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Electron microscopy in studies of the epidermal barrier function

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ABSTRACT
Skin permeability barrier is situated in the lower portion of the horny layer (stratum corneum, SC), at the top of the epidermis. This final product of epidermal terminal differentiation is composed of dead keratinocytes embedded in lipid extracellular matrix. In order to appropriately respond to the changing environmental challenges (e.g., mechanical and chemical stress, ambient humidity, microbiota), SC must be continuously recycled. Desquamation of the superficial cells is constantly compensated by cornification of the granular layer keratinocytes. During this process, living cells from the stratum granulosum undergo remarkable changes, starting with a massive secretion of lipids and proteins into the intercellular space, followed by an extensive cross-linking of proteins and surface lipids at the cell periphery, and ending with the cell death. Still, dead keratinocytes of SC, called corneocytes, maintain some structures present in the living precursors, notably cell-cell junctions, which become strengthened by the process of cross-linking to the cornified envelope and largely contribute to the remarkable mechanical resistance of the tissue. Progressive changes in the dead SC leading first to the formation of permeability barrier in the SC compactum, then to desquamation of the SC disjunctum are mediated by intra- and extra-cellular enzymes pre-formed in the granular layer. To operate, these enzymes need water environment and appropriate pH. Their activity is, thus, largely dependent and influenced by the ambient conditions, what explains how epidermal barrier function can be regulated by and adapt itself to the environment. As it comes to the extracellular lipid filler, rendering SC relatively impermeable to water and water-soluble substances, the auto-assembly of various lipid species into molecular bi-layers is indispensable for that function. Hydrophilic inclusions containing water-compatible molecules (proteins/enzymes, hyaluronan and other glycans), persisting from the living layers or freshly secreted to the extracellular space during cornification, get sequestered within the layered lipids. Swelling and coalescence of these lacunae upon SC hydration is observed. This may explain how such newly created water channels contribute to the passage of water-compatible compounds through the water-repellant SC barrier.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS

stratum corneum | electron microscopy | tight junctions | hydrophilic lacunae

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