

CLINICAL KNOWLEDGE INSIGHTS

CUTANEOUS ANATOMY & PHYSIOLOGY

FUNCTIONS OF THE SKIN

The skin is the largest organ of the body and is vital to an animal's survival. Skin performs many functions, including:

- Enclosing barrier
- Physical protection
- Flexibility for motion
- Temperature regulation
- Sensory perception
- Vitamin D production
- Storage
- Secretion
- Excretion
- Immunoregulation
- Antimicrobial protection
- Pigmentation
- Indicator of health

LAYERS OF THE SKIN

The skin is composed of distinct layers: epidermis, dermis and hypodermis (subcutaneous tissue).

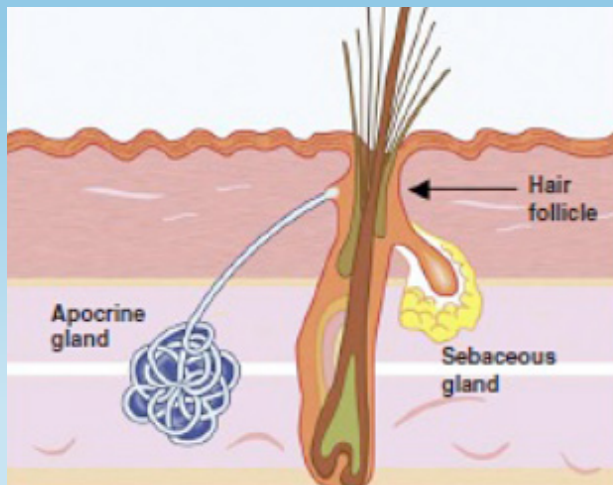
EPIDERMIS

The epidermis consists of multiple layers called strata. It varies in thickness depending on its location on the body.

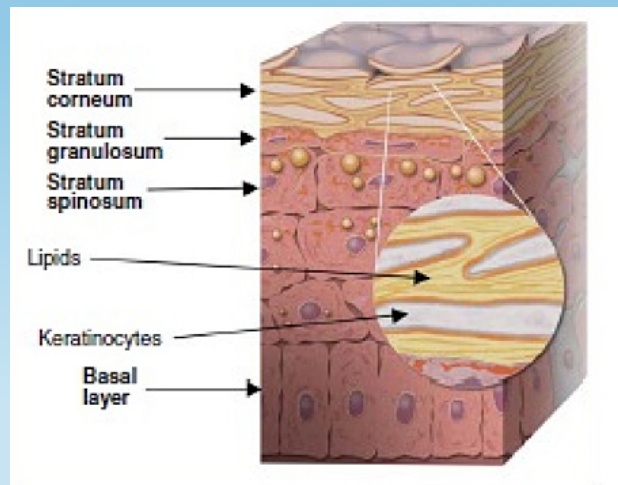
DERMIS

The dermis, or the middle layer of the skin, provides strength and elasticity. It is composed of collagen fibers, sweat glands, sebaceous glands, arrector pili muscles, hair follicles, and ground substance. Ground substance is composed of glycosaminoglycans and proteoglycans that function in water storage, homeostasis and support of other structures. Several types of cells are found in the dermis; fibroblasts, immature cells that help form collagen; mast cells, which release histamine, heparin and other inflammatory mediators in response to injury or allergic stimulation; histiocytes which can phagocytize (engulf) bacteria, and dermal dendrocytes which are antigen-processing cells.

CUTANEOUS ILLUSTRATIONS



Canine / feline skin cross-section



Layers of the skin

HYPODERMIS

The hypodermis (subcutaneous layer) is the deepest layer of the skin. It is primarily composed of adipose (fat) tissue, which functions as insulation, padding, and a storage place for reserve energy. The hypodermis also contains blood and lymph vessels and nerves.

PROTECTIVE CHARACTERISTICS OF THE SKIN

THE SKIN PROTECTS THE BODY BY 3 MECHANISMS

- The physical structure of the skin, primarily the hair and keratinized surface, serve as an outer barrier. These protect against the loss of water, electrolytes and other constituents. The turnover, or shedding, of superficial cells and hair assist in regulating the number of microorganisms and debris on the skin surface.
- The secretory products produced by the sebaceous and apocrine glands in the skin, sebum and sweat respectively, are the second protective component. These products include antimicrobial peptides, immunoglobulins, interferons, lipids, salts and organic acids which have antibacterial and antifungal properties. (See Figure 1.1)
- Normal bacterial flora protects the body against invasion by pathogenic bacteria by occupying microbial niches and producing substances that inhibit the growth of other microorganisms.

THE EPIDERMIS

The epidermis is composed of 4-5 layers, with the stratum corneum being the outer layer. Keratinocytes constitute 85-90% of the epidermal cells and synthesize keratin (an insoluble protein and the chief

constituent of skin, hair, and nails). Keratinocytes are called basal cells, prickly cells, granular cells, clear cells and cornified cells during various stages of their development. Other cells found within the epidermis include melanocytes (~5%), Langerhans cells (~5%) and Merkel cells (~2%).

FROM INNER TO OUTER, THESE ARE THE 5 LAYERS OF THE EPIDERMIS:

STRATUM BASALE (BASAL LAYER)

A single row of cells resting on the basement membrane, which separates the epidermis from the dermis. Two types of cells from the basal layer; keratinocytes and melanocytes. The keratinocytes constantly reproduce and are pushed upward, where they are shed as dead cells in the stratum corneum (horny layer). Melanocytes are regulated by genes and hormones, and also stimulated by sunshine or irritation, to produce melanin, which gives the skin its color.

STRATUM SPINOSUM (PRICKLE CELL LAYER)

This layer contains daughter keratinocytes from the basal layer, and Langerhans cells, which are antigen-presenting cells that function in immune surveillance. Keratinocytes in the stratum spinosum synthesize lipids that will be extruded into intercellular spaces when the cells reach the stratum granulosum.

STRATUM GRANULOSUM (GRANULAR LAYER)

This layer is formed by flattened nucleated keratinocytes which synthesize filaggrin and keratin filaments.

STRATUM LUCIDIUM (CLEAR LAYER)

This compact layer, formed by nonnucleated dead keratinocytes, is found only in the footpads of dogs and cats and is not shown in the diagram.

STRATUM CORNEUM (HORNY LAYER)

A thin outer layer of completely keratinized tissue embedded in a lipid matrix, the horny layer is constantly shedding. It forms a tough, flexible barrier, and with the granular layer helps prevent loss of moisture from the body and penetration of foreign substances or microorganisms into the body.

HAIR

Hair functions as a physical barrier to protect from trauma and UV radiation. It is also important in thermoregulation and sensory perception. Dogs and cats have compound hair follicles with clusters of primary hairs surrounded by groups of smaller secondary hairs. Hair follicles have cycles of activity consisting of anagen (growth), catagen (regression), telogen (resting) and exogen (shedding). Hair cycle activity is regulated by genetic factors, hormones, neurotrophins, photoperiod, temperature, nutrition, cytokines and intrinsic factors.

EPIDERMAL LIPIDS

Epidermal lipids have important roles in the function of the skin. Lipids are involved in barrier function, the cohesion and desquamation of corneocytes, and in the regulation of epidermal proliferation and

differentiation. Skin surface lipids of dogs are composed of cholesterol, cholesterol esters, diester waxes, free fatty acids and ceramides. The ceramides are particularly important in barrier function.

SKIN SENSATION

The skin is a major sensory organ. Thermoreceptors include cold and warm units. Mechanoreceptors are stimulated by touch, pressure, vibration or hair movement. Nociceptors respond to irritants and are also involved with hyperalgesia and pruritus. Pruritus, or itching, is an unpleasant sensation that provokes the desire to scratch. It is the most common symptom in veterinary dermatology. Pruritogenic mediators include acetylcholine, calcitonin gene-related peptide, corticotropin-releasing hormone, endocannabinoids, endothelins, endovanilloids, histamine, interleukin (IL)-2, IL-31, kallikreins, proteases, kinins, leukotrienes, neurokin A, nerve growth factor, thromboxane A2, tryptase, vasoactive intestinal peptide and others. Central factors such as anxiety or boredom, and competing cutaneous sensations including pain, touch, heat or cold can magnify or reduce the sensation of pruritus.