



Dry skin is also called xerosis. The complex factors contributing to dry, flaky skin are just beginning to be understood. Some of these relate to the environment and some relate to the particular individual involved. There are individual and genetic factors, which make some persons more susceptible than others to this problem. As the biochemistry of dry skin becomes better understood, we are better able to treat this problem.

## The Biochemistry of Dry Skin

The structure of the epidermis, the outermost layer of skin and the stratum corneum, and the outermost layer of the epidermis are of greatest importance in determining who develops dry skin and when it develops. The epidermis is composed of 4 layers. The cells of the inner layer migrate upward from the basal layer to the granular layer until they reach the outer layer of the stratum corneum. Through this migration, the cells change, losing their nuclei (inner portion containing DNA) and becoming keratinized, thus forming the outer protective keratin layer of the stratum corneum. This outer layer provides a barrier function; it keeps important substances such as cellular fluids and blood within the body and it helps keep out too much water, invading micro-organisms, and toxins that might harm the inner organism if allowed to pass through the skin. When no longer functional, cells of the outer stratum corneum are shed in a process called desquamation.

Junctional bridges called desmosomes hold all cells, including those of the stratum corneum, together. When the cells are no longer functional, the desmosomes break down so the cells are no longer held together and can be shed from skin surface. Desmosomes that are “too tight” do not allow for proper shedding of discarded cells. Several enzymes degrade the desmosomes and allow nonfunctional cells to detach from each other and desquamate (shed). Genetic differences in the amount or efficiency of these enzymes also determines the efficiency of this process. If the desmosomes are not degraded properly and the outer nonfunctional cells are held together longer than optimal, dry flaky sheets of skin develop in which the cells are still attached to one another. In a normal process, friction causes very tiny clumps of nonfunctional cells to be shed; in an abnormal process, these clumps are larger since the cells cannot dis-attach from each other, causing them to be more visible, flaky and unattractive.

The spaces between these cells and around the bridges are filled with a substance that provides the primary barrier to water loss. The composition of this substance is very important in protecting against excessive skin dryness. This substance has a very high fat content and such is called lipid-rich. There are primarily 3 critical compounds in this substance — ceramide, cholesterol, and fatty acids. The total amounts of these 3 compounds as well as their proportions to each other are all very important in healthy function of the skin barrier.

Ceramide, cholesterol, and fatty acids are further classified as to type. For example, there are 9 different chemical classes of ceramides, each doing something a little different from the others. We actually do not understand the exact roles of all of these subtypes as yet and much more research needs to be done in this area. We do know that the ceramides present as longer chains provide a better water barrier than the short-chain ceramides. People with dry skin (and with diseased skin) have too much of the short-chain ceramides and not enough of the long-chain ceramides. Linoleic acid, an essential fatty acid that must be provided in the diet, is especially important in the synthesis of long-chain ceramides. Essential fatty acids are found in the omega-3 and the omega-6 group, found in cold-water fish (salmon, herring, and mackerel) and in nuts, avocados, flax seed oil.

Some shapes of fats (lipids) in the skin act as better barriers than others. The “packing” of these molecules against and around each other determine how much water is let through. The amount of water allowed through a barrier is referred to as the barrier’s permeability; high permeability means a lot of water is let through and low permeability means less water is allowed through. As the cells of the epidermis migrate upward, the substance between them composed of these lipids changes configuration so that the barrier is weaker at the outermost layers of the stratum corneum. The deeper layers contain lipids that are more tightly packed against each other and less permeable to water; the outer layers have more loosely packed lipids and are more permeable to water. The more tightly packed lipids have rhomboid shapes (looking like a slightly squashed rectangle) and the loosely packed lipids have hexagonal shapes.

These packing states also influence the ease at which discarded cells are shed from the skin surface (desquamation). Higher ceramide content tends to keep the cells together. Aged skin at all times and everyone’s skin during winter contains a lower ceramide content; this contributes to weakened barrier function. People living in the very hot environment of the Arizona desert have skin with higher ceramide content which is, therefore, stronger than skin of those living in New York. A very humid environment causes a similar increase in the amount of ceramides. Lower amounts of ceramides are seen with dry, flaky skin. Changes in the types of ceramides are also seen in persons who develop dry skin very easily, such as those with atopic dermatitis (inflamed, dry skin secondary to allergy and hypersensitivity). People with atopic dermatitis have decreased skin moisture (impaired barrier function of skin) and have decreased skin lipids.

*Itch* — Dry skin itches. However, itch is a poorly understood component of dry skin. We know from animal studies that itching relates to individual and genetic differences in the spinal cord and in chemicals that transmit nerve impulses. Animals with genetic defects that spontaneously itch also have a stratum corneum with a weakened barrier function.

## Summary

Biological processes of the stratum corneum leading to dry skin, as described above, are—lower ceramide levels, deficient enzymes that break up desmosomes (which causes shedding skin cells to stick to each other longer than they should forming flaky sheets), lower levels of long-chain ceramides, disruption in lipid packing shapes, essential fatty acid deficiency, increased itching from a variety of mechanisms, and genetic differences which could lead to any of the above abnormalities.

## Treatment of Dry Skin

Doctors have very inconsistent prescribing practices in treating dry skin. Patients often receive conflicting and confusing advice, which causes difficulty in following a therapeutic regimen. In Great Britain, the “ABC Dry Skin and Eczema Management Programme” has been developed with a simple set of guidelines for treating dry skin. However, many substances helpful to dry skin have only fairly recently been described in the research lab and are unknown by many clinicians. Some of the agents that are known to help this problem are described below:

*Glycerol* — Glycerol helps with moisturization. It does so by helping desmosome bridges between stratum corneum cells to degrade so the cells can be shed appropriately. Glycerol also helps the lipid molecules between cells provide a better barrier to water. In addition, it somehow assists in the formation of the more effective long-chain ceramides. Urea-containing creams have also been found to moisturize, although they have a higher incidence of irritation associated with them than glycerol.

*Hydroxy Acids* — Both alpha hydroxy acids and beta hydroxy acids assist with the proper shedding of dead skin cells. Alpha hydroxy acids encourage lipid synthesis in the intercellular areas, which improves barrier function and improves dry skin. Lactic acid, an alpha hydroxy acid, particularly improves ceramide synthesis.

*Enzymes* — Some topical enzymes help the desmosome connections between cells break down so the cells can come apart and be shed. The pancreatic enzyme chymotrypsin and papain, found in pineapple, both work in this way. Enzymes from a bacterium called *Bacillus licheniformis* are also being studied in the research lab.

*Improving Lipid Synthesis* — Placing the correct ratio of a substance containing the 3 major intercellular lipids (ceramides, cholesterol, fatty acids) on the skin causes an improvement in dry skin. Furthermore, aged skin seems to be more deficient in cholesterol and providing a lipid mixture with more cholesterol accelerates skin barrier recovery in older persons, but not in younger.

*Niacinamide* — This Vitamin B3 derivative has several beneficial effects in dry skin. It encourages synthesis of ceramides.

*Linoleic Acid* — This is an essential fatty acid necessary for proper growth and development of the epidermis. It also is required for synthesis of the important long-chain ceramides necessary to protect against dry skin. An “essential” fatty acid refers to the fact that the substance cannot be made by the human body and must be provided in the diet. Other non-essential fatty acids, such as those found in coriander seed oil, improve dry skin by increasing ceramide synthesis.

*Controlling Itch* — New topical antihistamines that counteract histamine receptors in the skin will probably decrease itch in the future. Another receptor in the skin related to itching is the cannabinoid receptor (yes, the same one stimulated by marijuana) but, unlike the histamine receptor, it decreases itch. Itching also increases with inflammation, which activates and irritates nerve endings.

*Magnesium and Calcium* — Salts containing magnesium and calcium improve barrier function of the skin and help dry skin or prevent its development.

*Vitamin C* — Vitamin C increases ceramide synthesis in the skin and causes more of the long-chain beneficial ceramides to be made. Both these effects help with dry skin.

## Environmental Factors

Dry skin tends to worsen in the winter season. As mentioned earlier, there are differences in ceramide synthesis during winter, with a relative deficiency in the long-chain more protective ceramides. Low humidity of a dry environment, either in the winter or at other times, encourages itch by increasing mast cell number and histamine content in the skin, both of which contribute to itching. Lower humidity also changes the fatty acid content of the skin, causing dry skin. Too much exposure of the skin to water also disrupts the ability of the cells to act as an effective barrier. With aging and stress, the skin is less able to accommodate to environmental factors that may be present.

Interestingly, some buildings have been associated with the development of dry skin, especially dry facial skin. People with allergies were more sensitive to skin changes in “sick buildings”. The more time the person spent inside the building, the more likely he/she was to develop dry skin and itching related to it. Less frequent cleaning of the building led to more severe symptoms. High ventilation flows, passive smoking, and lack of in-room temperature controls were also associated with a higher incidence of dry skin.

## Product Recommendations for Dry Skin

Some of the iS CLINICAL® products recommended for dry skin include: MOISTURIZING COMPLEX and BODY COMPLEX for their moisturizing properties, ACTIVE SERUM™ for its exfoliating properties, PRO-HEAL™ SERUM ADVANCE+ for inflammation and itch control, and POLY-VITAMIN™ SERUM for healthy cellular metabolism and synthesis of protective skin components. SPF 25 TREATMENT SUNSCREEN helps avoid dryness related to new photo-damage. HYDRA-COOL™ SERUM helps soothe itch and provides additional hydration.

## References

“Dry Environment Increases Mast Cell Number and Histamine Content in Dermis in Hairless Mice”, Y Ashida, M Denda; *Br J Dermatol.* 2003 Aug;149(2):240-7.

“Changes in Environmental Humidity Affect the Water-Holding Property of the Stratum Corneum and its Free Amino Acid Content and the Expression of Filaggrin in the Epidermis of Hairless Mice”, C Katagiri, J Sato, J Nomura, M Denda; *J Dermatol Sci.* 2003 Feb;31(1):29-35.

“Effect of Exposure of Human Skin to a Dry Environment”, M Egawa, M Oguri, T Kuwahara, M Takahashi; *Skin Res Technol.* 2002 Nov; 8(4):212-8.

“Abrupt Decreases in Environmental Humidity Induce Abnormalities in Permeability Barrier Homeostasis”, J Sato, M Denda, S Chang, PM Elias, KR Feingold; *J Invest Dermatol.* 2002 Oct; 119(4):900-4.

“New Strategies to Improve Skin Barrier Homeostasis”, M Denda; *Adv Drug Deliv Rev.* 2002 Nov 1; 54 Suppl 1:S123-30.

“Hydration Disrupts Human Stratum Corneum Ultrastructure”, RR Warner, KJ Stone, YL Boissy; *J Invest Dermatol.* 2003 Feb; 120(2):275-84.

“Hydration Effects on the Protein Dynamics in Stratum Corneum as Evaluated by EPR Spectroscopy”, A Alonso, J Vasques da Silva, M Tabak; *Biochim Biophys Acta.* 2003 Mar 21; 1646(1-2):32-41.

“Advances in Stratum Corneum Biology and Understanding of Dry Skin”, AV Rawlings; *Cosmet Toiletr.* 2003 Aug; 118(8):36-42.

“Advances in Dry Skin Stratum Corneum Biology and Moisturization”, AV Rawlings; *Cosmet Toiletr.* 2003 Sep; 228(9):42-52.

“Symptoms Prevalence among Office Employees and Associations to Building Characteristics”, K Skyberg, KR Skulberg, W Eduard, E Skaret, F Levy, H Kjuus; *Indoor Air.* 2003 Sep; 13(3):246-52.

“Correlation between pH and Irritant Effect of Cleansers Marketed for Dry Skin”, L Baranda, R Bonzalez-Amaro, B Torres-Alvarez, C Alvarez, V Ramirez; *Int J Dermatol.* 2002 Aug; 41(8):494-9.

“A Double-Blind Study Comparing the Effect of Glycerin and Urea on Dry, Eczematous Skin in Atopic Patients”, M Loden, AC Andersson, C Anderson, IM Bergbrant, T Frodin, H Ohman, MH Sandstrom, T Sarnhult, E Voog, B Stenberg, E Pawlik, A Preisler-Haggqvist, A Svensson, M Lindberg; *Acta Derm Venereol.* 2002; 82(1):45-7.

“Pharmacotechnical Characterization and Effectiveness Testing of Proposed Emulsion for the Treatment of Dry Skin”, MM Jimenez, MJ Fresno Contreras, E Selles; *Boll Chim Farm.* 2002 Sep-Oct; 141(5):333-42.

“Advised Best Practice for the Use of Emollients in Eczema and other Dry Skin Conditions”, C Holden, J English, C Hoare, A Jordan, S Kownacki, R Turnbull, RC Staughton; *J Dermatolog Treat.* 2002 Sep;13(3):103-6.

“Xerosis and Pruritus in the Elderly: Recognition and Management”, RA Norman; *Dermatol Ther.* 2003;16(3):254-9.

“Comparison of Epidermal Hydration and Skin Surface Lipids in Healthy Individuals and in Patients with Atopic Dermatitis”, PG Sator, JB Schmidt, H Honigsmann; *J Am Acad Dermatol.* 2003 Mar;48(3):352-8.

“Phase Behavior of Stratum Corneum Lipid Mixtures Based on Human Ceramides: the Role of Natural and Synthetic Ceramide 1”, JA Bouwstra, GS Gooris, FE Dubbelaar, M Ponec; *J Invest Dermatol.* 2002 Apr;118(4):606-17.

“Efficacy of Stratum Corneum Lipid Supplementation on Human Skin”, L Coderch, M De Pera, J Fonollosa, A De La Maza, J Parra; *Contact Dermatitis.* 2002 Sep;47(3):139-46.

“C-fos Expression in Superficial Dorsal Horn of Cervical Spinal Cord Associated with Spontaneous Scratching in Rats with Dry Skin”, H Nojima, MI Carstens, E Carstens; *Neurosci Lett.* 2003 Aug 14;347(1):62-4.