Integumentary System
Overview
Functions

1. Protection
2. Excretion of wastes
3. Maintenance of $T_b$
4. Synthesis of vitamin $D_3$
5. Storage of lipids
6. Detection of sensory stimuli
Epidermis

• Tissue types
  - Stratified, squamous epithelium
    • Avascular; relies on diffusion from deeper cells

• Main function = protection against mechanical damage.
  - Primary cells = Keratinocytes - loaded with tough keratin.
Thick vs. thin

Thin: 4 “strata” of keratinocytes; each is multiple cells thick
Thick: 5 strata
Layers of the epidermis are known as “strata”

[Diagram showing layers of the epidermis with labels: Surface, Stratum corneum, Stratum lucidum, Stratum granulosum, Stratum spinosum, Stratum germinativum, Basal lamina, Dermis]
Stratum germinativum

- **Germinative (stem) cells** that replace shed keratinocytes.

- **Structure - Function (S-F): Protection**
  - Attached firmly to basal lamina via hemidesmosomes.
  - Epidermal ridges & dermal papillae - strength of attachment proportional to SA of basal lamina.
  - **Melanocytes**: pigment production cells

- **S-F: Sensation**
  - **Merkel cells**: touch sensitive
Cell types in germinative layer
Epidermal ridges produce fingerprints
Stratum spinosum

- “spiny layer”
- Still mitotically active
- S-F: Protection
  - Langerhans cells:
    Phagocytic WBC;
    stimulate immune
    response to
    microorganisms & skin
    cancers
  - Melanosomes
Stratum granulosum

- “grainy layer”
- S-F: Protection
  - Keratinocytes begin to produce proteins
  - Keratin & keratohyalin
- Cells membranes thicken; cells dehydrate; keratin fibers crosslink
Stratum lucidum

- Only in thick skin
- *Extra* layer of flat, densely packed keratinized cells
**Stratum corneum**

- *Exposed layer*
- 15-30 layers of keratinized cells
- Linked by desmosomes
- Cells are water-resistant
  - Lose through the epidermis ~ 1 pint of water per day
What happens to the epidermis when...

• You have a blister?
  - Damage to epidermis break connections to deeper layers & water accumulates here

• You take a bath?
  - Water diffuses into epidermal cells

• You float in the ocean?
  - Water diffuses out of epidermal cells
What factors contribute to skin color?

- **Carotene**: orange pigment
  - Important source of vitamin A

- **Melanin**: brown, yellow-brown, black pigment
  - Melanocytes produce melanin

- **Blood flow/hemoglobin**
  - Bound to $O_2$ = bright red $\rightarrow$ dilated capillaries
  - No $O_2$ = dark red; appears bluish $\rightarrow$ cold
Melanocytes produce melanin

Melanin transferred, via vesicles, to keratinocytes:

- **Stratum germinativum** & **spinosum** in ALL people
- **Stratum granulosum** in dark-skinned individuals
Melanocytes

- Synthesize melanin
- Freckles
- Protect from UV by surrounding nuclei with melanosomes
- Tanning = short-term physiological response
  - Melanin production occurs slowly, peaking 10th day after exposure
Hemoglobin

- Hb with $O_2$ = Red
- Hb without = Blue
- Get cold > vasoconstrict > reduced blood flow > tissue $O_2$ drops, $CO_2$ increases > hemoglobin releases $O_2$ > blue lips & nails
Dermis = connective tissue

- 2 major components
  - Superficial Papillary layer
  - Deep Reticular layer
Dermis = connective tissue

- Papillary layer
  - Areolar tissue
  - Contains capillaries, lymphatic vessels, sensory neurons
Dermis = connective tissue

- **Reticular layer**
  - Network of dense irregular CT.
  - Collagen fibers bind layers above (papillary) and below (subcutaneous)
  - Layers are indistinct
Hypodermis: Subcutaneous layer

- **Areolar and adipose tissue**
  - Highly elastic
- Not really part of the integumentary system
  - But it stabilizes skin in relation to underlying tissues
- Target site for subcutaneous injection
Accessory structures

- Occur in the dermis, BUT derived from epidermal tissue that projects down into dermis.
- Hair & hair follicles
- Sweat glands
- Sebaceous glands
- Nails
Hair

- *Nonliving; produced in hair follicles.*
- **Functions**
  - **Protection:** mechanical (bumps; dust inhalation), chemical (UV), biological (bacteria; insects).
  - **Insulation**
  - **Sensation**
Hair Structure

- Each hair wrapped in CT sheath
- Root hair plexus of sensory neurons
- Arrector pili muscle (smooth)
  - Contraction causes hair to stand erect - response to cold, fear, rage.
Hair Structure

(c) Hair shaft
Arrector
pili
Sebaceous
gland
Hair root
Hair bulb
in follicle

(d) Hair root
(cuticle, cortex,
medulla)
Internal epithelial
root sheath
External epithelial
root sheath
Glassy membrane
Medulla
Connective
tissue root sheath
Cortex
Hair matrix
Melanocyte
Hair papilla
Subcutaneous
adipose tissue

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Hair Function

- **Hair papilla (CT),** contains capillaries & nerves. Surrounded by
- **Hair bulb (epidermal cells; ET).** Produce
- **Hair matrix** which is loaded with germinative cells
Glands

• Sebaceous (oil) glands
  - Holocrine glands; produce a waxy, oily secretion (sebum)
  - Sebum = mixture of triacylglycerides, cholesterol, bactericides & electrolytes
  - Lubricates keratin, inhibits bacterial growth

• Sebaceous follicles NOT associated with hair
Sebaceous gland
Sweat (sudoriferous) glands

- **Apocrine sweat glands** (armpits)
- **Merocrine sweat glands** (all over body)
Apocrine sweat glands

- In Armpits
  - Secretion is sticky, cloudy (& odorous after bacteria eat it)
  - Begin secreting at puberty
  - Activated by pain, stress, sexual activity
  - Myoepithelial cells surround secretory cells and contract the gland
Merocrine Sweat glands

- All over the body
- Dense on palms and soles
- Produce sensible perspiration
  - Functions
    - Cool skin surface to reduce $T_b$
    - Excrete electrolytes
    - Protection via dilution or flushing
    - Bactericides
Other glands

- **Mammary**: modified *apocrine* sweat glands
- **Ceruminous**: Modified *merocrine* sweat glands in external ear passage -> produce ear wax
Factors inhibiting/limiting repair

- Number of Langerhans cells decrease by 50%
- Vitamin $D_3$ production declines by 75%
- Epidermis and dermis thin as germinative cells reduce activity
- Blood supply to dermis is reduced
- Melanocyte activity declines