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VORTEX-INTEGRATED BIO-EDITORS TO CATALYZE PERSONALIZED TREATMENT

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Abstract

Rapid advances in clinical medicine have revealed formidable obstacles associated with individual variations in treatment responses. The heterogeneity leads to the development of personalized medicine for better therapeutic outcomes, but systematic and quantitative single-cell level analyses are imperative to identify factors contributing to the heterogeneity. My group is dedicated to building better tools observe and modulate single cell behaviors to yield new insights into these clinical questions. We bring together of physics, biology, and engineering principles to construct innovative systems that exploit complex non-linear fluid dynamics to manipulate cells and particles for simple and fast biological assays. Particularly, we have developed a microfluidic vortex-assisted electroporator that can sequentially deliver multiple molecules into isolated cell populations in a dose-controlled manner. The system was validated for co-delivery of proteins of varied sizes, drug cocktail screenings, and phenotype alterations via plasmids, siRNA and miRNA using pure populations of cell lines. The fast and gentle blood processing mechanism preserves viability and gene expressions of processed cells and cells remaining in the flow-through solutions. Hence, the flow-through solutions can be recycled to further enhance target cell purification yields or to perform additional complimentary assays. On-going research programs include intrinsic cellular deformability measurement, high-throughput rare cell purification, single-cell assays for early cancer diagnosis, gene-editing platforms for primary cells, and T-cell reprogramming for adoptive cell therapy. Collectively, my group endeavors to construct robust and simple systems to directly assay cells and exosomes purified from patients' blood to perform genetic editing and to create drug delivery cargo to maximize the benefit of liquid biopsy.