Nanosecond (Gigahertz) and Microsecond (Megahertz) Pulsed Electric Field Interactions with Cell Membranes

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Abstract

High-intensity nanosecond pulsed electric fields permeabilize cell membranes, restructure phospholipid bilayers, cause intracellular calcium release, depolarize mitochondrial membranes, and induce apoptosis. Molecular simulations reveal the mechanism for the electric field-driven reorganization of phospholipid head groups and water molecules that results in the formation of membrane-spanning water bridges and conductive pores. Progress has been made in taking nanosecond electric pulses to the clinic for the treatment of skin cancers and other lesions, but a deeper understanding of the underlying biophysical phenomena will facilitate the application of this technology in cancer therapeutics through non-thermal, minimally scarring tumor ablation.

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