431k Nonviral Transfection of Cells Suspended in Resonant Acoustic Fields

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Even though limited by low transfection efficiency, nonviral-based gene therapy has gradually gained attention due to safety concern of using viral vectors. Quite a few physical and chemical approaches have been developled in the past. However, the application of those methods has been hampered by difficulty of making large-scaled settings. Among them, ultrasound-induced sonoporation has been widely implemented to enhance the efficiency of nonviral transfection. To augment gene delivery efficiency for clinical scale devices, the potency of resonant acoustic fields (RAF) rather than sonoporation was examined in this study. Under RAF exposure, suspended cells driven by the primary radiation force formed cell agglomerates on the pressure nodal planes. It is speculated that nanometer-sized nonviral DNA vectors, circulated between nodal planes by acoustic microstreaming, can harness the pre-formed cell bands as the nucleating sites to attach on. Due to the increase of encounters between gene vectors and suspended cells, transfection efficiency is thereby enhanced. In the experimental setup, 5x106 K562 erythroleukemia cells were exposed to 1-MHz RAF with 0.01 W/cm2 of intensity for 5 min in a 5-mL tubular acoustic chamber. To avoid electrostatic repulsion and facilitate the interaction between gene vectors and cells, eGFP-encoding DNA plasmids were complexed with polycationic polyethylenimine (PEI) prior to RAF exposure. Our results showed that the RAF brought PEI/DNA complexes into close contact with K562 cells at the pressure nodal planes, yielding a 10-fold increment of eGFP transgene expression. In summary, RAF operation was demonstrated to be an attractive engineering approach to enhance gene delivery efficiency. Moreover, it provides a feasible means for delivering nonvial gene vectors to cells suspended in large-scale settings which have significant implication for clinical use.