Dry Skin

CHEM 470

Formulations and Mechanisms

Dry skin, or xerosis

- congenital or acquired condition
- characterized by the lack of moisture in the SC (stratum corneum) where the normal moisture content is 10%
- defect in the permeability barrier allows excessive water to be lost

Causes of Dry Skin

- caused by harsh detergents, other contactants, and frequent bathing
- outer skin layers can stiffen and may develop cracks
- cracks become fissures into the skin that become irritated, inflamed, and itchy
- worse in areas of the body with relatively few oil glands such as the arms, legs and trunk

Features giving the impression of dry skin:

- Visible characteristics – redness, lackluster surface, dry, white patches, flaky appearance, cracks, and even fissures
- Tactile characteristics – rough and uneven
- Sensory characteristics – dry, uncomfortable, painful, itchy, stinging, and tingling sensation

TEWL

- The loss of water causes a loss of cohesive interaction between the corneocytes (which results in scaling and flaking of the skin).
- The surface appears dull because a rough surface is less able to refract light than a smooth surface.

Lipids

- Inverse relationship between lipid weight percent and permeability (Cooper et al. *J Invest Dermatol*, **1981**, *76*, 297) – think ceramides

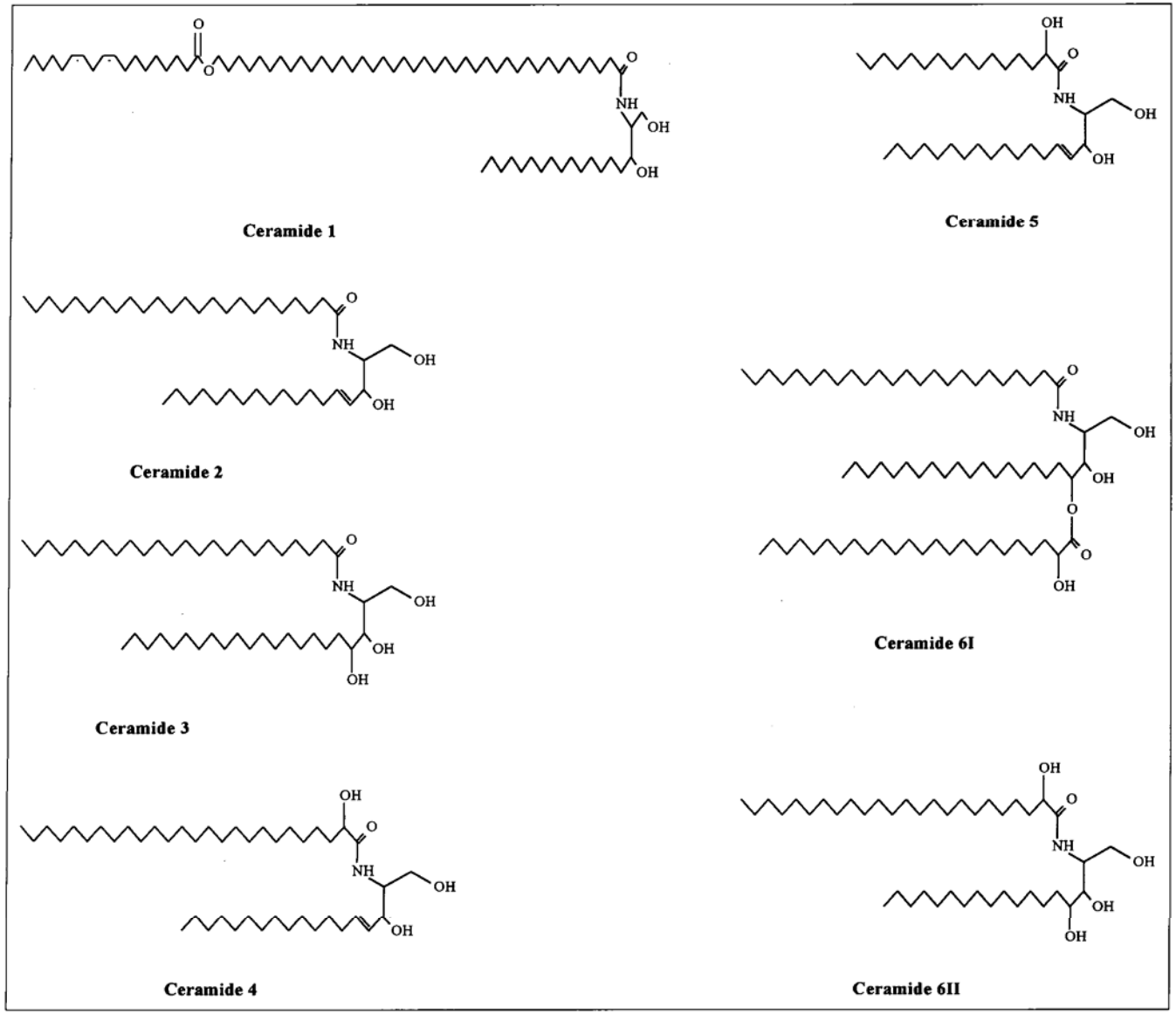


Figure 1-4.
Ceramides 1 to 6. Ceramide 1 is the most nonpolar. The polarity of each ceramide increases until ceramide 6, which is the most polar of the ceramide forms. There are two forms of ceramide 6: ceramide 6I and ceramide 6II.

Moisture and Dry Skin

- Not been conclusively shown that the water content of the stratum corneum is reduced in all dry skin conditions
- For example, reduced water content has not been detected in the dry-looking skin of patients with chronic renal failure
- In other studies, a decreased water content of the SC has been found in elderly patients with xerosis

Moisturizers

- Emollient – a material designed to soften the skin (emollient <> moisturizers, most contain humectants)
- Application of moisturizers to the skin induces tactile and visual changes of the skin surface
- Oil:water important for formulations

Moisturizers

- Recent studies indicate that moisturizers may have greater impact on the skin than is generally believed. Moisturizers affect the structure and barrier function not only of diseased skin, but also of skin that looks normal (Kligman, 1993).

Moisturizers in Relation to Skin Structure and Water Content

- SEM – surface morphology of the skin changed from a regular pattern to a coarser one, minor furrows
- Smoothing of the surface can be observed immediately after application of a moisturizer as a result of the filling of spaces between partially desquamated skin flakes, surface friction is also changed

Skin Structure and Water Content

- Water in the SC is associated with hydrophilic parts of the intercellular lipids and with the keratin fibers in the corneocytes (fibrous elements in corneocytes have hydrophilic properties and also contain a water-soluble fraction – NMF)

Skin Structure and Water Content

- Water content below 10% - primary water is tightly bound, presumable to the polar sites of the proteins
- Water content above 10% - secondary water is hydrogen bonded around the protein-bound water (this is the water that contributes to the plasticity of the SC)
- Water content above 40-50% the water resembles the bulk liquid

Possible Roles for Humectants

- NMF makes up about 15-20% of the total weight of the corneum

Amino acids	40.0
Pyrrolidone carboxylic acid	12.0
Lactate	12.0
Urea	7.0
Na, Ca, K, Mg, phosphate, chloride	18.5
NH_3, uric acid, glucosamine, creatinine	1.5
Rest unidentified	

NMF

- A deficiency of NMF is linked to dry skin conditions; humectants themselves affect the physical properties of the skin
- alpha-hydroxy acids and NMF increase skin elasticity and stimulate the keratinocyte ceramide synthesis
- if NMF is removed, water alone cannot restore elasticity

Roles of Lipids

- Recall that lipid composition of the epidermis changes dramatically during epidermal differentiation. There is a marked decrease in phospholipids and an increase in fatty acids and ceramides. In the final stages of this differentiation, keratinocytes discharge lipid-containing granules – lamellar bodies – into the extracellular spaces in the upper granular layer, where they form intercellular membrane bilayers. This lamellar material greatly expands the intercellular compartment and constitutes about 5-10% of the total weight of human SC.

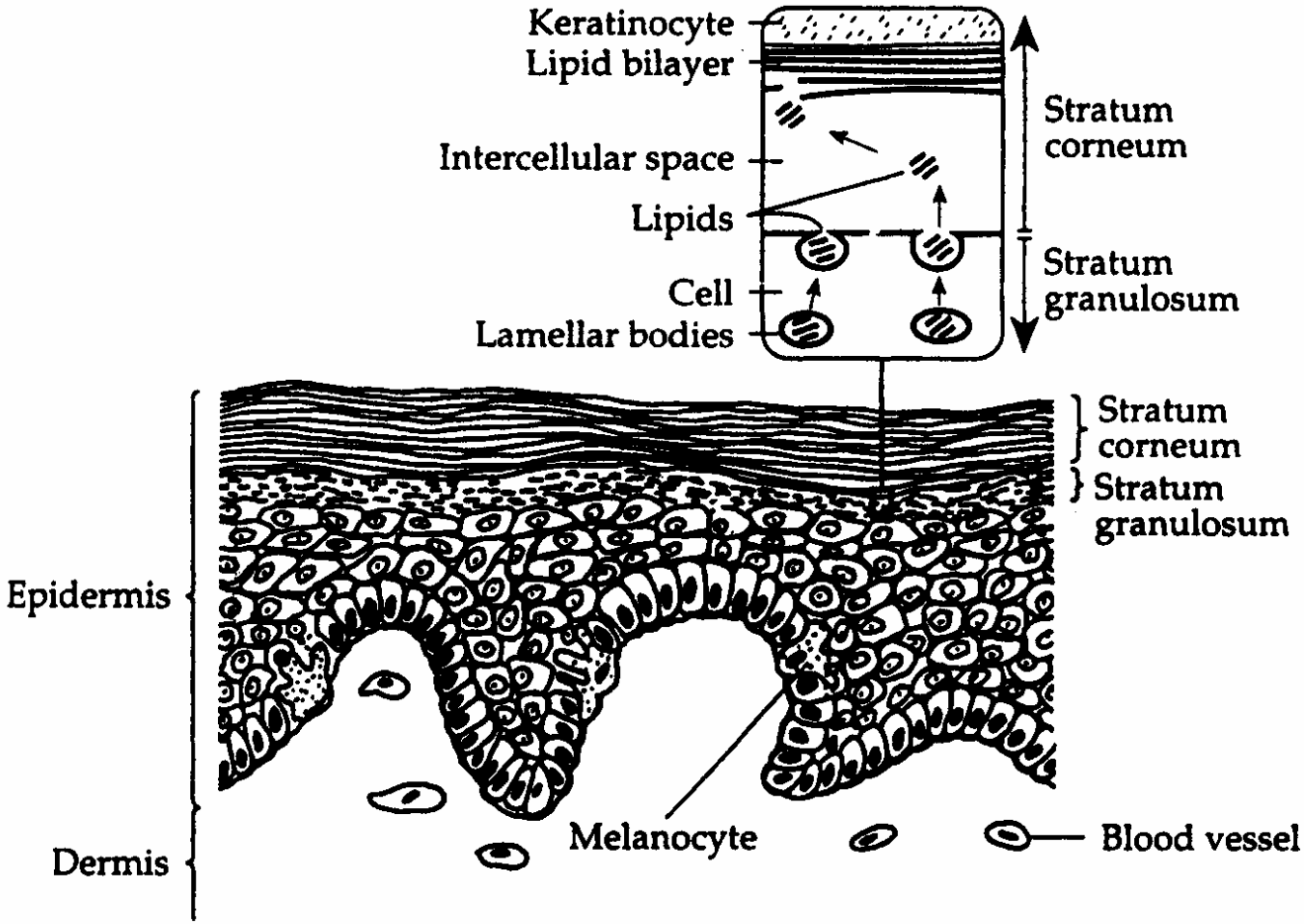


Figure 1 Structure of the epidermis and a schematic presentation of the formation of the intercellular lipid bilayer.

Artificial Moisturization Mechanisms

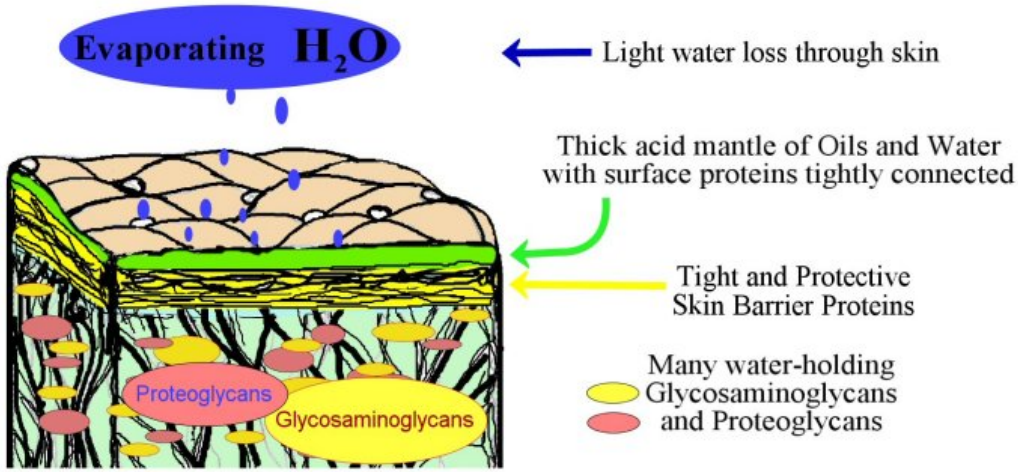
- Occlusion – simple reduction of the loss of water from the outside of the skin (lipids, e.g. petrolatum, beeswax, lanolin, and various oils)
- form an inert, epicutaneous, occlusive membrane
- unexpectedly, topically applied lipids can penetrate skin (Blaken, 1989; Mortz, 1997; Barany, 2001)

Artificial Moisturiztation

- linoleic acid
- anti-inflammatory action if taken orally (ingested) or topically (rubbed directly onto skin)
- linolenic acid (evening primrose oil)
- Best way to keep skin hydrated? eat plenty of foods rich in omega-3 and omega-6 fatty acids

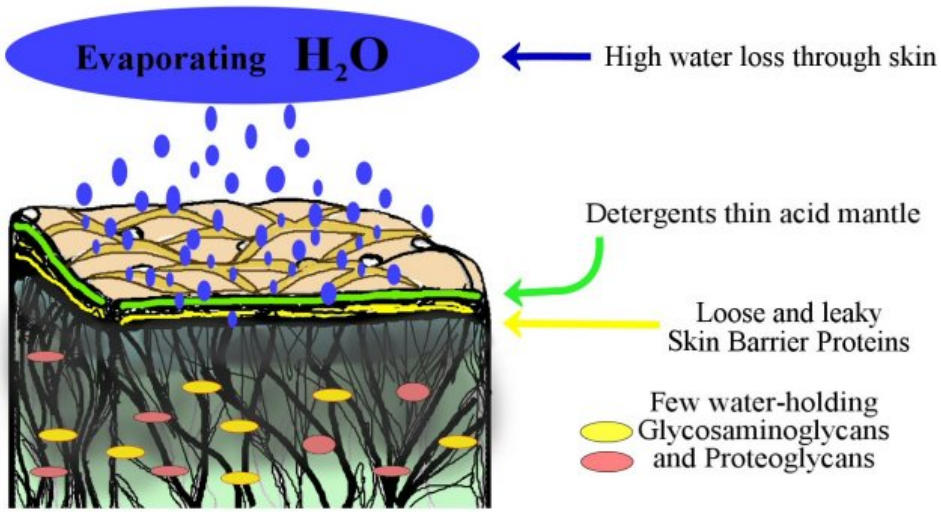
True Skin Moisturization

A Long Term Enhancement of Skin Health, Suppleness and Softness



False Cosmetic Moisturization

Quickly Makes Skin Attractive at Cosmetic Sales Counter but Slowly Damages the Skin



Moisturizers in Relation to Barrier Function

- cracks in skin
- lipid content
- protective creams for contact dermatitis may protect skin from toxins by forming a better barrier on the skin’s surface
- however, some creams can delay contact with certain toxins, whereas others enhance penetration of the same toxins (Bowman, 1982; Elsner, 1996; Loden, 1986)

Specifics

- lotions – alkaline, and can, over time deteriorate acid mantle in SC
- use of moisturizers on normal skin will increase permeability, and hydration may create interfacial defects in the lipid bilayer caused by phase separation
- urea in moisturizers (check your ingredients) can actually reduce TEWL, but can also make certain substances more likely to penetrate into the skin

Glycerin

- often used in formulations – strong humectant
- causes expansion of the SC

Hydroxy Acids

- alpha hydroxyl acids
- glycolic and lactic acids derived respectively from sugar cane and sour milk
- malic acid from apples, citric acid from citrus fruits, tartaric acid derived from grapes

Hydroxy Acids

- salicylic acid, beta hydroxyl acid derived from willow bark, wintergreen leaves, and sweet birch (and synthetic)
- exfoliations
- degrade the desmosomes and alow desquamation to proceed
- affect pH

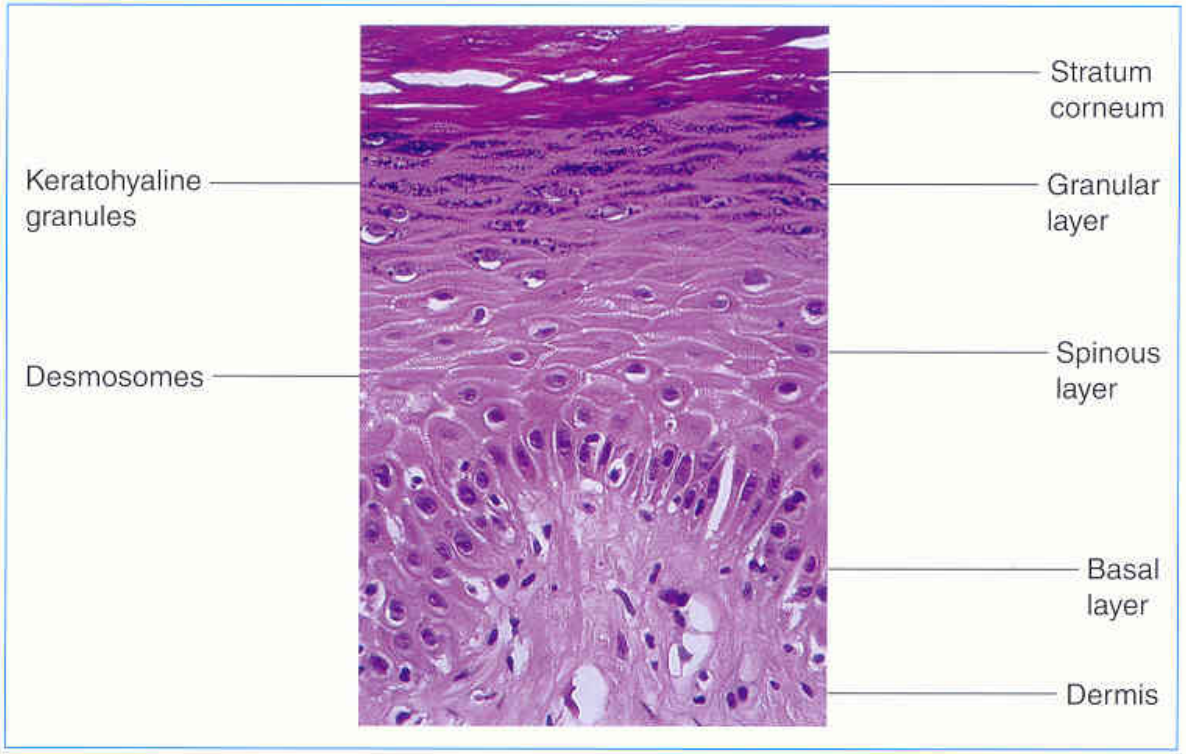


Figure 1-2.
Histopathology of the epidermis demonstrating the four layers. (Image courtesy of George Ioannides, MD).

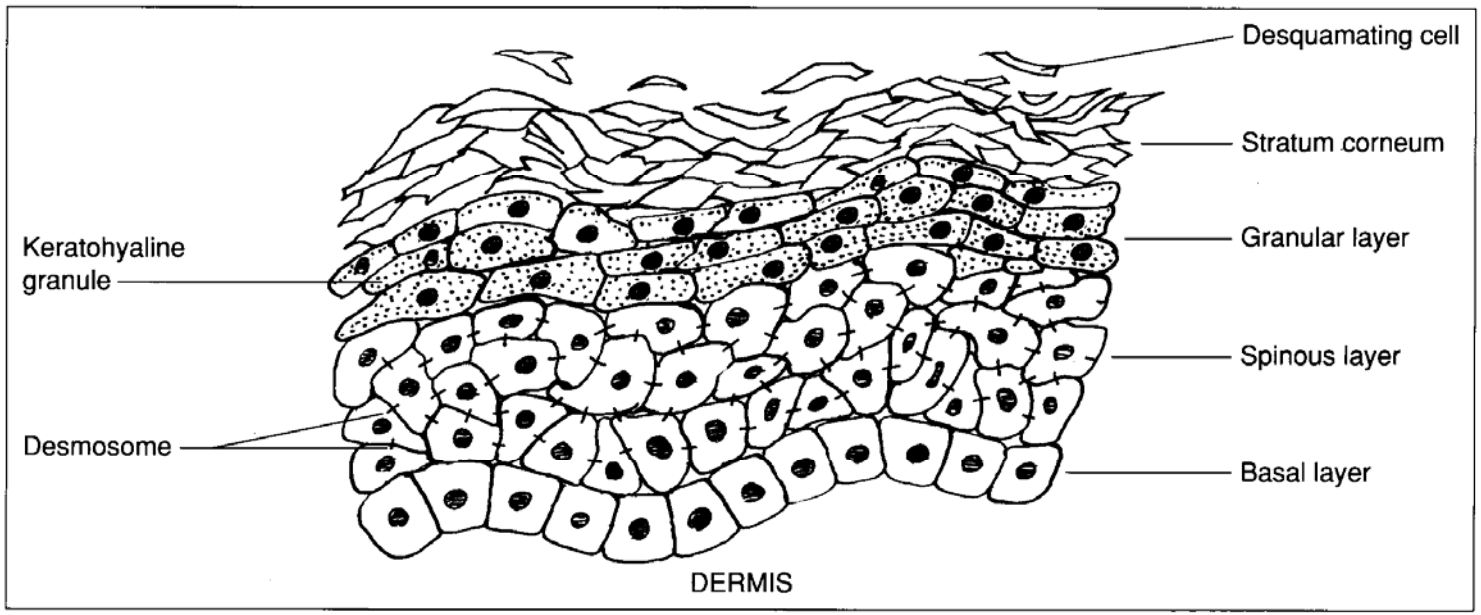


Figure 1-1.
The epidermis is made up of four layers as shown.

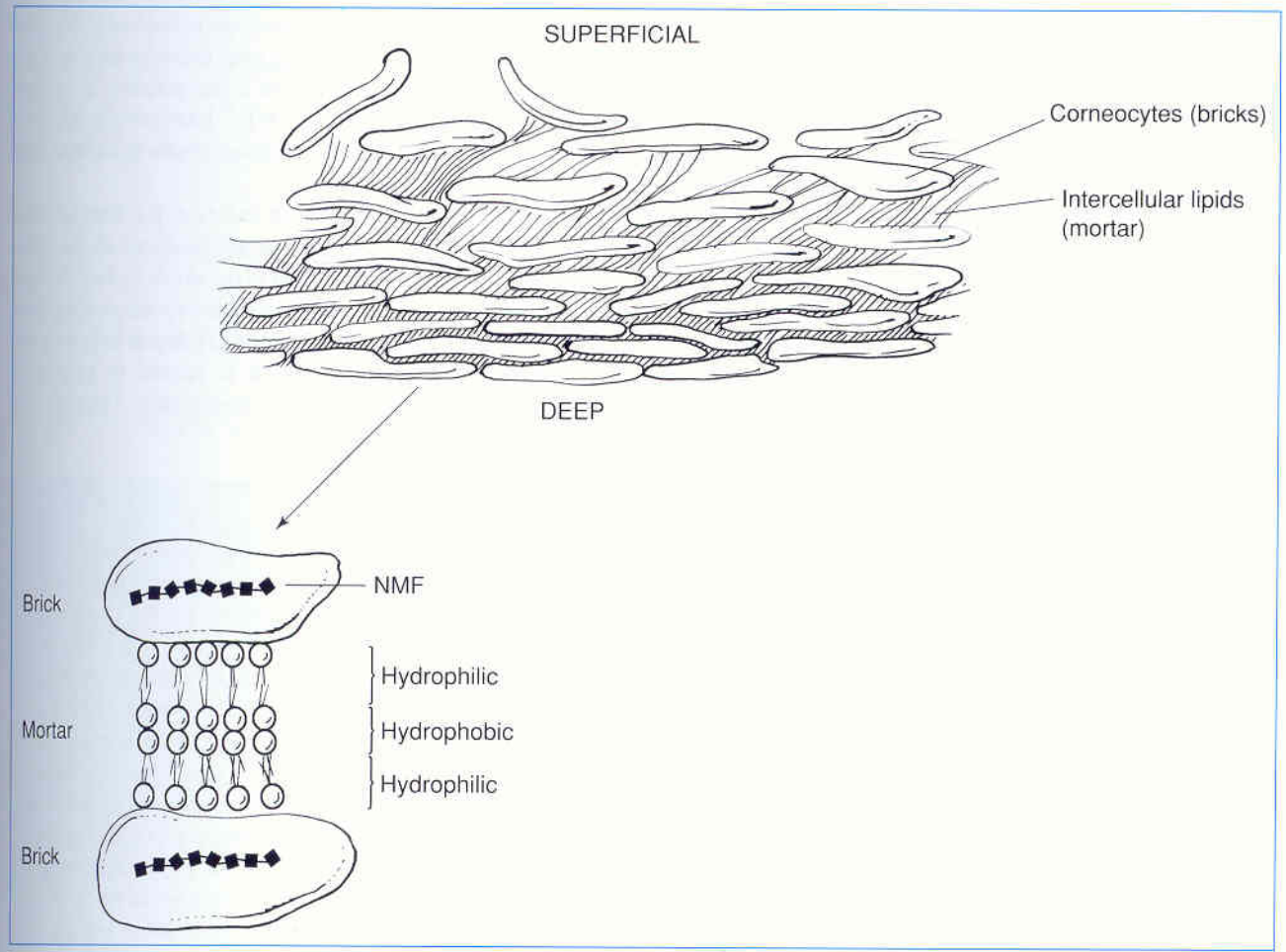


Figure 1-3.
The keratinocytes are embedded in a lipid matrix that resembles bricks and mortar. Natural moisturizing factor (NMF) is present within the keratinocytes. NMF and the lipid bilayer prevent dehydration of the epidermis.

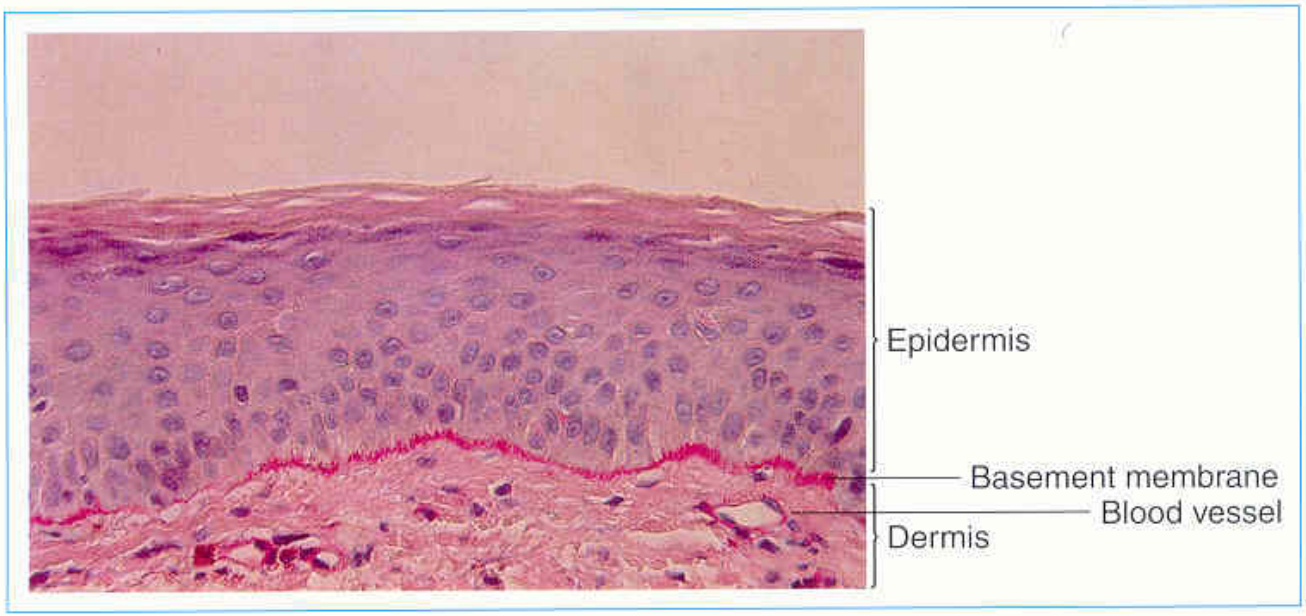


Figure 2-1.
Histopathology of the dermal-epidermal junction. The basement membrane separates the epidermis and the dermis. (Image courtesy of George Ioannides, MD).

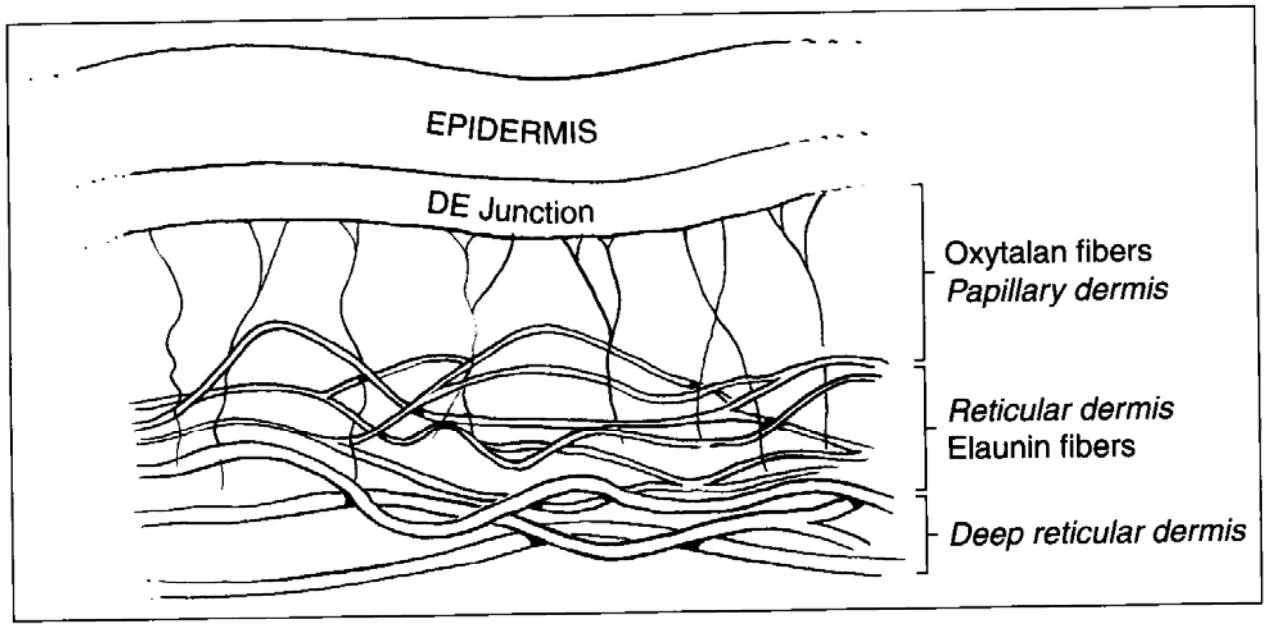


Figure 2-2.
The elastic fiber network in the dermis consists of immature oxytalan fibers in the superficial dermis and the more mature elaunin fibers in the middle dermis. The most mature elastic fibers are unnamed and are found in the deep reticular dermis.