Membranes, Glands & Skin

- Cells → tissues → organs
- Organs → groups of tissues working together to perform a common function
- By definition, some of the simplest organs are membranes and glands
- Neither fits the definition of organ very well, there are often exceptions

Membranes

- Different from cell membranes
- Most consist of at least 2 different tissues: epithelial, connective
- Usually considered part of another organ

Kinds of membranes in the body:

1. Mucous
   - Lines passages that open to exterior of body
   - Squamous or columnar epithelium on areolar tissue
   - Mucus made of glycoprotein mucin - has 4 subunits
   - Functions:
     1. Mucus traps particles to keep them from getting into lungs
        - Some pulmonary diseases are associated with too much mucus; cystic fibrosis, asthma, bronchitis
     2. Coats olfactory receptors
        - Molecules must dissolve in it to be detected
        - No mucus no smell
     3. Lubricates food in mouth for easier swallowing

2. Serous
   - Lines closed cavities of the body
   - Simple squamous epithelium on areolar tissue
   - Secretes serous fluid for lubrication
   - Thorax = pleura
   - Abdominal = peritoneum
   - Heart = pericardium
   - Parietal vs visceral

3. Synovial
   - Connective tissues only; no epithelial tissues
   - Lines joint cavities
   - Secretes fluid = synovial fluid
     - Reduces friction at moveable joints
   - Also forms fluid filled sacs around joints = bursae

4. Cutaneous
   - = Integumentary system
   - = Skin
   - Covers outer surface of body
Skin (Integumentary System)
also considered an organ or an organ system
body’s largest organ
→ organ of greatest surface area: 15-20 sq ft.
   (1.5-2 m²)
very complex:
   per sq inch:
   15 ft blood vessels
   4 yds nerves
   650 sweat glands
   100 oil glands
   1500 sensory receptor cells
   > 3 million cells total

General Functions:
1. acts as a protective barrier
   mechanical
   chemical
   bacterial → acid mantle
   UV → melanin pigment
   desiccation → keratin
2. temperature homeostasis
   > temp → sweat glands, flushing
avnascular (= no direct blood supply)
upper layers dead, filled with keratin (waxy protein)
lower layers living cells
replaced every 35-45 days
subdivided into 5 identifiable layers, eg.:
   stratum basale (stratum germinatium)
     lowermost layer of epidermis
     single cell layer thick
     composed of several types of cells
     keratinocytes
     → produce keratin, a waxy fibrous protein
     most cells of epidermis are these
     melanocytes → contain pigment (by phagocytosis) = melanin
     ~ 1/4⁰ of all cells in all races
     pigment helps prevent damage to skin cells
     → black people rarely have skin cancer
     Merkel’s cells → touch
     only cells that get adequate nutrition and oxygen by diffusion from tissues below
     actively dividing cells
     bordered below by basement membrane

  e. stratum corneum
     thickest of all layers; 3/4⁰ ’s the thickness of epidermis
     20-30 cell layers thick
     dead cells completely filled with keratin (= horny)
     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

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

4. sense of “touch”
   pressure
   light touch
   heat
   cold
   pain

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

Layers of Skin:
epidermis
dermis
hypodermis

Epidermis
stratified squamous epithelium

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
freckles & moles = local accumulation of pigments
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 \(\rightarrow\) poor oxygenation
erythema = redness \(\rightarrow\) emotional, hypertension, inflammation
pallor = paleness \(\rightarrow\) emotion, anemia, low blood pressure

**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
\(\rightarrow\) more fleshy and sensitive fingertips
\(\rightarrow\) 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 \(\rightarrow\) may indicate iron deficiency
eg. clubbed or swollen fingertips \(\rightarrow\) long term hypoxemia
from eg congenital heart defects and emphysema

**3. Skin Glands**

**a. Oil Glands (Sebaceous Glands, holocrine)**

2 or more per follicle
keeps hair soft and pliable

jaundice = yellowing \(\rightarrow\) liver disorder, \(\rightarrow\) bile pigments in blood
bronzing = Addison’s disease, adrenal cortex
bruising (hematoma)= escaped blood has clotted
hematomas \(\rightarrow\) deficiency in Vit C or hemophilia

**“Derivitives of skin”**

1. **Hair**

humans are born with as many follicles as they will ever have
hairs are among the fastest growing tissues in the body
covers entire body except palms, soles, lips,
nipples, parts of external genitals

formation of hair is similar to epidermis
heavily keratinized

hair follicles consists of:

**shaft**: visible part
**root**: growing part
**follicle**: sheath surrounding root
**papillae**: vascularized, growing part of hair
**Arrector Pili** muscles, attached to follicle, causes hair to
stand on end (cold, fright)
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; secrete sebum (breakdown products of dead cells) \(\rightarrow\) acne

b. Sweat Glands (sudoriferous or eccrine glands)

\[\sim 3\text{ Million total on skin;}\ \sim 3000\text{ sweat glands/inch}^2\]
most numerous on palms, soles, forehead, armpits
essentially a tiny coiled tube that opens to skin surface
helps maintain temperature and fluid/electrolyte balance
\(\rightarrow\) heat \(\rightarrow\) sweat \(\rightarrow\) evaporative cooling
c. Scent Glands (apocrine glands)
modified sweat glands \(\rightarrow\) 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
d. Mammary Glands
modified sweat glands; produce milk

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
\(\rightarrow\) 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
the 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

cased by excessive or chronic exposure to UV,
x-rays or radiation
\(\rightarrow\) people with light skin and exposed to lots of sunlight are most prone to skin cancers
most forms progress slowly and are easily treated
a few are deadly

1. Actinic keratoses
small scaly spots most common on face, lower arms and hands
untreated may become skin cancer

2. Basal Cell Carcinoma
least malignant \(\rightarrow\) rarely spreads
most common \(\rightarrow\) often caused by long term sun exposure
esp on head, neck and hands
Human Anatomy & Physiology: Membranes, Glands & Skin; Ziser Lecture Notes, 2010.4

sometimes shows as a reddish or flesh-colored bump that won’t go away; sometimes bleeds
stratum basale can’t form keratin
lose boundary layer between epidermis and dermis
results in tissue erosion and ulceration
can extend below the skin to bone and cause local damage
99% of these cancers are fully cured

3. Squamous Cell Carcinoma

usually appears as a bump or red, scaly patch
typically on ears, face, lips or mouth
cancer of the cells in stratum spinosum
usually induced by sun
cells grow rapidly and grow into the lymphatic tissues
can develop into large masses and can metastasize
when found early cure rate is 95%

4. Malignant Melanoma

most deadly form of skin cancer
\( \rightarrow \) kills 7,300/yr in US
cancer of pigment cells = melanocytes
rare ~1% of skin cancers
may appear suddenly or appear near a mole
sun exposure and heredity are factors
deadly, poor chance of cure once it develops
often begins with moles
warning signs include changes in moles, scaliness, oozing, bleeding, itchiness, or tenderness

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 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 \( \rightarrow \) tiny dilated blood 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
\( \rightarrow \) 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