Skin (Integumentary System)

considered an organ or an organ system

body’s largest organ
‡ organ of greatest surface area: 15-20 sq ft. (1.5-2 m²)

General Functions:
1. protection
   mechanical
   chemical
   bacterial
   UV
   desiccation

2. temperature homeostasis
   > temp ✳ sweat glands, flushing
   < temp ✳ arrector pili, pale

3. excretion
   affects fluid & electrolyte balance
   sweat glands release: water, salts, ammonia
   oil glands release: lipids, acids

4. sensation
   touch (light touch, wind, etc)
   pressure
   heat
   cold
   pain

5. synthesis
   vitamin D precursor passes through capillaries
   in skin and light converts it to vitamin D

6. nonverbal communication
   eg. humans and other primates have much
   more expressive faces than other animals

Layers of Skin:

epidermis
dermis
hypoderms
Epidermis
stratified squamous epithelium
upper layers dead, filled with keratin (waxy protein)
lower layers living cells
replaced every 35-45 days

subdivided into 5 identifiable layers:

a. **stratum basale**
lowermost layer of epidermis
single cell layer thick
only cells that get adequate nutrition and oxygen by diffusion from tissues below
actively dividing cells
bordered below by basement membrane

b. **stratum spinosum**
several layers thick
less mitosis
flattened, irregular, spindlike projections

[basale + spinosum = **stratum germinativum**
‡ growing layers]

c. **stratum granulosum**
very thin; 2-3 cell layers thick
as cells move up from s. basale they die & get flatter and thinner
keratinization begins here

d. **stratum lucidum**
thin translucent band
only found in thick areas of epidermis:
  soles of feet
  palms of hand

e. **stratum corneum**
thickest of all layers; 3/4 th's the thickness of epidermis
20-30 cell layers thick
dead cells completely filled with keratin
water resistant
main protection against biological and chemical assault

takes keratinocytes 30-40 days from their formation in s basale until they flake off of the s corneum

**cells of epidermis:**
1. **stem cells** ⚫ undifferentiated cells found only in deepest layer

2. **keratinocytes** ⚫ most cells in epidermis synthesize keratin

3. **melanocytes** ⚫ also in deepest layer synthesize pigment melanin

4. **Merkel cells** ⚫ touch receptors, attached to nerve cell

5. **dendritic cells** (Langerhans cells) ⚫ found in s spinosum and s granulosum
   are macrophages that stand guard against toxins, microbes and other pathogens that penetrate the skin ⚫ if detected they alert immune system

**Dermis (=hide)**

strong, flexible, connective tissue

gives skin its strength and resilience

gel-like matrix

contains collagen, elastic and reticular fibers

rich in nerves, receptors, blood vessels, lymph vessels

hair follicles and sweat glands extend into it

two layers:

**a. papillary layer**

mainly areolar connective tissue

lots of blood vessels

dermal papillae

capillary loops

sensory cells

produce finger prints

**b. reticular layer**

mainly dense (irregular connective tissue)

lots of collagen fibers

lines of cleavage between collagen bundles

⚫ tension lines

  longitudinal in limbs
  circular around trunk

incisions parallel to lines heal quicker

dermal tearing = stretch marks (silvery)

**Subcutaneous Layer**
= hypodermis or superficial fascia

below skin
mainly adipose tissue (ie subcutaneous fat)
insulation
infants and elderly have less of this than adults and are therefore more sensitive to cold

**Skin Color**

due to combination of three different pigments:

- **melanin**
  - yellow, orange, brown or black pigments
  - racial shades due mainly to kinds and amount of melanin pigments
  - mainly in stratum basale
  - also, amount varies with exposure to sun=suntan

- **carotene**
  - esp in stratum corneum and subcutaneous layers

- **hemoglobin**
  - in blood of skin capillaries

**Skin Color & Texture in Diagnosis**

- **cyanosis** = bluish cast ⇔ poor oxygenation
- **erythema** = redness ⇔ emotional, hypertension, inflammation
- **pallor** = paleness ⇔ emotion, anemia, low blood pressure
- **jaundice** = yellowing ⇔ liver disorder, >bile pigments in blood
- **bronzing** = Addison’s disease, adrenal cortex
- **bruising** (hematoma)= escaped blood has clotted
  - hematomas ⇔ deficiency in Vit C or hemophilia

- **leathery skin** = overexposure
  - clumping of elastin fibers
  - depressed immune system
  - can alter DNA to cause skin cancer

- **photosensitivity** = to antibiotics & antihistamines

“**Skin Markings**”

skin is marked by many lines, creases and ridges

- **friction ridges:**
  - ⇔ markings on fingertips characteristic of primates
  - allow us to manipulate objects more easily

- **flexion lines:**
  - on flexor surfaces of digits, palms, wrists, elbows etc
skin is tightly bound to deep fascia at these points

**freckles:**
- flat melanized patches
- vary with heredity or exposure to sun

**moles:**
- elevated patch of melanized skin, of the with hair
- mostly harmless, beauty marks

“**Derivitives of skin**”

during embryonic development 1000’s of small groups of epidermal cells from stratum basale push down into dermis to form hair follicles and glands

**1. Hair**
- covers entire body except palms, soles, lips, nipples, parts of external genitals

  hormones account for the development of “hairy” regions:
  - eg. head, axillary and pubic areas

  humans are born with as many follicles as they will ever have

  hairs are among the fastest growing tissues in the body

  formation similar to epidermis

  heavily *keratinized*

  consists of:
  - **shaft**: visible part
  - **root**:
    - **follicle**: sheath surrounding root
    - **papillae**: vascularized, growing part of hair
  - **Arrector Pili** muscles
    - attached to follicle
    - causes hair to stand on end (cold, fright)
  - **oil glands**: ≥2/follicle
  - **hair receptor**: entwines each follicle, responds to hair movements

  **hair color** depends on kinds (yellow, rust, brown, and black) and the amount of melanin cortex of shaft contains

  **hair texture** related to differences in cross-sectional shape
  - eg. straight hair is round
eg. wavy hair is oval
eg. tightly curly hair is relatively flat

2. Nails
scale-like modification of the epidermis

fingernails and toenails are clear, hard derivatives of stratum corneum

very thin, dead, scaly cells, densely packed together

corresponds to hoof or claw of animals

most mammals have claws, flat nails are a primate characteristic
    ⊕ more fleshy and sensitive fingertips
    ⊕ still can be used for digging and picking apart food, etc

features:

    **nail matrix**: growth zone beneath proximal skin
    nail bed composed of stratum basale

    **nail plate**: visible portion of nail

fingernails grow ~1 mm/wk; toenails more slowly

[adding gelatin to diet has no effect on growth or hardness of nails]

appearance of nails has diagnostic value:

    eg. spoonlike, flat, concave ⊕ may indicate iron deficiency

    eg. clubbed or swollen fingertips ⊕ long term hypoxemia
        from eg congenital heart defects and emphysema

3. Skin Glands

**Oil glands (Sebaceous Glands, holocrine)**

    2 or more per follicle
    keeps hair soft and pliable
    esp on face and scalp
    not on palms, soles or dorsal side of feet
    reduces heat loss
        lipids are poor heat conductors
    helps prevent water evaporation
    become active at puberty ⊕ acne
    secrete **sebum** = breakdown products of dead cells
Sweat Glands (sudoriferous)(eccrine glands)
~3 Million total on skin
~3000 sweat glands/inch²
most numerous on palms, soles, forehead, armpits
essentially a tiny coiled tube that opens to skin surface
helps maintain temperature and fluid/electrolyte balance
± heat ± sweat ± evaporative cooling

Scent Glands (apocrine glands)
modified sweat glands ± scent, pheromones
much less common
confined to axillary and genital area
their ducts empty into hair follicles
secretions contain fatty acids and proteins in addition to “sweat”
respond especially to stress and sexual stimulation

Mammary Glands
modified sweat glands
produce milk

Ceruminous Glands
modified sweat glands
in external ear canal
secrete waxy pigmented cerumin
protection ± traps dust and particles

Skin Imbalances & Aging
the skin can develop >1000 different ailments
the most common skin disorders result from allergies or infections
less common are burns and skin cancers

A. Allergies
   1. Contact Dermatitis
      allergic response
      eg. poison ivy, metals, etc

B. Infections
   1. viral
      eg. cold sores
      herpes simplex
      especially around lips and oral mucosa
   2. Fungal
      eg. athletes foot
   3. Bacterial
eg. boils and carbuncles
  inflammation of hair follicle and sebaceous glands
  esp on dorsal side of neck
eg. impetigo
  Streptococcus infection

C. Genetic Diseases

1. Psoriasis
   chronic, noninfectious skin disease
   skin becomes dry and scaly,
   often with pustules
   many varieties
   cycle of skin cell production increases by 3-4x’s normal
   stratum corneum gets thick as dead cells accumulate
   seems to be a genetic component
   often triggered by trauma, infection, hormonal changes or stress

2. Hypertrichosis (human werewolves)
   patients show dense hair growth on faces and upper bodies
   due to malfunction of gene on x chromosome
   ± a gene silenced during evolution has been reactivated

D. Burns

  too much sunlight or heat
  categorized by degree of penetration of skin layer
  1st degree burns
    skin is inflamed, red
    surface layer of skin is shed
  2nd degree burns
    deeper injury
    blisters form as fluid builds up beneath outer layers of epidermis
  3rd degree burns
    full thickness of skin is destroyed
    sometimes even subcutaneous tissues
    results in ulcerating wounds
    typically results in catastrophic loss of fluids:
      dehydration
      electrolyte imbalances
    also highly susceptible to infections
    slow recovery (from cells of hair follicles if they survive;
    otherwise must heal from margins of wound)
    may require:
      autografts
      cadaver skin
      pig skin
    prognosis may depend on extent of damage
extend of burn damage estimated by “rule of 9’s”
   head, arms ~9% of skin surface
   front and back of torso, each leg ~18% of skin surface
   groin ~1% of skin surface

E. Skin Cancer
   caused by excessive or chronic exposure to UV, x-rays or radiation
   most forms progress slowly and are easily treated
   a few are deadly
   1. Basal Cell Carcinoma
      least malignant
      most common
      stratum basale cant form keratin
      lose boundary layer between epidermis and dermis
      results in tissue erosion and ulceration
      99% of these cancers are fully cured
   2. Squamous Cell Carcinoma
      cancer of the cells in stratum spinosum
      usually induced by sun
      cells grow rapidly and grow into the lymphatic tissues
   3. Malignant Melanoma
      cancer of pigment cells = melanocytes
      rare ~1% of skin cancers
      deadly, poor chance of cure once it develops
      often begins with moles

F. Aging Skin
   effects often become noticeable by late 40’s

Hair
   thinner and grayer as melanocytes die and mitosis slows

Oil glands
   sebaceous glands atrophy
   skin and hair become drier

Skin Layers
   mitosis declines, collagen is lost from dermis
   skin becomes thinner and translucent
   looser and sagging as elastic fibers are lost and dermal papillae smooth out
   fewer blood vessels and those remaining are more fragile
   more bruising, slower healing and rosacea: tiny dilated blod vessels esp in nose and cheeks
   age spots – accumulation of pigment cells
   loss of immune cells and fibroblasts makes skin more susceptible
to recurring infections

thermoregulation is less efficient due to loss of blood vessels and glands

\[\text{‡} \] more vulnerable to hypothermia and heatstroke

**photoaging** = an acceleration of skin aging due to overexposure to sun (UV)

accounts for 90% of the changes that people find medically troubling or cosmetically disagreeable

**G. Autoimmune Disease**

eg. alopecia areata

causes hair to fall out in small round patches

~2% of population (4.7M in US) have some form of it

hair loss is usually short term and limited to a few patches in rare cases causes permanent loss of all body hair

[www.naaf.org](http://www.naaf.org)

**Clinical Terms:**

Necrosis – cellular or tissue death, gangrene

Biopsy – tissue analysis