

1 – Intro/Anatomy of skin, hair and nails

Vital Functions

- Sensation, barrier, immune surveillance, UV protection, thermoregulation

Fun facts

- The skin is the largest human organ, 15% of a person's body weight
- Skin **cancer** = most common cancer worldwide; affects 1 in 5 people
- Our skin is constantly being renewed, with the epidermis turning over q40-56 days, results in average person shedding **9 lbs** of skin yearly

Skin thickness varies based on....

- **Location:** epidermis is thickest on palms/soles at ~ 1.5mm (thickness of a penny), thinnest on eyelid/postauricular at ~ 0.05mm (paper)
- **Age:** Skin is relatively thin in children, thickens up until our 30's or 40's, and then thins out thereafter.
- **Sex:** Male skin is generally thicker than female skin in all locations

Overall Anatomy

- Epidermis
- Dermoepidermal junction (DEJ)
- Subcutaneous tissue

The Epidermis

Layers

- **Stratum corneum** (most superficial)
 - o Serves as a **barrier**, helping to keep the good stuff in (such as water) and the bad stuff out such as bacteria and allergens.
 - o Structure is analogous to bricks and mortar (corneocytes=bricks which are embedded in the mortar of lipids such as ceramides)
 - o Not present on mucosal sites
- **Stratum lucidum**
 - o Only present on the palms/soles, appears clear on H&E
- **Stratum granulosum**
 - o Produces the cornified cell envelope (composed of lipids and proteins; helps skin function as a mechanical and water barrier)
 - o Not present on mucosal sites

- **Stratum spinosum**
 - o Superficial to stratum basale, named for spiny-appearing desmosomes between cells
 - o Keratins 1 and 10 are expressed in this layer and are mutated in epidermolytic hyperkeratosis (aka bullous congenital ichthyosiform erythroderma)
- **Stratum basale**
 - o Located just above the basement membrane, is composed of 10% stem cells
 - o Keratins 5 and 14 are expressed in the basal layer and are mutated in patients with epidermolysis bullosa simplex (EBS)

Major CELL TYPES of the epidermis

1. **Keratinocytes (KC)** ("squamous cells", "epidermal cells")
 - o Make up most of epidermis, produce keratin
2. **Melanocytes (MC)**
 - o Neural-crest derived
 - o Normally present in ratio of 1 MC : 10 KC's
 - o Synthesize and secrete pigment granules called **melanosomes**
 - o *** Different races and skin types actually have the **same amount of melanoCYTES** but differ in the number, size, type, and distribution of melanoSOMES, with fairer skin types having more lighter-colored **pheomelanin** and darker skin types having more of the dark **eumelanin**.
3. **Langerhans Cells**
 - o Consist of 3-5% of the cells in the stratum spinosum, are derived from bone marrow, function as antigen-presenting cells
 - o Stain with S-100, CD1a, vimentin, Langerin, peanut agglutinin
 - o Contain Birbeck granules, which appear on electron microscopy as tennis racket-shaped organelles
 - o **Ultraviolet radiation decreases the number of Langerhans cells**, which may explain the mechanism of PUVA/narrow-band UVB in decreasing inflammation in psoriasis
4. **Merkel Cells**
 - o Located just above the basal cell layer of the epidermis and in the bulge region of hair follicles
 - o Believed to function as slow-adapting touch receptors
 - o Give rise to Merkel cell carcinomas, which are rare, aggressive skin cancers on the head and neck of elderly Caucasian patients

The DERMEOEPIDERMAL JUNCTION (DEJ) – to be discussed in the vesiculobullous podcasts

The Dermis

Papillary dermis (superficial)

- Appears wavy in 2D on biopsy specimens, as papillary dermis interdigitates with downward projections of epidermis (“rete ridges”)
- Contains the **sub-papillary plexus**, which contains arterioles, capillaries, venules, lymphatics, and nerves
- Contains Meissner corpuscles which sense touch and pressure.

Reticular dermis (deeper)

- Has its own plexus but contains larger blood vessels.
- Clinical correlation: **Clark’s levels for melanoma staging**
 - o Level 1 = in situ in the epidermis
 - o Level 2 = tumor reaches papillary dermis
 - o Level 3 = tumor fills papillary dermis
 - o Level 4 = tumor reaches reticular dermis
 - o Level 5 = Tumor invades subcutaneous tissue

Breslow’s depth: measures tumor depth in mm’s from the granular layer or base of an ulcerated melanoma to the bottom of the tumor

Dermal Cell Types

- **Fibroblasts** - produce collagen, elastin, and ground substance.
 - o **Collagen** - 70% of the dry weight of skin, important in wound healing (Type III fetal collagen → stronger type I collagen)
 - **COLLAGEN 1 AND 3 SYNTHESIS IS DOWNREGULATED BY CORTICOSTEROIDS (→ ATROPHY) AND UV LIGHT (→PHOTOAGING). UPREGULATED BY RETINOIC ACID.**
 - o **Elastic fibers** – help skin elasticity
 - Decrease in number with aging and are also defective in Marfan’s syndrome due to fibrillin-1 mutations.
 - o **Ground substance** – glycosaminoglycans (GAGs) and mucopolysaccharides
 - E.g. hyaluronic acid → maintains water within the dermis and is often used in many cosmetic fillers
- **Adnexa** – hair follicles, sebaceous and apocrine glands, eccrine glands
- Other cells/tissues: blood vessels, lymphatics, and nerves

THE SUBCUTANEOUS TISSUE (“Sub-Q”)

- is composed of lipocytes and fibrous septa containing collagen and larger blood vessels and nerves.
- Functions as an **energy store**, an **insulator** that protects underlying muscles and bones, and as an **endocrine organ**

where aromatase converts androstenedione to estrone (possible link between obesity and breast cancer)

THE ADNEXA (skin appendages)

Eccrine Glands

- Release **sweat** to help regulate body temperature by cooling the skin when the sweat evaporates.
- Located nearly everywhere on the skin except for the lips, the external auditory canal, the glans penis, and the labia minora and clitoris.
- The total mass of eccrine glands in our body is about the same as one kidney and can make up to 1.8 liters of sweat in an hour!
- NOT associated with the hair follicle
- Have **muscarinic acetylcholine receptors** which bind acetylcholine released from sympathetic nerves, which explains why we sweat when we’re nervous
 - o Nervous situation → sympathetic nerves are activated → release acetylcholine → binds receptors on our eccrine sweat glands → sweat is released → you’re a hot mess
 - o Explains why botulinum toxin injections, which block acetylcholine release, are effective for hyperhidrosis patients.

Apocrine Glands

- Locations (“4 A’s”) - the axilla, areola of the nipple, the anogenital region, and the auditory canal where they contribute to cerumen (earwax) formation
 - o Also make up the Moll’s glands of the eyelids (not to be confused with Meibomian glands, which are of sebaceous origin)
- Secrete odorless variety of proteins, carbohydrates, ammonia, lipids, and iron → digested by bacteria that create odorous byproducts → body odor
- Apocrine glands begin to function at puberty and are mainly stimulated by *sympathetic* adrenergic stimuli.

Sebaceous Glands

- Associated with hair follicles (unlike eccrine glands)
- Located everywhere except the palms and soles (which are hairless)
- Secrete sebum (composed mostly of triglycerides, wax esters, squalene, and free fatty acids)
- Under **hormonal** influence rather than neurologic influence as is seen with eccrine and apocrine glands

Hair follicles

- Fun facts
 - o Humans contain 5 million hairs on average
 - o On average, people have 100,000 hairs on the scalp and lose 100 scalp hairs daily.

- Blondes have thicker hair (~120k), red heads have ~80k
 - Hair on the scalp grows roughly 1 cm/month
 - Hair color depends on melanocytes in the hair bulb transferring melanosomes, which are pigment granules, to the keratinocytes in the bulb matrix.
 - **Darker** hair has mostly **eumelanin**, whereas **blonde** or **red** hair has more **pheomelanin**.
- *Add diagram of hair anatomy?

Hair anatomy

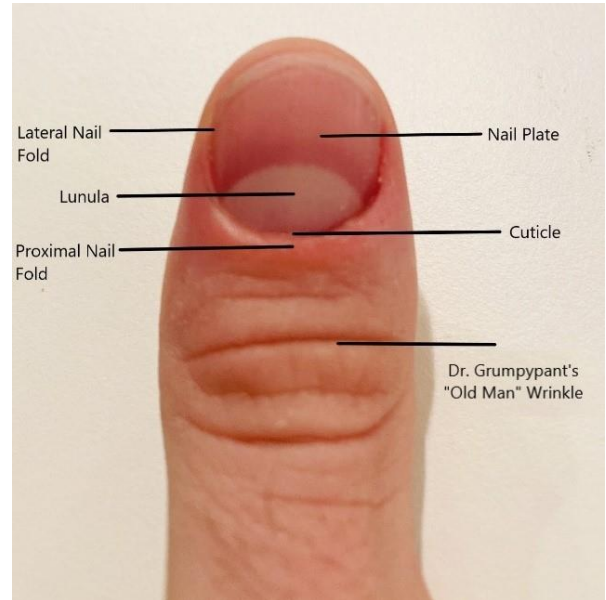
- 3 zones: infundibulum, isthmus, and inferior segment
- **Infundibulum**: from surface down to sebaceous gland insertion
 - Apocrine gland insertion is **Above** sebaceous gland insertion
 - Location of inflammation in lichen planopilaris
- **Isthmus**: from sebaceous insertion down to the Hair **bulge** (location of **arrector pili insertion**)
 - Location of inflammation in discoid lupus (**Discoid = Deeper**)
- **Inferior segment** – everything inferior to hair bulge
- Hair bulb
 - Located in deep dermis or superficial sub-Q for anagen hairs
 - Want to undermine beneath this plane in surgery, otherwise risk permanent hair loss (e.g. beard, scalp)
- Layers of hair from outside to in...
 - Glassy membrane (outermost)
 - Outer root sheath
 - Inner root sheath – itself has 3 layers...
 1. Henle's layer (outermost)
 2. Huxley's layer ("Henle hugs Huxley")
 3. Cuticle (innermost)
 - Hair shaft – also with 3 layers
 - Cuticle (outermost) – gives hair its shine after using conditioner
 - Cortex
 - Medulla

Hair growth

- Anagen phase (active growth)
 - Normally 85-90% of scalp hairs are in anagen phase; lasts 2-6 years on average.
 - Fractured by chemotherapy in anagen effluvium
- Catagen phase (involution phase)
 - < 1% of scalp hairs are in catagen phase at any given time due to its short length of approximately 2 weeks.
- Telogen phase (resting phase)
 - Lasts 3-5 months and thus 10-15% of hairs are in telogen phase in a normal patient.

- Telogen effluvium = early cessation of anagen phase so that >20% of hairs are in telogen phase.
 - Occurs approximately 3-5 months after a trigger such as an emotionally stressful event, severe illness, or pregnancy (prolonged anagen phase until delivery).

Nails



- Helpful in dermatology because specific nail changes are caused by a variety of conditions including psoriasis, alopecia areata, renal disease, and liver disease, amongst others
- Fingernails grow 2-3 mm per month on average and take 4-6 months to regrow its entire length.
- Toenails grow approximately 1 mm per month and take 12 to 18 months to regrow.
- **Nail plate** – hard part of the nail
- **Lateral nail fold** – the skin abutting the lateral sides of the nail plate
- **Proximal nail fold** – skin proximal to cuticle
- **Cuticle (eponychium)** - cornified epithelium overlying the lunula
- **Lunula** - white crescent-shaped region under the proximal nail plate
 - that represents the distal nail matrix.
- **Nail matrix** - underneath the cuticle and proximal nail fold.
 - The proximal matrix forms the top or dorsal nail plate, while the distal matrix forms the bottom or ventral nail plate.
 - Contains melanocytes, therefore melanomas can form in this location.
- **Nail bed** - underneath the nail plate, is distal to the lunula, and does not contain melanocytes.

Basic Histology Terminology

- **Acanthosis** - hyperplasia or thickening of the epidermis and is seen in hyperproliferative conditions such as psoriasis.
- **Spongiosis** - swelling and edema of the epidermis.
 - Spiny desmosomes between cells are visible.
- **Parakeratosis** - represents thickened stratum corneum *with* nuclei present
- **Hyperkeratosis** - thickened stratum corneum *without* nuclei present.
- **Hypergranulosis** - thickening of the granular layer and may be seen in lichen planus.
- **Papillomatosis** refers to multiple finger-like warty projections of the epidermis
- **Atrophy** thinning of a layer of skin, such as epidermal atrophy seen in lichen sclerosis.