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Optimization of high-efficiency transfection of human mesenchymal stem cells with nanosized polyplexes

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Introduction of foreign genes into mammalian cells is a critical technology that offers a strategy for the genetic modification of multipotent human mesenchymal stem cells (hMSCs) for therapeutic use in stem cell-based gene therapy. Unfortunately, adult primary cells including hMSCs are difficult to transfect with commonly used methods for introduction of exogenous DNA. Whereas more effective viral vectors involve safety risks, nonviral methods are often inefficient for most primary cells. Herein we used polyplex nanoparticles for the development of high effective non-viral gene delivery techniques to genetic modification of low passage human umbilical MSC from Wharton's jelly.

In this study, for obtaining nanosized polyplexes (under 400 nm) we used 3 cationic polymers: branched polyethylenimine (PEI), modified galactose-bearing PEI (L-PEI), the commercial carrier TurboFect and the plasmid DNA encoding enhanced green fluorescent protein (eGFP). Transfection effectiveness of polyplexes have been evaluated by fluorescence microscope and FACS after 48 hr of growth post transfection, and green fluorescent protein expression in terms of quantity was calculated against recombinant eGFP by Bio-Tek Synergy HT. For all of the tested nanoparticles the critical transfection parameters leading to maximal high transfection efficiency (i.e. 99.4% for TurboFect, 66.8% for PEI and 23.4% for L-PEI) have been optimized.

As polyplex-transfected cells have shown high viabilities (>90%) and maintenance of MSC properties, the use of such nanoparticles might be an advantageous transfection strategy for safe genetic modification of human stem cells in cell-based gene therapy.