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皮膚の瑞々しさを作り出す表皮細胞のかたち

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Shapes of Epidermal Cells for the Barrier Homeostasis

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Abstract

The barrier of tight junction (TJ) covers the surfaces of the body and organs to keep tissue homeostasis. There exists only one single layer of TJ in the epidermis, a keratinized stratified epithelium, where maintaining TJ barrier homeostasis is crucial for proper formation of stratum corneum. The mechanism by which keratinocytes continuously turn over without compromising the TJ barrier was unknown. We visualized the three-dimensional organization of epidermal TJ by whole-mount staining of mouse ear skin for ZO-1 and found that double-edged TJ polygons were scattered in a single-layered TJ honeycomb. *In vivo* live imaging of Venus-fused ZO-1 transgenic mice demonstrated that a new TJ polygon is appeared sporadically at the basal side of each TJ-bearing cell, resulting to form double-edged polygons. Subsequently the apical-side TJ polygon disappears, thereby expelling the cell from the inside to the outside TJ barrier. Permeation assay using exfoliative toxin that digests Dsg1 revealed that Dsg1 molecules enclosed by the basal-side TJ polygon were escaped from the digestion, confirming the occlusive function of the basal-side TJ polygon. Isolated TJ-bearing cells have a polyhedral shape similar to flattened Kelvin's tetrakaidecahedron previously observed in corneocytes, which is a flattened variation of the optimized shape to solve the space partitioning problem coined by Lord Kelvin in 1887. The flattened tetrakaidecahedron shape of cells enables the spatiotemporal orchestration of cell movement across the TJ with maintaining TJ barrier homeostasis and cell–cell spatial relationships. Our observations shed light on the hidden cellular architecture essential for developing epidermal barriers.

Key words:　tight junction, epidermal barrier, stratum corneum, Kelvin's tetrakaidecahedron.