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新時代を拓く香粧品科学

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Pioneering a New Era with Cosmetic Science

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**Abstract**

Cosmetic science is pioneering a new era, with cosmetics evolving from daily commodities to essential tools that significantly support quality of life (QOL) and self-expression in modern society. This paper explores the future of this field from a pharmaceutical perspective, focusing on the science of transdermal absorption and the intricate structure of the skin. The greatest challenge to the transdermal delivery of active ingredients is the formidable barrier function of the skin's outermost layer, the stratum corneum. This thin layer's resilience is attributed to its unique "brick-and-mortar" structure, where protein-rich corneocytes ("bricks") are embedded in a highly organized intercellular lipid matrix ("mortar"). This lipid matrix—composed primarily of ceramides, cholesterol, and free fatty acids—forms specific, tightly packed lamellar structures (Long and Short Periodicity Phases) that effectively block the passage of substances. Advanced analytical techniques, such as synchrotron X-ray diffraction and differential scanning calorimetry (DSC), are essential for elucidating this complex nanoscale architecture. Research utilizing these methods shows that penetration enhancers, like oleic acid or menthol, improve permeability by fluidizing these lipid structures. They disrupt the highly ordered orthorhombic and hexagonal packing of the lipids, inducing a reversible transition to a more disordered, liquid crystalline state, which creates pathways for molecules to permeate the skin. Understanding these molecular-level mechanisms is not only critical for designing safer and more effective cosmetics and transdermal drug delivery systems but also offers vital insights into the pathology of skin diseases like atopic dermatitis, which are characterized by a compromised barrier. The ongoing integration of advanced structural analysis and cosmetic science promises to drive future innovations that enhance human health and well-being.

**Key words:** Cosmetic science, Transdermal absorption, Stratum corneum, Intercellular lipids, Lamellar structure, Synchrotron X-ray diffraction.