The Integumentary System

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Integumentary System

• The skin is the largest organ in the body: 12-15% of body weight, with a surface area of 1-2 meters.

• Skin is continuous with, but structurally distinct from mucous membranes that line the mouth, anus, urethra, and vagina.
DIFFERENTS PARTS

- Integumentary System
- Follicles and Glands
- Hair and Nails
- Skin and Homeostasis
- Skin and Sensory Reception
- Skin and Synthesis
- Skin Is Selectively Permeable
Two distinct layers occur in the skin: the dermis and epidermis.

The basic cell type of the epidermis is the *keratinocyte*, which contain keratin, a fibrous protein.

Basal cells are the innermost layer of the epidermis.

*Melanocytes* produce the pigment melanin, and are also in the inner layer of the epidermis.

*The dermis is a connective tissue layer under the epidermis, and contains nerve endings, sensory receptors, capillaries, and elastic fibers.*
Skin, thick trichrome

- stratum corneum
- stratum granulosum
- stratum lucidum
- stratum spinosum
- stratum basale
- dermis
The stratum lucidum is found only in thick skin.
Structure of the Skin

Outer layers
(a) Epidermis - most superficial
(b) Dermis
(c) (Hypodermis/Subcutaneous Tissue)

Epidermis
Five layers
Stratum Germinativum (Basal Layer)
Stratum Spinosum (Prickly Layer)
Stratum Granulosum (Granular Layer)
Stratum Lucidum
Stratum Corneum (Horny Layer)
1/Stratum Germinativum (Basal Layer)  
Innermost layer to the Dermis  
Separated from the underlying Dermis by a basement membrane  
Cuboidal shaped cells, with large nuclei & distinct cell content, particularly Ribosome's for Keratin production  
Mitotic activity most evident in this layer, replacing cells in upper layers  
Approx 14 days for cells to move through this layer  
As the cells hit the upper part of this layer, they increase the amount of Keratin in them as Keratin granules  
Melanocytes are scattered throughout this layer which synthesize the black pigment Melanin

2/Stratum Spinosum (Prickly Layer)  
This second layer is sometimes considered to be part of the st. germinativum.  
Polyhedral shaped cells held together by intercellular bridges (or prickles) but become flattened towards the top  
Prominent nuclei and cytoplasmic basophilia indicate active protein synthesis  
A fibrillar protein aggregates in these cells to form intracellular fibrils known as tonofibrils which converge upon the desmasomes of the prickles. These tonofibrils become more prominent toward the st. granulosum

3/Stratum Granulosum (Granular Layer)  
Third layer  
Contains melanocytes and basophilic granules which are thought to be the precursor to Keratin  
Flattened and diamond shaped cells which are characterized by numerous, dense basophilic granules which crowd the cytoplasm and tend to obscure the tonofibrils
Stratum Lucidum
Questionable fourth layer which is often so thin that it is sometimes considered not to be a transitional layer between the st. granulosum and the st. Corneum. It is so thin that there is debate currently that the layer is an artefact of the electron microscope and doesn’t in fact exist. Supposedly most pronounced in the palms of the hands and the soles of the feet.
Cells show signs of disintegration and have lost their nuclei and organelles.

Stratum Corneum (Horny Layer)
Final layer or the Horny layer.
Cells are non-nucleated disintegrated, fused, flattened squamous cells which are filled with Keratin fibres (matured Keratin).
Little water.
Forms the protective barrier for the skin.
As the junctions become interrupted, the cells are desquamated.
Dermis
Contains two layers
Papillary Layer which is closest to the Epidermis
Reticular Layer

Papillary Layer
Consists of loose connective tissue with fine Collagen and Elastin fibres
Folded into ridges or papillae which extend into the Epidermis
Especially noticeable in the palms and soles (fingerprints)
Contains nerve fibres and blood vessels which extend into the folds, supplying the Epidermis which is avascular
Rete pegs (?)

Reticular Layer
No defined boundary between the two layers
Contains denser connective tissue and many thick Collagen fibres
(Hypodermis)
Technically not part of the skin
Composed of loose connective tissue and contain lots of Adipose Tissue for metabolism, insulation,
EPIDERMIS: Cell types

Keratinocytes

Langerhans APC cell

Merkel cell

Melanocyte to make & transfer pigment

Dead

Alive

Nerve cell represented by its axon
The image illustrates a cross-section of skin, divided into layers:

- **EPIDERMIS**
  - Meissner's corpuscle
  - Capillary loop

- **DERMIS**
  - Papillary layer
  - Reticular layer
  - Duct
  - Pacinian corpuscle
  - Sweat gland
  - Fat cells

- **HYPODERMIS**
  - Fat cells

The image represents a detailed anatomy of skin layers and their components, highlighting the differences between thick, hairless skin and the associated structures.
THICK, HAIRLESS SKIN

EPIDERMIS
- no hair follicles
- no sebaceous glands

dermal papilla
- dense thick collagen fibers
- elastic fibers

sweat gland opens at top of ridge

Pacinian corpuscle

Capillary loop

Coiled duct of sweat gland & secretory profiles of coiled tubule
Most of your body is covered by a fairly thin cutaneous membrane, which has hairs growing from it. This portion of the integumentary system is often called **hairy skin** (it may also be called “thin skin”).

The palms of your hands and the soles of your feet are covered with a thicker cutaneous membrane, which has no hairs.

This portion of the integumentary system is called **thick skin**.
THIN HAIRY SKIN

Epidermis

Hair shaft

Sebaceous gland

Hair follicle

Root sheath

Matrix

Papilla of Hair follicle

Arrector pili muscle

Sweat gland

Epidermis

DERMIS

HYPODERMIS
Autonomic motor

Sweat gland

Epidermis

THIN HAIRY SKIN: Innervation

Arrector pili muscle

Sudomotor

Sensory

Pilomotor

Vessel

Vasomotor

Autonomic motor
epidermis
1. The outermost layer of skin consisting of several layers of epithelial cells, keratinocytes; and, in the inner layer of the epidermis, basal cells and melanocytes.
2. The outer layer of cells in the plant body, often covered by a waxy cuticle.
Thin Skin
dermis  One of the two layers of skin; a connective tissue layer under the epidermis containing elastic and collagen fibers, capillary networks, and nerve endings.
The papillary dermis (PD) contains vascular networks that have two important functions. The first being to support the avascular epidermis with vital nutrients and secondly to provide a network for thermoregulation. The vasculature is organized so that by increasing or decreasing blood flow, heat can either be conserved or dissipated. The vasculature interdigitates in areas called dermal papillae (DP). The papillary dermis also contains the free sensory nerve endings and structures called Meissner’s corpuscles in highly sensitive areas.
The integumentary system has multiple roles in:

- homeostasis,
- including protection,
- temperature regulation,
- sensory reception,
- biochemical synthesis,
- and absorption.

All body systems work in an interconnected manner to maintain the internal conditions essential to the function of the body.
Immunology of Skin

Structures
Epidermal barrier - innate immunity, protective barrier

Cells
Langerhans cell
Outermost immune cell
Important role in antigen presentation

T lymphocyte
Circulate through normal skin
Different types are present
Mast cell
Normal residents of the Dermis
Part of the inflammatory reaction
Keratinocyte
Have an immunological function
Can produce pro-inflammatory Citokines
Can express immune reactive molecules & intercellular adhesion molecules
Functional Systems

Skin-associated Lymphoid Tissue
Skin has a regulatory immunological function
Blood, Lymphatic drainage, circulating Lymphocytes & resident immune cells
Cytokines & eicosanoids
Mediate inflammatory response as well as action between cells
Complement
Activation of a complement cascade of events in the inflammatory response eg. Lysis & Chemotaxis for Neutrophils & Macrophages

Adhesion molecules
Help bind T cells & increase cell trafficking to the area
Immunogenetics
Tissue type Antigens of an individual
These Antigens are found in the major histocompatibility complex (MRC)
MRC located on the HLA gene cluster on chromosome 6
Vital for immunological recognition
eg. Psoriasis is associated with the B13 HLA Antigen
Hypersensitivity reactions and the Skin
Inappropriate or exaggerated response where tissue damage results
4 types
Type I (immediate)
Type II (antibody-dependent cytotoxicity)
Type III (immune complex disease)
Type IV (cell mediated or delayed)
hair

Skin, hairy H&E

- hair
- dermal sheath
- inner and outer root sheath
- bulb
- dermal papilla
Hair follicles of terminal hair span the entire dermis and usually extend deep into the hypodermis. Most of them will be cut at odd angles and only a few good longitudinally or transversely cut profiles are visible.

The hair may have been lost during the preparation of the specimen and not all hair follicles will contain hairs.

Although it is often possible to see the attachment of the arrector pili muscle into the hair follicle or the papillary layer of the dermis, both attachments are hardly ever visible in the same section.
sebaceous gland

lumen of hair follicle

sebaceous gland

arrector pili
Activity 1

• Of what type of tissue is the stratum basale made?

• **Stratum germinativum or stratum basale** is the layer of keratinocytes that lies at the base of the epidermis immediately above the dermis.

2. Of what type of tissue is the stratum granulosum made?

   *It consists of a single layer of tall, simple columnar epithelial cells lying on a basement membrane*

3. Which layer of the epidermis is the apical layer?

   *Keratin part [striatum corneum]*
4. Which layer of the epidermis is in contact with the basement membrane? (Hint: refer back to Chapter 6 if you cannot remember what the basement membrane is.)
Look your books for this one

6. Of what type of tissue is the papillary layer of the dermis made?

**loose connective tissue,**

The papillary layer lies directly beneath the epidermis and connects to it via papillae (finger-like projections).

Some papillae contain capillaries that nourish the epidermis; others contain Meissner's corpuscles, sensory touch receptors.

7. Of what type of tissue is the reticular layer of the dermis made?

**dense connective tissue**

contains criss-crossing collagen fibers that form a strong elastic network.

This network forms a pattern called cleavage (Langer's) lines.

The reticular layer also contains Pacinian corpuscles, sensory receptors for deep pressure.

This layer contains sweat glands, lymph vessels, smooth muscle, and hair follicles.

8. Of all the sub-layers of the cutaneous membrane, which is the thickest in thick skin?
8. Why is it important that the stratum corneum of thick skin is thicker than the stratum corneum of hairy skin? (Hint: Recall where thick skin is located.)

Protection,

Several layers of cells containing keratohyalin granules are visible in thick skin.

10. How many total sub-layers of the epidermis and dermis are found in hairy skin?

11. List all of the different types of tissue found in the layers that make up the cutaneous membrane of hairy skin.
To resume

**Epidermis:** Stratified squamous cornified epithelium of the skin.

**Dermis:** Connective tissue layer beneath the epidermis. Its thickness varies in different parts of the body. It is rich in collagenous and elastic fibers. The part of the dermis underlying the epithelium is called the papillary layer. The deeper part is the reticular layer, in which sebaceous glands are found. In addition, hair follicles, sweat glands, and Pacinian corpuscles occur in this layer. In the face, the striated muscles of facial expression terminate in the dermis.

**Sebaceous gland:** Holocrine variety of gland in which the entire cell is lost along with the secretory products. Intimately associated with hair follicles into which they drain. Composed of a group of saclike alveoli ensheathed by a thin layer of connective tissue. The alveoli are composed of stratified cuboidal or polyhedral epithelium[ cells that fill the sac. The secretion of the sebaceous gland is an oily substance (sebum) that lubricates the epidermis and hair.

**Sebaceous gland cell:** Note the peripheral, small cuboidal cells and the more central, larger polyhedral or spheroidal cells. Oily droplets increase with an increase in size of the cells. See Plate 83.

**Nucleus:** Nuclei of peripheral cells are rounded. Nuclei of centrally located cells are either shrunken or absent. This nuclear change is part of the degenerative process by which the entire cell is lost, along with its secretion product.

**Hair follicle:** Surrounds the hair shaft and is composed of inner epidermal epithelial elements and outer dermal connective tissue elements.

**Hair shaft:** Located within the follicle. The free end of the hair projects from the surface of the skin.
Stratum Malpighii:
Mitotic cell division occurs in this layer. Desmosomes join adjacent cells. Prominent nuclei with small dark nucleoli. Nuclear staining characteristics indicate that these nuclei are functionally active.
thoracic vertebral segmentation defects. In the lumbar region, increased interpediculate distance, flattening of the vertebral bodies and narrowing of the intervertebral spaces, as well as the presence of a calcified "spur" on the lateral view were consistent with diastematomyelia. Ultrasound showed a split cord.