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

4. cutaneous

= integumentary system
= skin

covers outer surface of body

also forms fluid filled sacs around joints
= bursae
- reduces friction of muscles, tendons and ligaments moving
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
   UV
   desiccation
2. temperature homeostasis
   > temp → sweat glands, flushing
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
~1/4 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; 3/4’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
erthema = redness → emotional, hypertension, inflammation
pallor = paleness → emotion, anemia, low blood pressure

"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/ cm² 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;
~ 2/3’rd’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:

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

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/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
- \( \text{heat} \rightarrow \text{sweat} \rightarrow \text{evaporative cooling} \)

**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"

**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

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

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
  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 won’t go away; sometimes bleeds
  stratum basale cant form keratin
  lose boundary layer between epidermis and dermis
  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
  esp on head, neck and hands
  sometimes shows as a reddish or flesh-colored bump that won’t go away; sometimes bleeds
  stratum basale cant form keratin
  lose boundary layer between epidermis and dermis
  can develop into large masses and can metastasize 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 mole
  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

Clinical Terms:
  Necrosis – cellular or tissue death, gangrene
  Biopsy – tissue analysis

www.naaf.org