THE INTEGUMENTARY SYSTEM

- Skin and subcutaneous tissue
- Functions of the skin
- Epidermis and dermis
- Hypodermis
- Thick and thin skin
- Skin color
- Skin markings
- Hair and nails
- Cutaneous glands
- Skin disorders

SKIN AND SUBCUTANEOUS TISSUE

- The body’s largest and heaviest organ
  - Covers an area of 1.5-2.0 m²
  - 15% of body weight
- Consists of two layers:
  - Epidermis – stratified squamous epithelium
  - Dermis – connective tissue layer
- Hypodermis – another connective tissue layer below the dermis
- Most skin is 1-2 mm thick
- Ranges from 0.5 mm on eyelids to 6 mm between shoulder blades
- Thick skin – on palms and soles, and corresponding surfaces on fingers and toes
- Has sweat glands, but no hair follicles or sebaceous (oil) glands
- Epidermis 0.5 mm thick
- Thin skin – covers rest of the body
- Epidermis about 0.1 mm thick
- Has sweat glands, but no hair follicles or sebaceous glands

FUNCTIONS OF THE SKIN

- Resistance to trauma and infection
  - Keratin
  - Acid mantle
- Other barrier functions
  - Waterproofing
  - UV radiation
  - Harmful chemicals
- Vitamin D synthesis
- Skin first step
- Liver and kidneys complete process
- Sensation
  - Skin is our most extensive sense organ
- Thermoregulation
  - Thermoreceptors
  - Vasodilation
- Nonverbal communication
  - Acne, birthmark, or scar
- Transdermal absorption
  - Administration of certain drugs
- Skin disorders
- Hair and nails
- Cutaneous glands

OVERVIEW

- Integumentary System – consists of the skin and its accessory organs
- Hair, nails, and cutaneous glands
- Most visible system and more attention paid to this organ system
- Inspection of the skin, hair, and nails is significant part of a physical exam
- Skin is the most vulnerable organ
  - Exposed to radiation, trauma, infection, and injurious chemicals
- Receives more medical treatment than any other organ system
- Dermatology – scientific study and medical treatment of the integumentary system

EPIDERMIS AND CELL TYPES

- Epidermis – keratinized stratified squamous epithelium
- Five types of cells of the epidermis
  - Stem cells
    - Undifferentiated cells that give rise to keratinocytes in deepest layer of epidermis (stratum basale)
  - Keratinocytes
    - Great majority of epidermal cells
    - Synthesize keratin
  - Melanocytes
    - Occur only in stratum basale
    - Synthesize pigment melanin that shields DNA from UV rays
    - Brached processes that spread among keratinocytes
  - Tactile ( Merkel) cells
    - In basal layer of epidermis
    - Touch receptor cells associated with dermal nerve fibers
  - Dendritic ( Lengthening) cells
    - Microtubules originating in bone marrow that guard against pathogens
- In stratum spinosum and granulosum
- Stand guard against bacteria, viruses, and other pathogens that penetrate skin

CELL TYPES AND LAYERS OF THE EPIDERMIS
STRATUM BASALE
- A single layer of cuboidal to low columnar stem cells and keratinocytes resting on the basement membrane
- Melanocytes and tactile cells are scattered among the stem cells and keratinocytes
- Stem cells of stratum basale divide
  - give rise to keratinocytes that migrate toward skin surface
  - replace lost epidermal cells

STRATUM SPINOSUM
- Consists of several layers of keratinocytes
- Thickest stratum in most skin
  - in thick skin, exceeded by stratum corneum
- Deepest cells remain capable of mitosis
  - cease dividing as they are pushed upward
- Produce more and more keratin filaments which causes cell to flatten
  - higher up in this stratum, the flatter the cells appear
- Dendritic cells found throughout this stratum
  - Named for artificial appearance created in histological section
  - Numerous desmosomes and cell shrinkage produces spiny appearance

STRATUM GRANULOSUM
- Consists of 3 to 5 layers flat keratinocytes
- Contain coarse dark-staining keratohyalin granules
- Produces lipid-filled vesicles that release a glycolipid by exocytosis of waterproof the skin
  - Forms a barrier between surface cells and deeper layers of the epidermis
  - Cuts off surface strata from nutrient supply

STRATUM LUCIDUM
- Seen only in thick skin
- Thin translucent zone superficial to stratum granulosum
- Keratinocytes are densely packed with eleidin
- Cells have no nucleus or other organelles
- Zone has a pale, featureless appearance with indistinct boundaries

STRATUM CORNEUM
- Up to 30 layers of dead, scaly keratinized cells
- Form durable surface layer
  - Surface cells flake off (exfoliate)
- Resistant to abrasion, penetration, and water loss

LIFE HISTORY OF KERATINOCYTES
- Keratinocytes are produced deep in the epidermis by stem cells in stratum basale
  - Some deepest keratinocytes in stratum spinosum also multiply and increase their numbers
- Mitosis requires an abundant supply of oxygen and nutrients
  - Deep cells acquire from blood vessels in nearby dermis
  - Once epidermal cells migrate more than two or three cells away from the dermis, their mitosis ceases
- Newly formed keratinocytes push the older ones toward the surface
  - In 30 - 40 days a keratinocyte makes its way to the skin surface and flakes off
    - Slower in old age
    - Faster in skin injured or stressed
    - Calluses or corns - thick accumulations of dead keratinocytes on the hands or feet
**DERMIS**
- Dermis – connective tissue layer beneath the epidermis
- Ranges from 0.2 mm (eyelids) – 4 mm (palms & soles)
- Composed mainly of collagen with elastic fibers, reticular fibers, and fibroblasts
- Well supplied with blood vessels, sweat glands, sebaceous glands, and nerve endings
- 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
- More areolar and adipose than dermis
- Pads body
- Binds skin to underlying tissues
- Drugs introduced by injection
  - highly vascular & absorbs them quickly
- Subcutaneous fat
  - energy reservoir
  - thermal insulation
  - 8% thicker in women

**SKIN COLOR**
- Melanin – most significant factor in skin color
  - produced by melanocytes
  - accumulate in the keratinocytes of stratum basale and stratum spinosum
  - eumelanin – brownish black
  - pheomelanin - a reddish yellow sulfur-containing pigment
- People of different skin colors have the same number of melanocytes
  - dark skinned people
    - produce greater quantities of melanin
    - melanin granules in keratinocytes more spread out than tightly clumped
    - melanin breaks down more slowly
    - melanized cells seen throughout the epidermis
  - light skinned people
    - melanin clumped near keratinocyte nucleus
    - melanin breaks down more rapidly
    - little seen beyond stratum basale
- Amount of melanin also varies with exposure to ultraviolet (UV) rays of sunlight

**OTHER FACTORS IN SKIN COLOR**
- Hemoglobin - red pigment of red blood cells
  - adds reddish to pinkish hue to skin
- Carotene - yellow pigment acquired from egg yolks and yellow/orange vegetables
  - concentrates in stratum corneum and subcutaneous fat

**ABNORMAL SKIN COLORS**
- Cyanosis – blueness of the skin from deficiency of oxygen in the circulating blood
  - airway obstruction (drowning or choking)
  - lung diseases (emphysema or respiratory arrest)
  - cold weather or cardiac arrest
- Erythema – abnormal redness of the skin due to dilated cutaneous vessels
- Pallor – pale or ashen color when there is so little blood flow through the skin that the white color of dermal collagen shows through
  - emotional stress, low blood pressure, circulatory shock, cold, anemia
- Albinism – genetic lack of melanin that results in white hair, pale skin, and pink eyes
  - have inherited recessive, nonfunctional tyrosinase allele
- Jaundice - yellowing of skin and sclera due to excess of bilirubin in blood
  - cancer, hepatitis, cirrhosis, other compromised liver function
- Hematoma – (bruise) mass of clotted blood showing through skin
- Bronzing - golden-brown color of Addison disease (deficiency of glucocorticoid hormone)

**SKIN MARKINGS**
- Friction ridges – the markings on the fingertips that leave oily fingerprints on surfaces we touch
  - everyone has a unique pattern formed during fetal development and remain unchanged throughout life
  - not even identical twins have identical fingerprints
  - allow manipulation of small objects
- Flexion lines (flexion creases) – lines on the flexor surfaces of the digits, palms, wrists, elbows
  - marks sites where the skin folds during flexion of the joints
- Freckles and moles – tan to black aggregations of melanocytes
  - freckles are flat, melanized patches
  - moles (nevus) are elevated melanized patches often with hair
    - moles should be watched for changes in color, diameter, or contour
    - may suggest malignancy (skin cancer)
- Hemangiomias (birthmarks) – patches of discolored skin caused by benign tumors of dermal blood capillaries
  - some disappear in childhood – others last for life
  - capillary hemangiomas, cavernous hemangiomas, port-wine stain
**DISTRIBUTION OF HUMAN HAIR**

- Hair is found almost everywhere on the body except:
  - palms and soles
  - ventral and lateral surface of fingers and toes
  - distal segment of the finger
  - lips, nipples, and parts of genitals
- Limbs and trunk have 55 – 70 hairs per cm²
- Face about 10 times as many
- 30,000 hairs in a man’s beard
- 100,000 hairs on an average person’s scalp
- Number of hairs does not differ much from person to person or even between sexes
  - differences in appearance due to texture and pigmentation of the hair

**TYPES OF HUMAN HAIR**

- Three kinds of hair grow over the course of our lives
  - Lanugo - fine, downy, unpigmented hair that appears on the fetus in the last three months of development
  - Vellus - fine, pale hair that replaces lanugo by time of birth
    - two-thirds of the hair of women
    - one-tenth of the hair of men
    - all of hair of children except eyebrows, eyelashes, and hair of the scalp
  - Terminal - longer, coarser, and usually more heavily pigmented
    - forms eyebrows, eyelashes, and the hair of the scalp
    - after puberty, forms the axillary and pubic hair
    - male facial hair and some of the hair on the trunk and limbs

**STRUCTURE OF HAIR AND FOLLICLE**

- Hair is divisible into three zones along its length
  - Bulb - a swelling at the base where hair originates in dermis or hypodermis
  - Only living hair cells are in or near bulb
  - Root - the remainder of the hair in the follicle
  - Shaft - the portion above the skin surface
- Dermal papilla - bud of vascular connective tissue encased by bulb
  - Provides the hair with its sole source of nutrition
- Hair matrix - region of mitotically active cells immediately above papilla
  - Hair’s growth center

**HAIR GROWTH AND LOSS**

- Hair cycle - consists of three developmental stages
  - Anagen - growth stage - 90% of scalp follicles at any given time
    - lasts 6-8 years in young adult
  - Catagen - shrinking stage (2-3 weeks)
    - Base of hair keratinizes into a hard club, and hair is now known as club hair
    - Loses its anchorage
    - Easily pulled out by brushing
  - Telogen - resting stage (1-3 months)

- Club hair may fall out during catagen or telogen or pushed out by new hair in the next anagen phase
- We lose about 50 – 100 scalp hairs daily
- Alopecia - thinning of the hair or baldness
- Pattern baldness - the condition in which hair loss from specific regions of the scalp rather than thinning uniformly
  - Combination of genetic and hormonal influence
  - Baldness allele is dominant in males and expressed only in high testosterone levels
  - Testosterone causes terminal hair in scalp to be replaced by vellus hair
- Hirsutism - excessive or undesirable hairiness in areas that are not usually hairy
FUNCTIONS OF HAIR

- Most hair on trunk and limbs is vestigial
  - little present function
  - warmth in ancestors
- Hair receptors alert us of parasites crawling on skin
- Scalp helps retain heat and prevents sunburn
- Pubic and axillary hair signify sexual maturity and aids in transmission of sexual scents
- Guard hairs (vibrissae) - guard nostrils and ear canals
- Eyelashes and eyebrows
- Nonverbal communication

SWEAT GLANDS (SUDORIFEROUS)

- Two kinds of sweat (sudoriferous) glands
  - merocrine (eccrine) sweat glands
    - most numerous skin glands - 3 to 4 million in adult skin
    - watery perspiration that helps cool the body (500 ml per day)
  - apocrine sweat glands
    - occur in groin, anal region, axilla, areola, bearded area in mature males
    - produce sweat that is thicker, milky, and contains fatty acids
    - scent glands that respond to stress and sexual stimulation
    - pheromones – chemicals that influence the physiology of behavior of other members of the species
    - bromhidrosis - disagreeable body odor produced by bacterial action on fatty acids

SEBACEOUS GLANDS

- Sebum – oily secretion produced by sebaceous glands
- Flask-shaped glands with short ducts opening into hair follicle
- Holocrine gland – secretion consists of broken-down cells
  - replaced by mitosis at base of gland
- Keeps skin and hair from becoming dry, brittle, and cracked
- Lanolin – sheep sebum

CERUMINOUS GLANDS

- Found only in external ear canal
- their secretion combines with sebum and dead epithelial cells to form earwax (cerumen)
  - keep eardrum pliable
  - waterproofs the canal
  - kills bacteria
  - makes guard hairs of ear sticky to help block foreign particles from entering auditory canal
- Simple, coiled tubular glands with ducts that lead to skin surface

SKIN CANCER

- Skin cancer – induced by the ultraviolet rays of the sun
  - most often on the head and neck
  - most common in fair-skinned people and the elderly
  - one of the most common cancers
  - one of the easiest to treat
  - has one of the highest survival rates if detected and treated early
  - three types of skin cancer named for the epidermal cells in which they originate
  - basal cell carcinoma, squamous cell carcinoma, and malignant melanoma
BASAL CELL CARCINOMA
- Most common type
- Least dangerous because it seldom metastasizes
- Forms from cells in stratum basale
- Lesion is small shiny bump with central depression and beaded edges

SQUAMOUS CELL CARCINOMA
- Arise from keratinocytes from stratum spinosum
- Lesions usually appear on scalp, ears, lower lip, or back of the hand
- Have raised, reddened, scaly appearance later forming a concave ulcer
- Chance of recovery good with early detection and surgical removal
- Tends to metastasize to lymph nodes and may become lethal

MALIGNANT MELANOMA
- Skin cancer that arises from melanocytes
- Less than 5% of skin cancers, but most deadly form
- Treated surgically if caught early
- Metastasizes rapidly - unresponsive to chemotherapy - usually fatal
- Greatest risk factor – familial history of malignant melanoma
- High incidence in men, redheads, people who experience severe sunburn in childhood
  ABCD--asymmetry, border irregular, color mixed and diameter over 6 mm

UVA, UVB AND SUNSCREENS
- UVA and UVB are improperly called “tanning rays” and “burning rays”
- Both thought to initiate skin cancer
- Sunscreens protect you from sunburn but unsure if provide protection against cancer
  - chemical in sunscreen damage DNA and generate harmful free radicals

BURNS
- Burns - leading cause of accidental death
  - fires, kitchen spills, sunlight, ionizing radiation, strong acids or bases, or electrical shock
  - deaths result primarily from fluid loss, infection and toxic effects of eschar – burned, dead tissue; debridement – removal of eschar
- Classified according to the depth of tissue involvement
  - First-degree burns – partial thickness burn - involve only the epidermis
    - marked by redness, slight edema, and pain
    - heal in a few days
    - most sunburns are first degree burns
  - Second-degree burns – partial thickness burn - involve the epidermis and part of the dermis
    - leaves part of the dermis intact
    - red, tan, or white
    - two weeks to several months to heal and may leave scars
    - blistered and very painful
  - Third-degree burn – full thickness burn – the epidermis and all of the dermis, and often some deeper tissues (muscles or bones) are destroyed
    - often require skin grafts
    - needs fluid replacement and infection control

DEGREES OF BURN INJURIES
(a) First degree
(b) Second degree
(c) Third degree
SKIN GRAFTS AND ARTIFICIAL SKIN

- Third-degree burns require skin grafts
- Graft options
  - autograft - tissue taken from another location on the same person’s body
  - split-skin graft - taking epidermis and part of the dermis from an undamaged area such as the thigh or buttocks and grafting it into the burned area
  - isograft - skin from identical twin
- Temporary grafts (immune system rejection)
  - homograft (allograft) – from unrelated person
  - heterograft (xenograft) – from another species
  - amnion from afterbirth
  - artificial skin from silicone and collagen