells that produce pigment
Homeostatic Imbalances

- **callus**
  - a response to excess pressure or irritation
  - the rate of mitosis increases in the stratum basale, creating a thicker epidermis
• **blister**
  
  - Separation between the epidermis and the dermis.
  - Constant rubbing or irritation (burn), some plasma leaks from the blood vessels into the dermis and accumulates.
• **wart**
  – an epidermal growth on the skin caused by the invasion of a virus
• hives
  – raised areas of the skin, due to allergies
• **Necrotizing fasciitis:**
  “flesh eating bacterium”
  – Caused by *Streptococcus Group A*
Dermis

- Located under the epidermis
- Thicker than the epidermis
- Composed of dense fibrous connective tissue
Dermis con’t

• The fibers make the dermis strong and stretchable (“hide”)
  – Collagen fibers
    • Hydrates skin by binding water
  – Elastic fibers
    • Elasticity

• Aging: sagging and wrinkles
  – Decreased number of collagen and elastic fibers
  – Subcutaneous tissue loses fat
Skin with decreased turgor remains elevated after being pulled up and released.
• The thickness of the epidermis and dermis varies according to the location in the body
• Example – your palms and the bottoms of your feet have much thicker layers of skin than your eyelids and underarms
2 major regions of the Dermis

- Papillary
  - Upper region
  - Dermal papillae: finger-like projections on superior surface
  - Pain & touch receptors
Dermal Papillae cont.

- Definite patterns on hands and feet in increase friction and gripping ability
- Genetically determined (fingerprints)
Reticular layer of dermis

- Deepest layer
- Contains blood vessels, sweat & oil glands
- Deep pressure receptors
- Phagocytes
Homeostatic Imbalance

- Decubitus ulcer
  - Weight of body puts pressure on skin over bony projections
  - Restricts blood flow
  - Cells die & ulcer forms
Subcutaneous Layer

- The dermis lies on top of the subcutaneous layer
- Also called the hypodermis
- Composed of adipose tissue (fat) and loose connective tissue
• Subcutaneous Layer performs 2 main roles:
  1. helps insulate the body from extreme temperature changes in the external environment
  2. anchors the skin to the underlying structures
• A few areas of the body have no subcutaneous layer; the skin is anchored directly to the bone

• An example is the skin over your knuckles – it is wrinkled and creased because it is directly connected to your bones.

• Imagine what we would look like if all of our skin was attached directly to bone!!
Skin Color

• Why are there different colors of skin?
• Skin color is determined by many factors:
  1. genetic
  2. physiologic
  3. disease
• Skin pigments are genetically determined
• Deep within the stratum basale layer of the skin are cells called MELANOCYTES
• Melanocytes secrete a skin-darkening pigment called MELANIN
• Melanin can be yellow, brown or black
Melanocytes

Epithelial cell
Melanocyte
Melanosomes
Nucleus
Golgi apparatus
• The melanin stains the surrounding cells, causing them to darken

• The more melanin secreted, the darker the skin color

• Every person has the SAME NUMBER of melanocytes

• What determines our skin color is not the numbers of melanocytes, but the AMOUNT OF MELANIN SECRETED
- Sun exposure stimulates melanin production
- Melanocytes form an umbrella to shield other cell’s DNA from UV radiation
Too much sun

– Elastic fibers clump (leathery skin)
Too much sun cont.

- Depresses immune system
  - Herpes simplex I eruption
Problems with Melanocytes

- If the melanocytes completely fail to secrete melanin – the condition is known as ALBINISM.

- In these people, the skin, hair, and the colored part of the eye (iris) are white.

- In a condition known as VITILIGO, there is a loss of melanin in scattered areas of the body, leaving patches of white.
Albinism and Vitiligo
• When melanin stains unevenly, you get freckles and moles

• Moles are a normal occurrence; most people have 10 – 20 moles

• Unfortunately, a mole may undergo malignant (cancerous) change, forming MALIGNANT MELANOMA
In addition to melanin, skin also contains a yellow pigment called **CAROTENE**.

The yellowish tint of carotene in most people is hidden by the effects of melanin.

People of Asian descent have little melanin in their skin, the carotene gives their skin a yellow tint.
Why are fair-skinned people so pink??

- Fair-skinned people produce so little melanin, you can actually see some of the dermis layer.

- Since the dermis layer is rich in blood vessels, the blood actually gives the skin a pinkish tint.
Homeostatic Imbalances

- Cyanosis
  - Blue
  - Decreased oxygen in hemoglobin
  - Heart failure
  - Breathing disorders
Homeostatic Imbalances cont.

• Erythema
  – Blushing (blood vessels dilate)
  – Fever
  – High blood pressure
  – Inflammation
“He was white as a sheet”

- Pallor: pale skin
  - Stress or scared. (a constriction of the blood vessels, decreasing
  - Anemia
  - Low blood flow
Homeostatic Imbalances cont.

- Jaundice
  - Excess bile pigment deposited in skin
  - Liver disorder
  - Blood incompatibility between mom and baby
Homeostatic Imbalances

- Hematoma
  - Blood deposited in skin
  - Deficiency in vitamin C
Hair

- Body hair is considered a vestigial organ
- Like furry pets, we depended on a thick crop of hair to keep us warm
Hairless areas on our bodies: palms of hands, soles of feet, lips, nipples, parts of the external reproductive organs
• In some areas, hair performs important functions

• Eyelashes and eyebrows protect eyes from dust and perspiration

• Nasal hairs trap dust and prevent it from being inhaled into the lungs

• Hair on the scalp helps keep us warm
Chief Parts of Hair

• **Shaft** – the part above the surface of the skin

• **Root** – the part that extends from the dermis to the surface

• Each hair arises from a group of epidermal cells that penetrate, or project down, into the dermis, forming a **hair follicle**
• The epidermal cells at the base of the hair follicle receive a rich supply of blood from the dermal blood vessels.

• As these cells divide and grow, the older cells are pushed toward the surface of the skin.

• As the cells move away from the blood supply, they die.
The cells become keratinized, like other skin cells

The hair that we brush, blow dry, and curl every day is a collection of dead keratinized cells
Hair Color

- Hair color is genetically controlled and is determined by the type and amount of melanin.

- An abundance of melanin produces dark hair; less melanin produces blonde hair.

- With age, melanocytes become less active, producing less melanin – the absence of melanin produces white hair.
• Interesting thing about red hair....

• It is due to a modified type of melanin that contains the element iron!
Hair Types

- The shape of the hair is determined by the shaft

- **Straight hair** – round shaft
- **Wavy hair** – oval shaft
- **Curly and kinky** – flat shaft
How does hair stand up on end?

- Attached to each hair follicle is a bundle of smooth muscle cells called the **ARRECTOR PILI**.

- When cats are frightened, these muscles contract, pulling the hair in an upright position.
• When humans get cold or scared, the arrector pili muscles contract, hair stands on end causing goose bumps.

• This response to cold is called shivering which increases heat production.
Nails

- Nails are thin plates of stratified squamous epithelial cells that contain a very hard form of keratin

- Nails are found on the distal ends of fingers and toes

- Their purpose is to protect these structures from injury
Nail Structure

- **Free edge** – at the tip, not attached to the skin
- **Nail body** – fingernail, attached to skin
- **Nail root** – where the cells of the nail develop and are keratinized
• As the nail grows, it slides over a layer called a nailbed, a part of the epidermis.

• The pink color of nails is due to the blood vessels in the underlying dermal layer beneath the nail.

• The cuticle is a fold of the stratum corneum.
Nails

Diagram showing the structure of nails, including:
- Free edge
- Nail body
- Lunula
- Eponychium (cuticle)
- Nail root
- Eponychium
- Nail root (under the skin)
- Nail matrix
- Bone
- Nail bed
- Epidermis
Glands

- 2 major exocrine glands (secretes substances into a duct that leads to the outside of the body):
  - SEBACEOUS glands (oil glands) – associated with hair follicles and are found in all areas of the body that have hair
  - They secrete an oily substance called SEBUM that flows into the hair follicle and then out onto the surface of the skin
• The sebum lubricates and helps waterproof the hair and skin

• The sebum also inhibits (prevents) the growth of bacteria on the skin

• With aging, sebum production gradually decreases, which accounts for the brittle hair and dry skin seen in older persons
Homeostatic Imbalance

• Acne vulgaris
  – Active infection of the sebaceous glands
  – Whitehead: sebaceous duct blocked by sebum
  – Blackhead: sebum oxidizes and dries
Homeostatic Imbalances cont.

- Seborrhea
  - Cradle cap
  - Overactive sebaceous glands
• SUDORIFEROUS GLANDS (sweat glands) – located in the dermis and the subcutaneous layer

• Found in all regions of the skin and are particularly abundant in the palms and soles

• These glands secrete sweat

• An individual has about 3 million sweat glands!!

• There are 2 types of sweat glands – apocrine and eccrine glands
Apocrine Glands

• Associated with hair follicles

• Found in the axillary and genital areas

• They respond to stress and become active when a person is frightened, upset, in pain, or sexually excited

• Since the development of these glands is stimulated by sex hormones, they become more active during puberty
• The sweat produced by these glands does NOT have a strong odor….

• But….if allowed to accumulate on the skin by not bathing, bacteria starts to break down the sweat into chemicals that have a STRONG odor

• This is why we use deodorants
Eccrine Glands

- Are the more numerous and widely distributed sweat glands

- Located throughout the body, but are especially numerous on the forehead, upper lip, palms, and soles

- They are NOT associated with hair follicles
• The sweat produced by eccrine glands plays an important role in temperature regulation

• As sweat evaporates from the skin surface, it takes the body’s heat with it, cooling the body

• These are the glands that make you sweat profusely on hot days or during strenuous exercise
Unlike apocrine glands, which become active during puberty, the eccrine glands function throughout your entire lifetime.

A person must have the ability to sweat to maintain proper body temperature.
Glands of the skin

- Sweat pores
- Duct
- Arrector pili (smooth muscle)
- Sebaceous gland
- Merocrine sweat gland
- Apocrine sweat gland
- Hair follicle
- Hair bulb
Regulation of Body Temperature

- Heat is a form of energy (thermal) and is produced by the millions of chemical reactions occurring in the cells of the body (metabolism).

- The heat produced by metabolizing cells causes body temperature.

- Regulated by the hypothalamus in the brain.
• The body constantly produces heat and constantly loses heat

• Most of the heat loss (80%) occurs through the skin

• The other 20% is by the lungs and excretory products (urine and feces)
• Normal body temperature ranges between 97°F and 100°F, with an average of 98.6°F

• A higher-than-normal body temperature is called HYPERThERMIA or a FEVER, usually accompanied by an infection

• A lower-than-normal body temperature is called HYPOThERMIA and is most likely to develop when a person is exposed to cold environmental temperatures
More Homeostatic Imbalances

• Athlete’s foot
  – Fungus infection
  – Itchy, red, peeling skin between toes
• Impetigo
  – Water-filled lesions that develop a yellow crust
  – Bacterial infection
  – Highly contagious
Burns

- Tissue damage and cell death due to heat, electricity, UV radiation or chemicals
- May be life threatening
- Dehydration & electrolyte imbalance most concern for the first 24 hours
- Infection after that
Rule of Nines

• Divides body into 11 areas, each accounting for 9% of total body surface (plus additional 1% for genitals)
• Used to measure how much body surface is burned
• Can calculate amount of fluid lost
Classified according to severity

- First degree
  - Epidermis damaged
  - Sunburn
• Second degree
  – Epidermis & upper dermis damaged
  – Blisters
  – Rarely scarring
• Third degree
  – Destroys entire thickness of skin
  – Blackened or blanched skin
  – Nerve endings destroyed
  – Regeneration not possible
  – Skin grafting necessary
Burns are critical if

- 25% of body has second degree burns
- 10% of body has third degree burns
- Third degree burns of face, hands, or feet
UV Light

- UVA - aging
- UVB – carcinogen
Skin Cancer

- Risks: UV radiation, infections, chemical or physical trauma
- Three types
  - Basal cell carcinoma
  - Squamous cell carcinoma
  - Malignant melanoma
Basal cell carcinoma

- Cells of stratum basale altered so they cannot form keratin
- Proliferate & invade dermis and hypodermis
- Sun-exposed areas of face
- 99% cure
Squamous cell carcinoma

- Cells of stratum spinosum
- Most often on scalp, ears, hands & lips
- Grows fast & metastasizes to lymph nodes
- Sun induced
- Prognosis is good if caught early
Malignant Melanoma

- Cancer of melanocytes
- A previously smooth mole that becomes darker and develops a rough or notched edge
- Metastasizes very rapidly making it very difficult to treat (50% survival rate)
- Exposure to sunlight increases the risk of malignant melanoma
Malignant melanoma
ABCD Rule

- Asymmetry: 2 sides of pigmented spot do not match
- Border irregularity: borders of the lesion exhibit indentations
- Color: different colors in a pigmented area
- Diameter: larger than 6mm (pencil eraser)