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Supporting Information

Tailoring Head-Tail Mesoporous Silica Nanoparticles for Enhanced Gene Transfection

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Characterization details

The morphology of the silica nanoparticles was characterized by transmission electron microscopy (TEM) using a JEOL 7700 microscope operated at 100 kV. The TEM specimens were prepared by dispersion of the samples in ethanol under ultrasonication, followed by depositing the solution directly onto a carbon film supported copper grid and leaving the film to air dry. The electron tomography analysis was performed on a FEI Tecnai F30 in bright-field TEM mode operated at 300 kV with a Gatan single tilt holder. The ET specimens were prepared by dispersion of the samples in ethanol by ultrasonication, and then deposition directly onto a formvar film supported by a copper grid (hexagonal 50 mesh, Electron Microscopy Science). Colloidal gold particles (10 nm) were deposited on both surfaces of the grid as fiducial markers for the subsequent image alignment procedures. The tomographic tilt series were carried out by tilting the specimen inside the microscope around a single axis under the electron beam. TEM images were recorded over a tilt range of +65 º to -65 º at an increment of 1 ° per tilt. IMOD was used for image processing and reconstruction, allowing the fine structures of the asymmetric nanoparticle visualized in 3D. Nitrogen sorption analysis was conducted using Micromeritics Tristar 3020. Prior to measurement, all samples were subject to vacuum at 180°C for at least 12 h for degassing. The total pore volume was calculated from the amount adsorbed at maximum relative pressure (P/P_0) of around 0.99. The Barret-Joyner-Halenda (BJH) method was used to calculate the pore size distribution, derived from the adsorption branches of the isotherms. The specific surface areas were calculated using the Brunauer-Emmett-Teller (BET) method. The zeta potential of the silica nanoparticles before and after PEI modification was measured in 10 mM PBS using a Zetasizer Nano-ZS from Malvern Instrument. The samples were firstly dispersed in PBS and ultrasonicated for approximately 20 min. The nitrogen content in PEI modified nanoparticles was determined by CHNS-O Elemental Analyzer, using a Thermo Flash EA1112 Series.

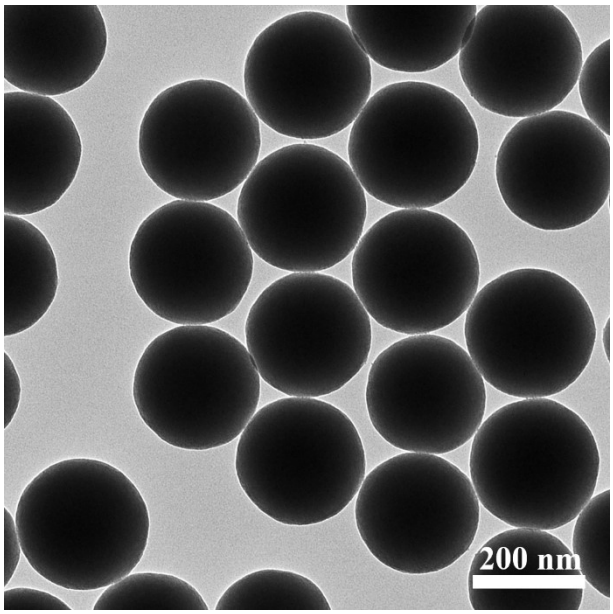

Figure S1 TEM image of stöber silica nanospheres with average particle size around 200 nm.

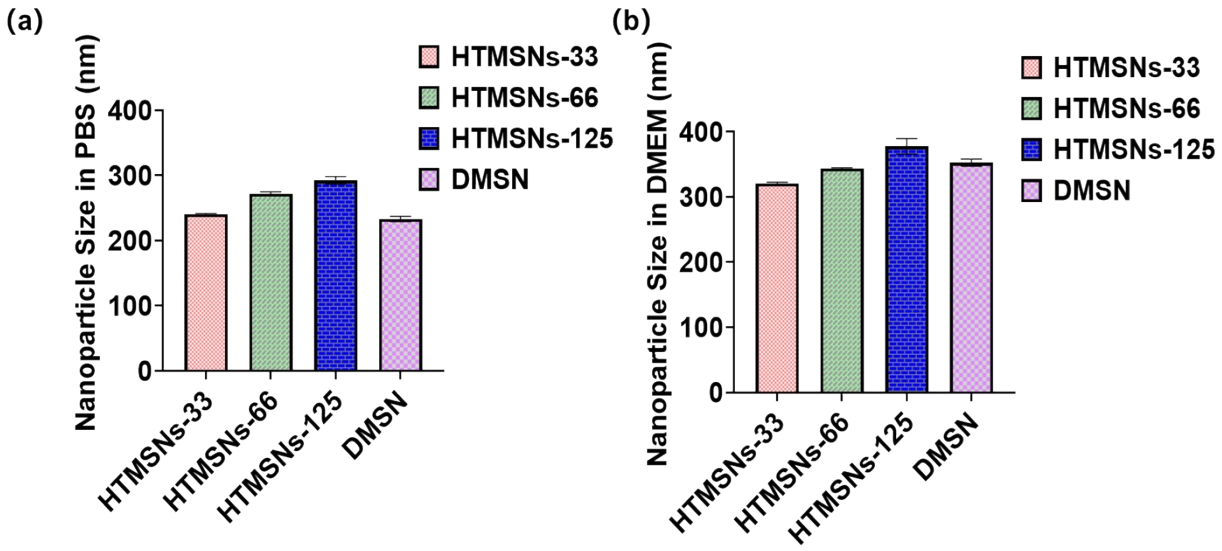

Figure S2 Nanoparticle size distributions measured in PBS (a) and DMEM (b) by dynamic light scattering (DLS).

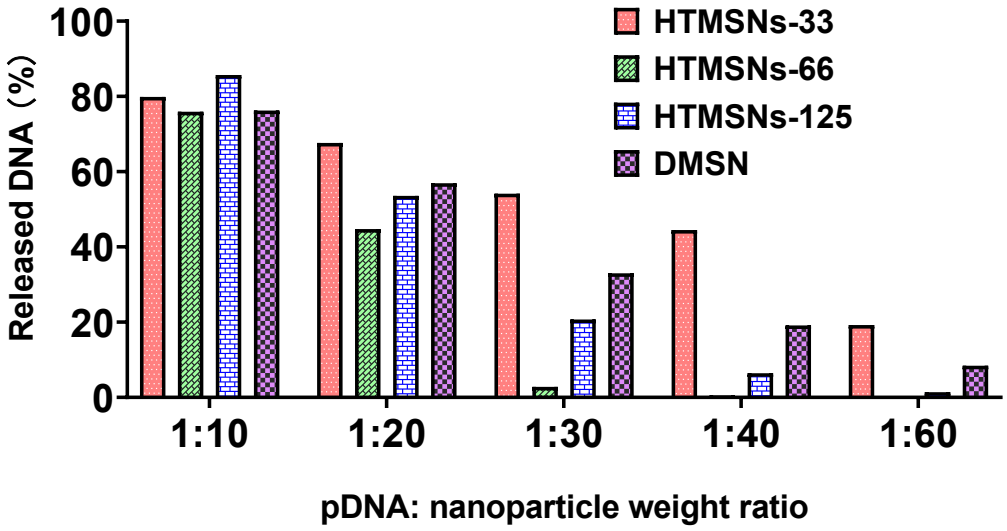

Figure S3 Quantification of the DNA released from nanoparticles under gel electrophoresis analysis using Image J.

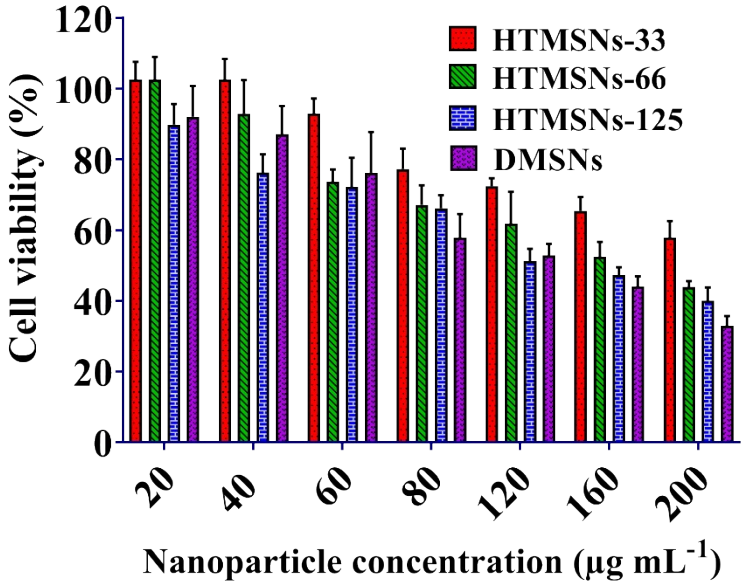

Figure S4 Cell viability of HEK-293T cells treated with pDNA loaded SNPs-PEI engineered with different morphologies at nanoparticle concentrations from 20 to 200 μg mL^{-1}.

Table S1. Physicochemical characterizations of silica nanoparticles

Nanoparticles	S_{BET} [m^2/g]	V_{total} [cm^3/g]	Pore Size [nm]	After PEI modification	
				N content [wt %]	PEI content [wt %]
HTMSNs-33	193	0.279	18.8	1.50 ± 0.01	4.61 ± 0.03
HTMSNs-66	262	0.369	18.8	2.71 ± 0.03	8.31 ± 0.08
HTMSNs-125	293	0.384	21.2	2.73 ± 0.03	8.39 ± 0.09
DMSNs	243	0.537	18.6	3.08 ± 0.03	9.46 ± 0.09