

# **Understanding of direct translocation of nanoparticle across cell membrane: analysis by molecular dynamics simulation and planer lipid bilayer method**

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In next generation cosmetics utilizing nanoparticles, the nanoparticles are often required to translocate across a cell membrane. Application of the external electric field has been utilized to increase the cell membrane permeability, however, damage to the cell can be a great concern. Using a molecular dynamics simulation, we here show that even under a weak external electric field that is lower than the membrane breakdown intensity a cationic nanoparticle directly translocates across a model cell membrane without membrane disruption. We then reveal its physical mechanism. At the contact interface between the nanoparticle and the cell membrane, the electric potential across the membrane is locally enhanced by superimposing the nanoparticle surface potential on the externally applied potential, resulting in the nanoparticle direct translocation. Our finding implies that by controlling the nanoparticle-induced local enhancement of the membrane potential the cellular delivery of nanoparticles via non-endocytic and non-disruptive pathway can be realized.