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Anatomy, Skin (Integument), Epidermis

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Last Update: December 14, 2017.

Introduction

Skin is the largest organ in the body. It covers the body's entire external surface, serving as a first-order barrier against pathogens, UV light, and chemicals, and provides a mechanical barrier to injury. It also regulates temperature and amount of water released into the environment.

Skin Thickness

- Hairless skin of the palms of the hands and soles of the feet is thick skin, referring to thickness of epidermis.
- The thickest skin based on the thickness of the dermis is on the upper portion of the back. But it is considered “thin skin” histologically because of epidermal thickness.

Layers of Epidermis

- **Stratum basale** aka stratum germinativum – deepest layer, separated from dermis by basement membrane (basal lamina) and attached by hemidesmosomes. Cells are cuboidal to columnar and are mitotically active stem cells.
- **Stratum spinosum** aka prickle cell layer - irregular, polyhedral cells with processes (“spines”) that extend outward and contact neighboring cells by desmosomes.
- **Stratum granulosum** - diamond shaped cells which contain keratohyalin granules; aggregates keratin filaments present in cornified cells.

- **Stratum lucidum** - if present, thin clear layer consisting of eleidin (transformation product of keratohyalin); usually seen in thick skin only.
- **Stratum corneum** - outermost layer, made up of keratin and horny scales which were once living cells; dead cells known as squamous (anucleate); layer which varies most in thickness, especially thick in callused skin.

Cells of the Epidermis

- Keratinocytes
- Melanocytes
- Langerhans' cells
- Merkel's cell

Keratinocytes

- Predominate cell type of epidermis.
- Originate in basal layer.
- Produce keratin.
- Formation of epidermal water barrier.

Melanocytes

- Derived from neural crest cells.
- Manufacture melanin.
- Melanin mainly found in stratum basale and is protective against UV radiation; melanocytes found between cells of stratum basale.
- Produced by oxidation of tyrosine to 3,4–DOPA by tyrosinase and then there is the transformation of DOPA into melanin.
- Melanocytes send out long processes extending between epidermal cells, contacting them.
- Melanin granules from melanocytes are transferred via the long processes to cytoplasm of basal keratinocyte.

- Melanin transferred to neighboring keratinocytes by “pigment donation”; involves phagocytosis of tips of melanocyte processes by keratinocytes.

Langerhans’ Cells

- Dendritic, antigen-presenting, need special stains to visualize in stratum spinosum (mainly).
- Mesenchymal origin, derived from stem cells of bone marrow – part of mononuclear-phagocytic system.
- Birbeck granules.
- Express MHC I and MHC II molecules.
- Uptake antigens in skin and transport to lymph node.

Merkel Cells

- Modified epidermal cells in stratum basale.
- Sensory function for fine-touch, most populous in fingertips.
- Bound to adjoining keratinocytes by desmosomes and have intermediate keratin filaments.

Dermis

It consists of two layers of connective tissue which merge together, no clear demarcation.

- **Papillary layer** - Outer layer, thinner, composed of loose connective tissue and contacts epidermis.
- **Reticular layer** - Deeper layer, thicker, less cellular, and consists of dense connective tissue/ bundles of collagen fibers.

The dermis houses the skin appendages (sweat glands and hairs), many sensory neurons, and blood vessels.

Hypodermis

Also called subcutaneous fascia,

- Deepest layer of skin.

- Contains adipose lobules along with some skin appendages (hair follicles), sensory neurons, and blood vessels.

Function

The skin has multiple functions including:

- Barrier - water, bacterial, mechanical, UV light.
- Immunological.
- Homeostasis - temperature regulation and water loss.
- Sensory - touch, heat/cold.
- Endocrine - Vitamin D.
- Exocrine - secretion of sweat, sebum, etc.
- Appearance - reflects general health of the body.

Embryology

The embryology of the skin includes:

- Epidermis - derived from ectoderm; keratinized stratified squamous epithelium.
- Dermis - derived from mesoderm; dense connective tissue.
- Hypodermis – subcutaneous tissue/fascia deep to dermis; provides anchorage.
- Epidermal appendages - hair, hair follicles, sweat glands, sebaceous glands, nails, (mammary glands).

Blood Supply and Lymphatics

Blood flow to the skin is a very effective mechanism for heat transfer from the body to the environment, which is controlled by the autonomic nervous system. Increase in body temperature will cause vasodilation of skin blood vessels. This dilation is caused by inhibition of the sympathetic centers in the posterior hypothalamus (that control blood vessel tone), to increase heat loss from the body. Decreased body temperature will cause vasoconstriction of skin blood vessels throughout the body. This vasoconstriction is caused by

stimulation of the posterior hypothalamic sympathetic centers to decrease heat loss from the body.

Nerves

Nerves include:

Free Nerve Endings

- Neuronal receptors in the epidermis.
- Terminate in the stratum granulosum.Most numerous.
- Lack a connective tissue or Schwann cell investment, “free.”
- Heat, cold, itch, and pain.
- Surround most hair follicles - mechanoreceptors (“whiskers”).

Pacinian Corpuscle

- Deep pressure receptors for mechanical and vibratory pressure; enclosed in connective tissue capsule.
- Found in deeper dermis, hypodermis, and associated with joints, periosteum, organs.
- Myelinated nerve ending surrounded by a capsule.
- “Onion” appearance on microscope.
- Responds to pressure and vibration by displacement of the capsule lamellae which causes depolarization of the axon.

Meissner’s Corpuscles

- Touch receptors within dermal papillae.
- Especially responsive to low-frequency stimuli in papillary layer of hairless skin (lips, palmar surfaces, etc.).
- Appear like a twisted string on microscopy.

Ruffini’s Corpuscles

- In the dermis.
- Mechanical displacement of collagen fibers.

Muscles

Arrector Pili Muscle

- A bundle of smooth muscle fibers that attach to the connective tissue sheath of the hair follicle.
- When muscle contracts, pull hair follicle outward and makes the hair stand up. Hairs do not exit perpendicular but at an angle.
- Produce goosebumps or dimpling of the skin.
- Also, produces a squeezing of sebaceous glands causing their secretions to be emptied.

Physiologic Variants

Skin is continuously shed/desquamated in the following sequence:

1. Cell division occurs in stratum basale/germinativum. One cell remains, another cell is pushed toward surface. Basal cells begin synthesis of tonofilaments (composed of keratin) which are grouped into bundles (tonofibrils).
2. Cells are pushed into stratum spinosum. In the upper part of the spinous layer, cells begin to produce keratohyalin granules having intermediate-associated proteins, filaggrin, and trichohyalin; helps aggregate keratin filaments and conversion of granular cells to cornified cells, i.e. keratinization. Cells also produce lamellar bodies.
3. Cells are pushed into stratum granulosum and become flattened and diamond shaped. The cells accumulate keratohyalin granules mixed between tonofibrils.
4. Cells continue to stratum corneum where they flatten and lose organelles and nuclei. The keratohyalin granules turn tonofibrils into a homogenous keratin matrix.
5. Finally, cornified cells reach the surface and are desquamated via a break-down of desmosomes. Proteinase activity of KLK (kallikrein-related serine peptidase) is triggered by lowered pH near the surface.

Surgical Considerations

Langer's Lines: The collage and elastic fibers in the reticular dermis form regular lines of tension in the skin. If the skin incisions are made along these lines, less scarring will occur.

Clinical Significance

Skin is divided into multiple areas called dermatomes. There are 30 dermatomes on the body. They are numbered according to the level of spinal vertebral from which they arise. There are seven cervicals, 12 thoracics, five lumbar, and five sacral. Certain diseases like shingles have symptoms that involve a dermatome pattern. Also, dermatomes help to diagnose the level of vertebral spinal injury.

Other Issues

Histological Variants

Epidermal water barrier established by:

- **Cell envelop** - A layer of insoluble proteins on the inner surface of plasma membrane. It is formed by cross-linking of small proline-rich proteins and larger proteins (e.g., cystatin, desmoplakin, filaggrin, involucrin, keratin chains, and loricrin) and contributes to strong mechanics of barrier.
- **Lipid envelope** - A lipid/hydrophobic layer attached to outer surface of plasma membrane. As keratinocytes in stratum spinosum produce keratohyalin granules, they also produce lamellar bodies (containing a mixture of glycosphingolipids, phospholipids, and ceramides) assembled within Golgi. Lamellar bodies' contents are then secreted by exocytosis into extracellular spaces between the stratum granulosum and corneum.

Questions

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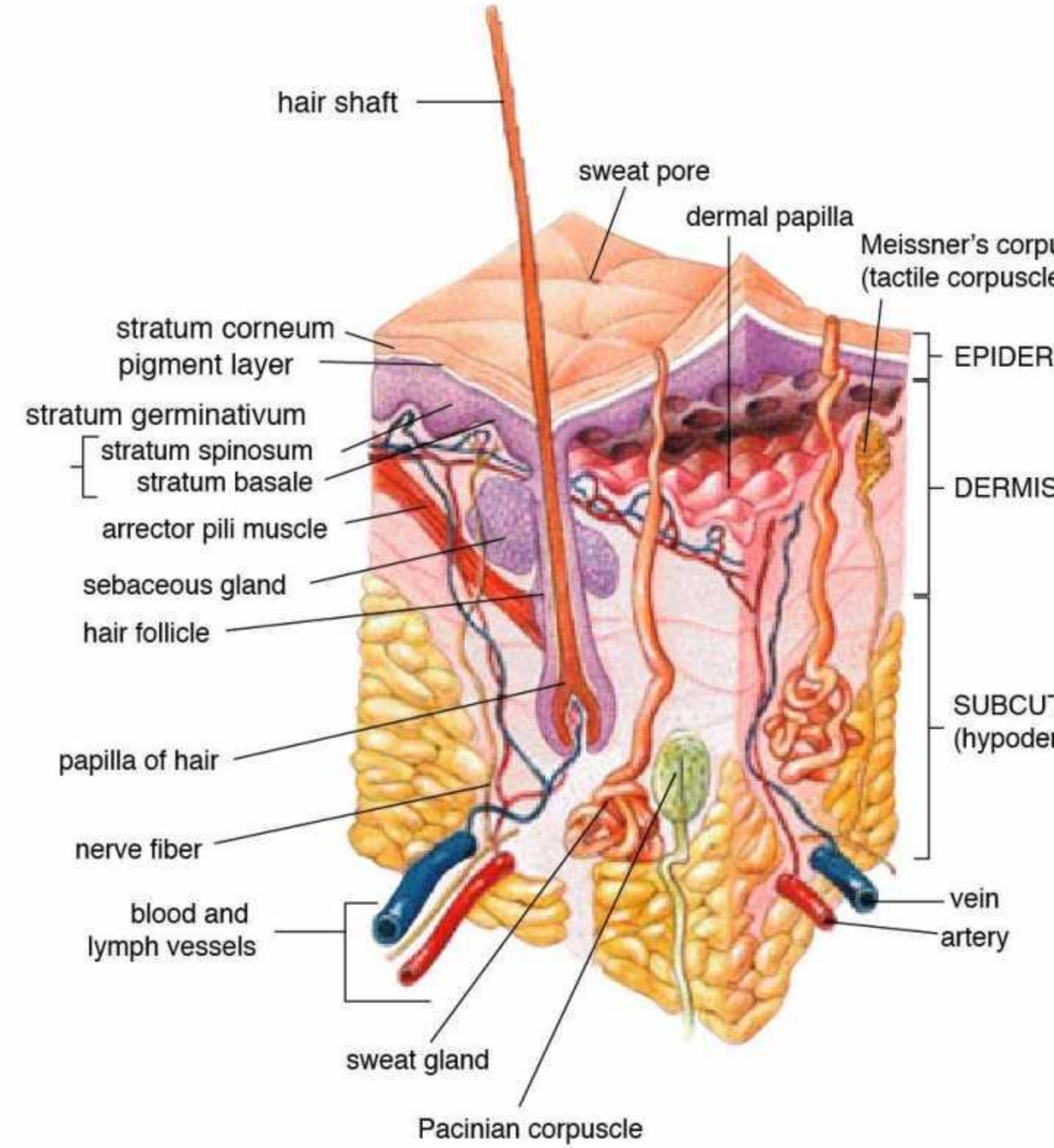
Figures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(hypoder
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