

# 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 m<sup>2</sup>)

## 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, spinelike 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<sup>th</sup> '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

**“Derivatives 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:**  $\geq 2$ /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/inch<sup>2</sup>

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. athlete's 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
  - 1<sup>st</sup> degree burns
    - skin is inflamed, red
    - surface layer of skin is shed
  - 2<sup>nd</sup> degree burns
    - deeper injury
    - blisters form as fluid builds up beneath outer layers of epidermis
  - 3<sup>rd</sup> 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

‡ 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