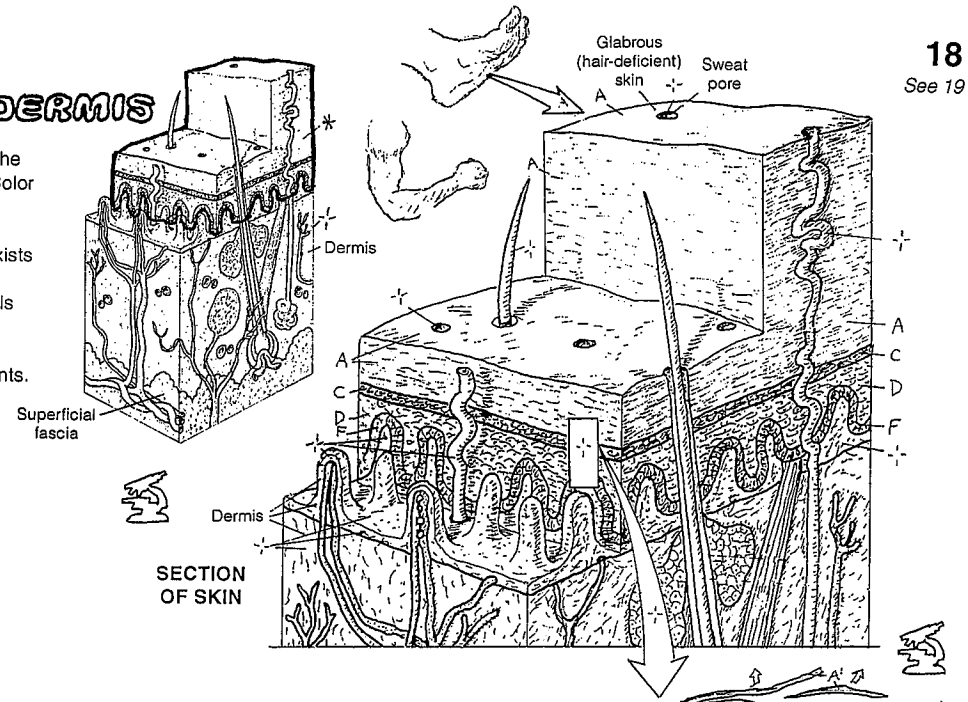
See 19

THE INTEGUMENT: EPIDERMIS

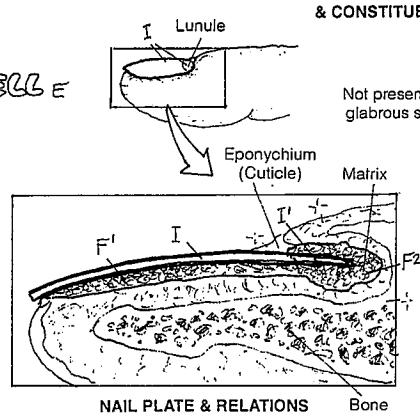
CN: Use very light colors except for E, G, and H. (1) To the right of these notes, color the entire epidermis gray. (2) Color the strata of the epidermis in the larger skin section. The thicker part of stratum corneum (A) reflects the nature of glabrous (hair-deficient) skin. The stratum lucidum (C) exists only in glabrous skin; it is too thin a layer to be shown in these views. (3) Color the strata and their constituent cells in the lower illustration, beginning with the bottom layer (F) and working upward in the direction of cell migration. (4) Color the section of the nail and its supporting elements.

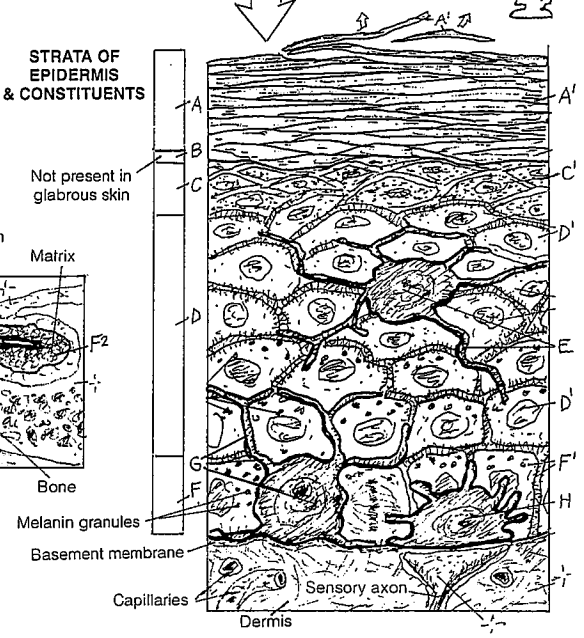


EPIDERMIS*

- STRATUM CORNEUM A
  - CORNEOCYTE A'
- STRATUM LUCIDUM B
  - KERATINOCYTE NS
- STRATUM GRANULOSUM C
  - KERATINOCYTE C'
- STRATUM SPINOSUM D
  - KERATINOCYTE D'
  - LANGERHAN'S (DENDRITIC) CELL E
- STRATUM BASALE F
  - MITOTIC KERATINOCYTE F'
  - MELANOCYTE G
  - MERKEL CELL H

NAIL PLATE I / NAIL ROOT I'
NAIL BED F' MATRIX F2





"There is no magician's mantle to compare with the skin in its diverse roles of waterproof, overcoat, sunshade, suit of armor and refrigerator, sensitive to the touch of a feather, to temperature, and to pain, withstanding the wear and tear of three score years and ten, and executing its own running repairs."[1]

The skin is composed of an avascular, stratified squamous epithelial layer (*epidermis*) and a vascular fibrous layer (*dermis*). Within each layer, there is considerable variation. The epithelial layer consists of 4–5 levels of keratin-producing epithelial cells (keratinocytes). Absent capillaries, the layers of epithelia receive their nutrition by diffusion. The outer layers of the epidermis reflect the effects of dehydration.

Mitotic keratinocytes are columnar or cuboidal epithelia forming a single layer (*stratum basale*) separated from the dermis by a basement membrane (epidermal-dermal junction). These are the germinating cells; their progeny are pushed upward by succeeding generations. *Melanocytes* produce melanin granules that disperse along their cytoplasmic extensions (dendrites). These dendrites are woven among the cells of the strata basale and spinosum, and they disseminate melanin among the keratinocytes. Melanin protects the skin from ultraviolet (UV) radiation. Merkel cells are very sensitive to mechanical deformation (touch) of the surface of the skin. The connection with the sensory axon (nerve fiber) is probably similar to a synapse (see Plates 72, 91).

The stratum spinosum consists of several levels of cuboidal and squamous keratinocytes. The cells here have many intracellular filaments that converge on the cell membrane at desmosomes (recall Plate 10). Intercellular tonofibrils, radiating out from the cell surface, can be seen in tissue preparations where their appearance is enhanced by cellular dehydration during processing. This gives a "prickly" appearance to the cells of this stratum. Another kind of dendritic cell, the *Langerhans cell,* is seen in both strata basale and spinosum as well as the dermis. These dendritic cells are essentially phagocytic and present antigen to T lymphocytes (see Plate 124).

The stratum granulosum consists of flattened keratinocytes characterized by disintegrated nuclei and cytoplasmic keratohyalin and lamellar granules. The lipid-rich content of the lamellar granules fills the intercellular spaces, greatly contributing to the impermeability of the skin.

The thin stratum lucidum is seen only in glabrous (hair-deficient) thick skin. Its squamous keratinocytes are filled with filaments; the nuclei of these cells have largely disappeared.

The outermost stratum corneum is composed of multiple layers of squamous, lifeless, keratin-filled cells (*corneocytes*). Keratin is a scleroprotein, the polypeptides of which are intertwined with filaments within the cytoplasm. Loosening and detaching of the dead, outer layers of the stratum corneum is ongoing and involves breaking the intercellular junctional devices (desmosomes, filaments, amorphous lipid substance). The stratum corneum may be as thin as 5 layers (skin of the eyelid) and as thick as 50 layers (plantar surface of the foot).

Nails are plates of compacted, highly keratinized cells of the stratum corneum. Located on the dorsal aspect of each digit, they are translucent, revealing the vascular *nail bed* below. The nail bed consists of the strata basale and spinosum only. The proximal part of the nail plate (*nail root*) fits into a groove under the proximal nail fold. The epithelia around the root are the matrix or the source tissue for the nail plate, and they extend from the region of the nail root to the lunule (lighter, opaque area at the proximal part of the nail plates, seen best on the thumb). The nail plate is formed as the epithelia of the matrix grow distally. The nail plate is continually pushed distally by the keratinizing epithelia migrating from the matrix.

[1]Quote taken, with permission, from Lockhart, R.D., Hamilton, G.F., and Fyfe, F.W. ANATOMY THE HUMAN BODY. 2nd ed., Faber and Faber, Publishers, Ltd., London, 1965.

THE INTEGUMENT: DERMIS

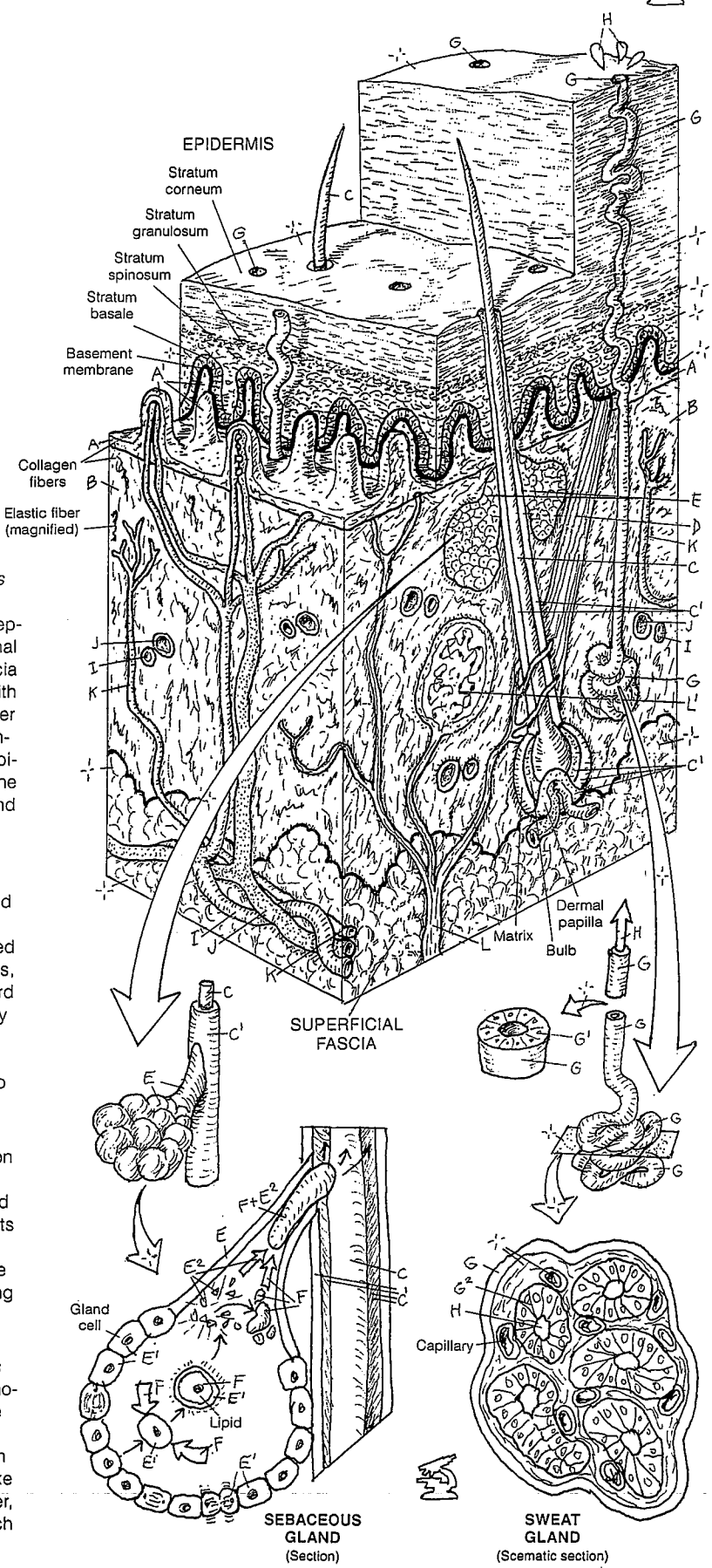
DERMIS
- PAPILLARY LAYER / LOOSE C.T. A
  - DERMAL PAPILLA A'
- RETICULAR LAYER / DENSE C.T. B
  - HAIR SHAFT C / FOLLICLE C'
  - ARRECTOR PILI MUSCLE D
  - SEBACEOUS GLAND E
    - EPITHELIAL CELL E'
      - SECRETION F
    - BURST EPITH. CELL E^2
    - SEBUM F+E^2
  - SWEAT GLAND G
    - DUCT EPITHELIUM G'
    - GLAND EPITHELIUM G^2
    - SWEAT H

ARTERY I VEIN J

LYMPHATIC VESSEL K

NERVE L / RECEPTOR L'

CN: Use red for I, blue for J, green for K, yellow for L, and light colors for the rest. (1) In the skin section, color the hair shafts (C) and sweat pores (G) in the otherwise uncolored epidermis. (2) Follow the text carefully as you color the enlarged views of the sebaceous (E) and sweat (G) glands.



The dermis consists of a fibrous connective tissue supporting *arteries* and *veins, lymphatic capillaries,* nerves and sensory receptors (see Plates 18, 91), and a number of accessory structures. The dermis is separated from the epidermis by a basement membrane (epidermal-dermal junction). On the deep side, the dermis is bordered by superficial fascia (hypodermis, subcutaneous tissue), a loose connective tissue layer with variable amounts of adipose tissue. The upper or most superficial layer of dermis is the *papillary layer,* characterized by a vascular, loose connective tissue. Pegs of this layer (dermal papillae) poke up into the epidermis. These pegs have strong attachment to the basement membrane and contain vessels, nerve endings, and axons among the collagen and elastic fibers. The subjacent *reticular layer* has a more dense fibrous character.

Hair shafts rise from epidermal *follicles* pushed down into the dermis (and hypodermis in the scalp) during development. They are not found in thick skin. The follicle begins at the site where the hair leaves the epidermis; it terminates in the form of a bulb. Hair shafts are composed of layers of keratin surrounded by layers of follicular cells (root sheaths, glassy membranes). The base of the follicle (hair bulb) is turned inward (invaginated) to accommodate a vascular dermal papilla. An obliquely placed bundle of smooth muscle attaches the outer membrane of the follicle to a papillary peg under the epidermis. This is the *arrector pili muscle.* When it is contracted, the hair to which it is attached erects to become perpendicular with the skin surface. In many mammals, hair standing on end is a sign of increased vigilance.

Sebaceous glands are grape-shaped collections of cells with a common duct (acini; holocrine gland) that surround hair follicles. The base of each gland is mitotically active; the daughter cells move into the gland center and become filled with lipid. Continued lipid engorgement results in *burst cells.* The secretory product and the cell debris constitute *sebum.* The gland duct transports the sebum to the epidermal surface or into the upper hair follicle. Sebum coats the skin and hairs, providing a degree of waterproofing. Sebum may play a social role, in terms of olfactory identification.

Sweat glands are coiled tubular glands in the deep dermis. The *ducts* of these glands traverse the epidermis by spiraling around the keratinocytes and open onto the epidermal surface. The glandular cells at the base of the sweat gland are in intimate proximity to capillaries, just as the glomerulus is in relation to the visceral layer of the renal capsule in the kidney. The cells produce sweat, a filtrate of plasma, somewhat like the filtrate of the renal corpuscle (Plate 149). Sweat is largely salt water, with a dash of urea and other molecules. Sweating is a means by which the hypothalamus can induce a degree of cooling by evaporation.