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

6-1

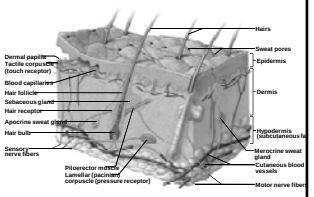
OVERVIEW

- 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

6-2

SKIN AND SUBCUTANEOUS TISSUE

- The body's largest and heaviest organ
  - covers area of 1.5 -2.0 m^2
  - 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 sole, 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
  - possesses hair follicles, sebaceous glands and sweat glands



6-3

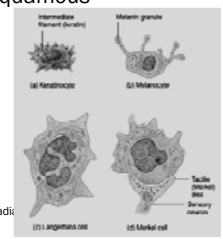
FUNCTIONS OF THE SKIN

- 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
  - vasoconstriction / vasodilation
- Nonverbal communication
  - acne, birthmark, or scar
- Transdermal absorption
  - administration of certain drugs steadily through thin skin – adhesive patches

6-4

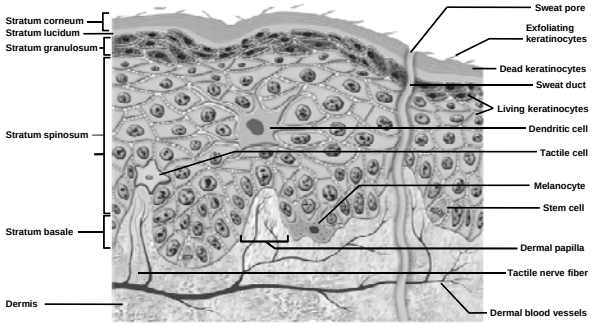
EPIDERMIS AND CELL TYPES

- 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 radi
    - branched processes that spread among keratinocytes
  - **tactile (merkel) cells**
    - in basal layer of epidermis
    - touch receptor cells associated with dermal nerve fibers
  - **dendritic (Langerhans) cells**
    - macrophages originating in bone marrow that guard against pathogens
    - found in stratum spinosum and granulosum
    - stand guard against toxins, microbes, and other pathogens that penetrate skin



6-5

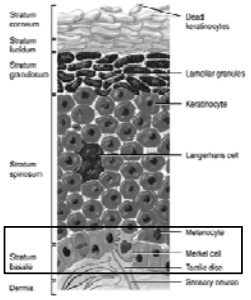
CELL TYPES AND LAYERS OF THE OF THE EPIDERMIS



6-6

STRATUM BASALE

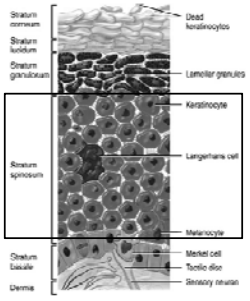
- A single layer of cuboidal to low columnar stem cells and keratinocytes resting on the basement membrane
  - melanocytes and tactile cells are scattered among the stem cells and keratinocytes
- Stem cells of stratum basale divide
  - give rise to keratinocytes that migrate toward skin surface
  - replace lost epidermal cells



6-7

STRATUM SPINOSUM

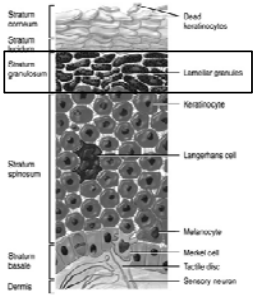
- Consists of several layers of keratinocytes
- Thickest stratum in most skin
  - in thick skin, exceeded by stratum corneum
- Deepest cells remain capable of mitosis
  - cease dividing as they are pushed upward
- Produce more and more keratin filaments which causes cell to flatten
  - higher up in this 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



6-8

STRATUM GRANULOSUM

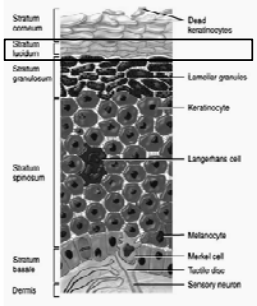
- Consists of 3 to 5 layers flat keratinocytes
- Contain coarse dark-staining keratohyalin granules
- Produces lipid-filled vesicles that release a glycolipid by exocytosis of waterproof the skin
  - forms a barrier between surface cells and deeper layers of the epidermis
  - cuts off surface strata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



6-9

STRATUM LUCIDUM

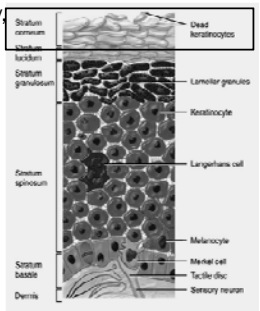
- Seen only in thick skin
- Thin translucent zone superficial to stratum granulosum
- Keratinocytes are densely packed with eleidin
- Cells have no nucleus or other organelles
- Zone has a pale, featureless appearance with indistinct boundaries



6-10

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



6-11

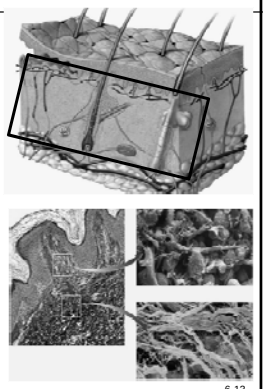
LIFE HISTORY OF KERATINOCYTES

- 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 f

6-12

DERMIS

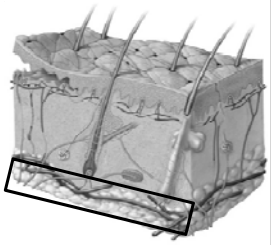
- Dermis – connective tissue layer beneath the epidermis
- Ranges from 0.2 mm (eyelids) – 4 mm (palms & soles)
- Composed mainly of collagen with elastic fibers, reticular fibers, and fibroblasts
- Well supplied with blood vessels, sweat glands, sebaceous glands, and nerve endings
- Dermal papillae - extensions of the dermis into the epidermis
  - forming the ridges of the fingerprints
- Layers
  - papillary layer
  - reticular layer is deeper part of dermis



6-13

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



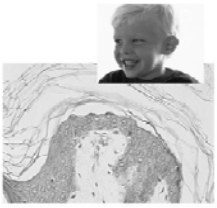
6-14

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

6-15

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

6-16

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)

6-17

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)
- Hemangiomas (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

6-18

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 cm^2
  - 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

6-19

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

6-20

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

21

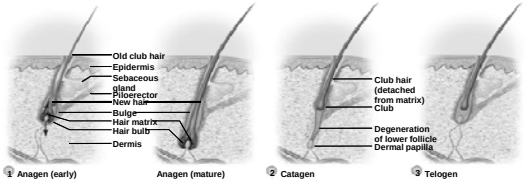
STRUCTURE OF HAIR AND FOLLICLE

- Three layers of the hair in cross-section from inside out
  - Medulla
  - Cortex
  - Cuticle
- Texture – related to differences in cross-sectional shape
  - straight hair is round
  - wavy hair is oval
  - curly hair is relatively flat
- Color – due to pigment granules in the cells of the cortex
  - brown and black hair is rich in eumelanin
  - red hair – low eumelanin but a high pheomelanin
  - blond hair intermediate amount of pheomelanin ; very little eumelanin
  - Gray and white hair scarcity or absence of melanin in the cortex and the presence of air in the medulla

6-22

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)



6-23

HAIR GROWTH AND LOSS

- 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

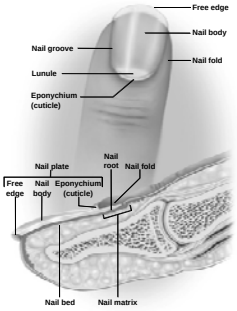
6-24

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

6-25

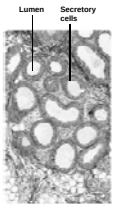
FINGERNAIL STRUCTURE



6-26

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



(a) Apocrine gland

6-27

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

(c) Sebaceous gland

6-28

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

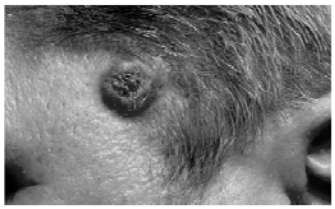
6-29

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

6-30

BASAL CELL CARCINOMA



(a) 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

6-31

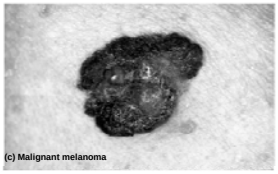
SQUAMOUS CELL CARCINOMA

(b) 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

6-32

MALIGNANT MELANOMA



(c) 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

6-33

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

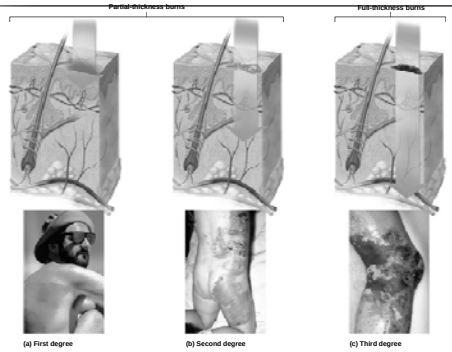
6-34

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

6-35

DEGREES OF BURN INJURIES



(a) First degree (b) Second degree (c) Third degree

6-36

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

6-37