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

contain specialized cells called **goblet cells** that secrete the **mucus**

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

4. protects lining of stomach and intestine from digestive juices

   too little mucus→ ulcers, heartburn, etc

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**
→ reduces friction of muscles, tendons and ligaments moving

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 m^2)

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

<temp → arrector pili, pale

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

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

Layers of Skin:

epidermis
dermis
hypodermis

Epidermis

stratified squamous epithelium
avascular (=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; 2 main ones:

eg. stratum basale (germinativum)
lowermost layer of epidermis
single cell layer thick

melanocytes → contain pigment (by phagocytosis) = melanin
~1/4th of all cells in all races
pigment helps prevent damage to skin cells
→ black people rarely have skin cancer

actively dividing cells

bordered below by basement membrane

eg. stratum corneum

thickest of all layers; 3/4th 's the thickness of epidermis

dead cells completely filled with keratin

water resistant

main protection against biological and chemical assault

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

melanin is produced by special pigment cells = **melanocytes** in the stratum basale

yellow, orange, brown or black pigments

racial shades due mainly to kinds and amount of melanin pigments

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 →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

"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

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

1. Hair

hairs are among the fastest growing tissues in the body

covers entire body except palms, soles, lips, nipples, parts of external genitals

eg ~ 55-70 hairs/ cm^2 on trunk, arms and legs
~10x's as many on face; ~30,000 hairs in man's beard; ~ 100,000 hairs on scalp

numbers don't differ much between individuals, only texture and pigmentation

hormones account for the development of "hairy" regions:

eg. head, axillary and pubic areas

baldness:genetic; stress or trauma; treated with minoxidil

different kinds of hairs with different functions (esp in other mammals; not as much in "naked ape")

lanugo → fine, downy, unpigmented hair of fetus

vellus → fine hairs replace lanugo at birth, also fine, unpigmented; ~ 2/3rd 's of women's hair 1/10th of men's hair

terminal hairs (protective hairs) → eyelashes, nose, ears; after puberty axillary and pubic hair

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)

oil glands: ≥2/follicle

hair receptor: entwines each follicle, responds to hair movements

color of hair:

depends on kinds (yellow, rust, brown and black)

and the amount and kind of melanin

cortex of shaft contains 2 forms of melanin:

eumalanin → brownish black

pheomelanin → reddish yellow

eg. **brown** and **black** hair rich in eumelanin

eg. **red** hair more pheomelanin, less eumelanin

eg. **blond** hair intermediate pheomelanin and very little eumelanin

eg. **gray** and **white** hair scarcity or no melanin and air in medulla of hair shaft

texture of hair:

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

a. 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; secrete **sebum** (breakdown products of dead cells) →acne

b. Sweat Glands (sudoriferous or eccrine glands)

~3 Million total on skin; ~3000 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

→ heat → sweat → evaporative cooling

c. 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

d. Mammary Glands

modified sweat glands; produce milk

e. Ceruminous Glands

modified sweat glands in external ear canal
secrete waxy pigmented cerumin for 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

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,
xrays or radiation
→ 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 keratosis

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

2. Basal Cell Carcinoma

least malignant → rarely spreads
most common
→ often caused by long term sun exposure
esp on head, neck and hands
sometimes shows as a reddish or flesh-colored bump that wont go away; sometimes bleeds
stratum basale cant 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 metastisize
when found early cure rate is 95%

4. Malignant Melanoma

most deadly form of skin cancer
→ 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 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 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
→ 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

Clinical Terms:

Necrosis – cellular or tissue death, gangrene

Biopsy – tissue analysis