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

often considered as parts of other organs but as a group of tissues working together they can be thought of as organs in their own right as well

Membranes

different from cell membranes

most membranes 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 of all organs that open to outside of the body

   consists of an epithelial sheet underlain by a layer of loose areolar connective tissue called the lamina propria

   in the mucous membrane of the digestive system the lamina propria rests on a layer of smooth muscle cells.

   contain specialized cells called goblet cells that secrete the mucus

   mucus is 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 ventral cavities of the body; pleural, pericardial and abdominopelvic cavities

   simple squamous epithelium on areolar tissue

   secretes serous fluid for lubrication

   thorax = pleura
   abdominal = peritoneum
   heart = pericardium

   parietal vs visceral

3. Synovial

   loose connective tissue only; no epithelial tissues
   → not technically an ‘organ’

   lines cavities of moveable joints

   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
Glands

gland = cell or organ that secretes substances for use in the body or the elimination of wastes

some are unicellular glands

→ isolated gland cells in epithelial tissues

individual gland cells (=goblet cells) are sometimes important components of mucous membranes

e.g. goblet cells in in respiratory and digestive systems

→ between columnar cells that serve other functions

→ they produce mucin which mixes with water to produce a thick slimy mucus for protection

e.g. the digestive tract has many isolated endocrine cells that secrete hormones that control digestion

most glands are multicellular glands consisting of sheets of epithelial tissue that invaginate to create multicellular “organs”

multicellular glands can be considered organs since they are usually composed of:

→ epithelium walled ducts and secretory cells

→ surrounded by supported connective tissues supplied with blood vessels and nerves

multicellular glands can be exocrine or endocrine:

Exocrine Glands

secrete products onto the skin or into body cavities (e.g. digestive tract)

exocrine glands have 2 basic parts:

→ an epithelium walled duct that carry their products to the epithelial surface

→ a secretory unit consisting of secretory epithelium

→ also, usually contain supportive connective tissue carrying blood vessels and nerves

→ often, the connective tissue forms a fibrous capsule that extends into and partitions the gland into subdivisions or lobes

→ simple vs compound: unbranched vs branched ducts

→ tubular vs acinar: gland same diameter throughout vs saclike gland area

Types of Secretions

1. Serous Glands

produce thin watery fluid

e.g. perspiration, milk, tears, digestive juices

2. Mucous Glands

secrete glycoprotein called mucin

after secretion mucin absorbs water and becomes mucus

→ e.g. in tongue and roof of mouth

3. Mixed Glands

produce both types of secretions

→ e.g. submaxillary and sublingual glands

4. Cytogenic Glands

release whole cells

→ e.g. testes and ovaries release sex cells

Methods of Secretion

1. Merocrine (eccrine) glands

most glands

→ release secretions by exocytosis

Apocrine glands misnomer for some of these

→ e.g. tear glands, pancreas, gastric glands

2. Holocrine Glands

very few glands are this type

→ cells accumulate products

→ then whole cell disintegrates

→ secretion is mixture of cell fragments and product

→ e.g. oil glands of scalp, some glands in eyelids

Endocrine Glands

ductless glands

→ they secrete their products directly into surrounding capillaries

→ their main products are hormones that travel through the blood to trigger a reaction in specific target organs
Skin (Integumentary System)
can be considered an organ or an organ system
body's largest organ
→ organ of greatest surface area: 15-20 sq ft. (1.5-2 m²)
~7% of body weight
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. production of vitamin D
   vitamin D precursor (7-dehydrocholesterol; also a cholesterol precursor) passes through capillaries in skin and light converts it to vitamin D

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:

a. stratum basale (str. germinativum)
   lowermost layer of epidermis → single cell layer thick
   composed of several types of cells:
   keratinocytes → produce keratin a waxy fibrous protein
   most common kind of cell in epidermis
   melanocytes → contain pigment = melanin
   ~1/4th of all cells in this layer in all races
   darker skin has more and darker pigment, not more melanocytes
   pigment helps prevent damage to skin cells
   → black people rarely have skin cancer
   Merkel's cells → touch
   sit on basement membrane
   → only cells that get adequate nutrition and oxygen by diffusion from tissues below
   actively dividing cells
b. stratum spinosum
   several layers thick
   less mitosis
   contains many spindleshaped extenskons of cells in tissue preparations (not in the living cells)
   scattered within are star-shaped dendritic cells
   part of the immune system
   they remove foreign proteins that have invaded the epidermis and use these proteins to trigger a larger immune response if necessary
c. stratum granulosum
   very thin; 2-3 cell layers thick
   as cells move up from str. basale they die & get flatter and thinner
   keratinization begins here
   also has dendritic cells
d. stratum lucidum
   thin translucent band of keratinized cells
   only found in thick areas of epidermis:
soles of feet
palms of hand

e. stratum corneum
  thickest of all layers; 3/4ths 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
  str. basale until they flake off from the str. corneum
  in a lifetime we shed abt 40 lbs of skin cells

cells of epidermis:
  1. stem cells \(\rightarrow\) undifferentiated cells found only in
deepest layer
  2. keratinocytes \(\rightarrow\) most cells in epidermis
      synthesize keratin
  3. melanocytes \(\rightarrow\) also in deepest layer
      synthesize pigment melanin
  4. Merkel cells \(\rightarrow\) touch receptors, attached to nerve cell
  5. dentritic cells (Langerhans cells) \(\rightarrow\) found in str.
      spinosum and str. granulosum
      are macrophages that stand guard against toxins,

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)

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
  darker skin color may protect agains UV radiation or protect folic
  acid (a B vitamin) circulating in the blood
  however darker skin inhibits the synthesis of vitamin D

“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

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
hematoma = "black & blue marks" indicating clotted blood from damaged blood vessels; eg. bruises
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/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
velvus → fine hairs replace lanugo at birth, also fine, unpigmented;
~ 2/3¹⁄³ of women’s hair 1/10th of men’s hair

终端 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:

eumelanin → 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 \( \Rightarrow \) 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
      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 Million total on skin; \( \sim \) 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
      \( \Rightarrow \) 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
   e. Ceruminous Glands
      modified sweat glands in external ear canal
      secrete waxy pigmented cerumin for protection
      \( \Rightarrow \) 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
      \( \Rightarrow \) a gene silenced during evolution has been reactivated

D. Burns
   too much sunlight or heat
categorized by degree of penetration of skin layer
   1\(^{st}\) degree burns
   skin is inflamed, red
   surface layer of skin is shed
   2\(^{nd}\) degree burns
   deeper injury
   blisters form as fluid builds up beneath outer layers of epidermis
   3\(^{rd}\) 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

Skin cancer is the most common form of cancer in US
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

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