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Single cell nano-electroporation to laser induced photoporation: Novel approaches for cell therapy and diagnostics

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The ability to precisely deliver of foreign cargo into single living cells is of great interest in cell biology and therapeutics research. Conventional bulk electroporation is widely used but has been known to cause high percentage of cell death and require high voltage sources. Microfluidic electroporation platforms can provide high delivery efficiency with high cell viability through better-controlled electric fields applied to cells. Here we develop micro/nano fabricated single cell electroporation platforms, which is an efficient and fast method for multi-nanolocalized single cell nano-electroporation, where electroporation takes place on a multiple region of individual single cell membrane using ITO nano-electrodes array. The gap between two nano-electrodes are 70 nm with triangle tip diameter of 40 nm, which intense an electric field in a precise region of single cell membrane to deliver biomolecules with high transfection efficiency and high cell viability.

On the other hand we developed photoporation based devices, where nano-second pulse laser is used to interact with metal or metal nanoparticles and form plasmonic nanobubbles, which rapidly grew, coalesced and collapsed to induce an explosion, resulting strong fluid on the cell membrane. Thus plasma membrane can disrupt and form transient membrane pores, allowing the delivery of cargos from outside to inside the cell. Using both of these techniques we successfully deliver dyes, DNA, RNA, QDs and nanoparticles, bacteria in cancer cells as well as stem cell. These new approaches can allow us to analyse different dyes/biomolecules interaction in single living cell with spatial, temporal, and qualitative dosage control, which potentially applicable for medical diagnostics and therapeutic studies.

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