

Supporting Information for

Polymer-coated NaYF₄:Yb³⁺, Er³⁺ Upconversion

Nanoparticles for Charge-dependent Cellular

Imaging

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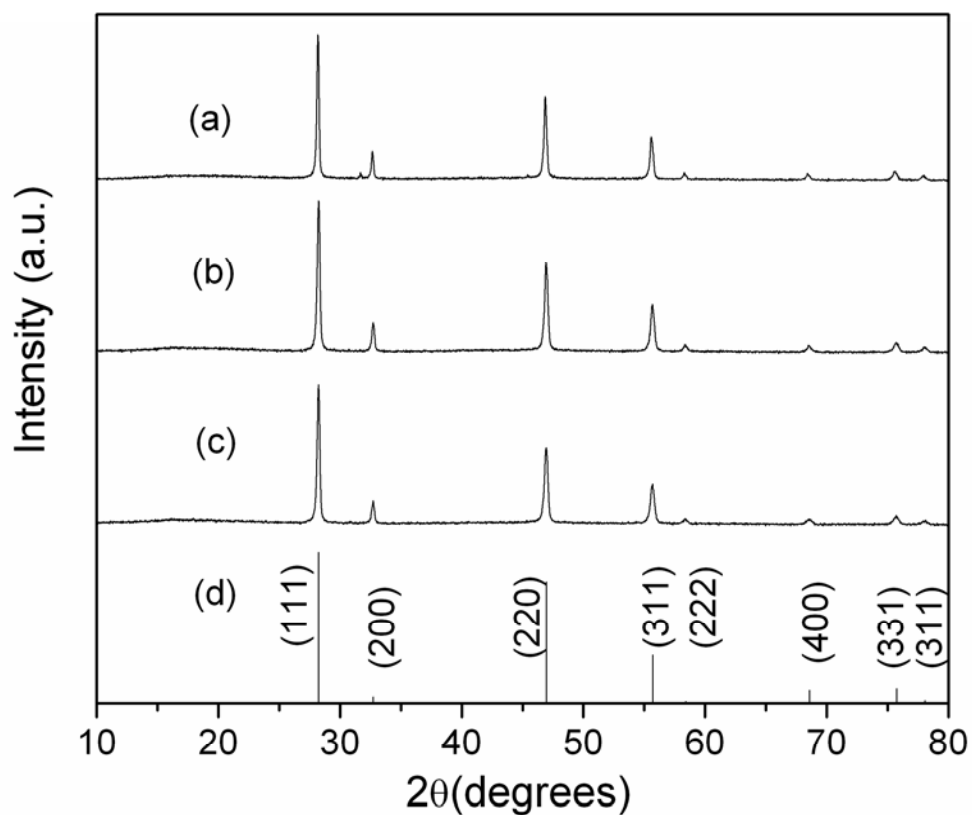
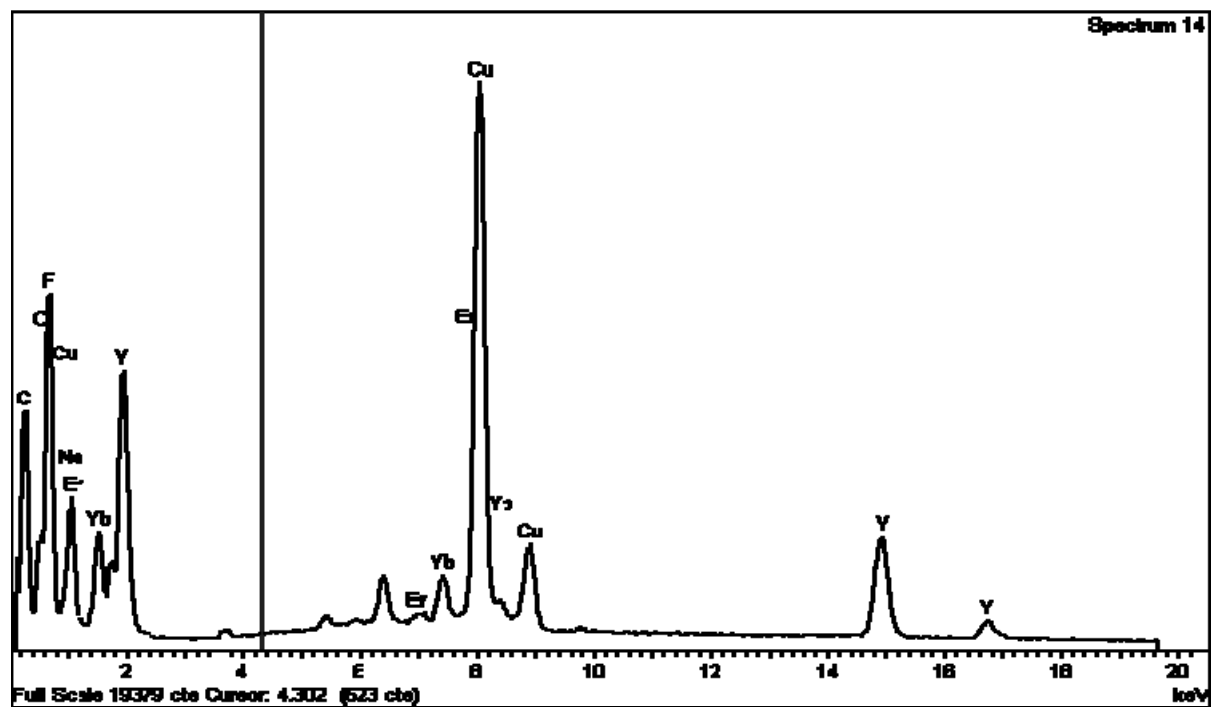


Figure S1. X-ray power diffraction (XRD) spectra of NaYF₄:Yb³⁺, Er³⁺ NPs with various polymer coatings (a) UCNP-PEI, (b) UCNP-PVP, (c) UCNP-PAA, (d) Line pattern of the calculated cubic phase of NaYF₄ (PDF 77-2042).



Element	Peak	Area	k	Abs	Weight%	Weight%	Atomic%
	Area	Sigma	factor	Corrn.		Sigma	
C K	75145	844	2.208	1.213	15.80	0.16	38.86
O K	29700	637	1.810	1.078	4.55	0.09	8.40
F K	118170	793	1.574	1.040	15.18	0.10	23.60
Na K	45865	624	1.237	1.049	4.67	0.06	6.00
Cu K	337660	1119	1.366	0.970	35.12	0.14	16.33
Y K	85222	707	2.467	0.970	16.01	0.12	5.32
Er L	7802	763	2.226	0.971	1.32	0.13	0.23
Yb L	42134	846	2.290	0.971	7.35	0.14	1.25
Totals					100.00		

Figure S2. EDX spectrum of UCNP-PVP (upper) and the corresponding quantitative analysis as shown in the table list (lower).

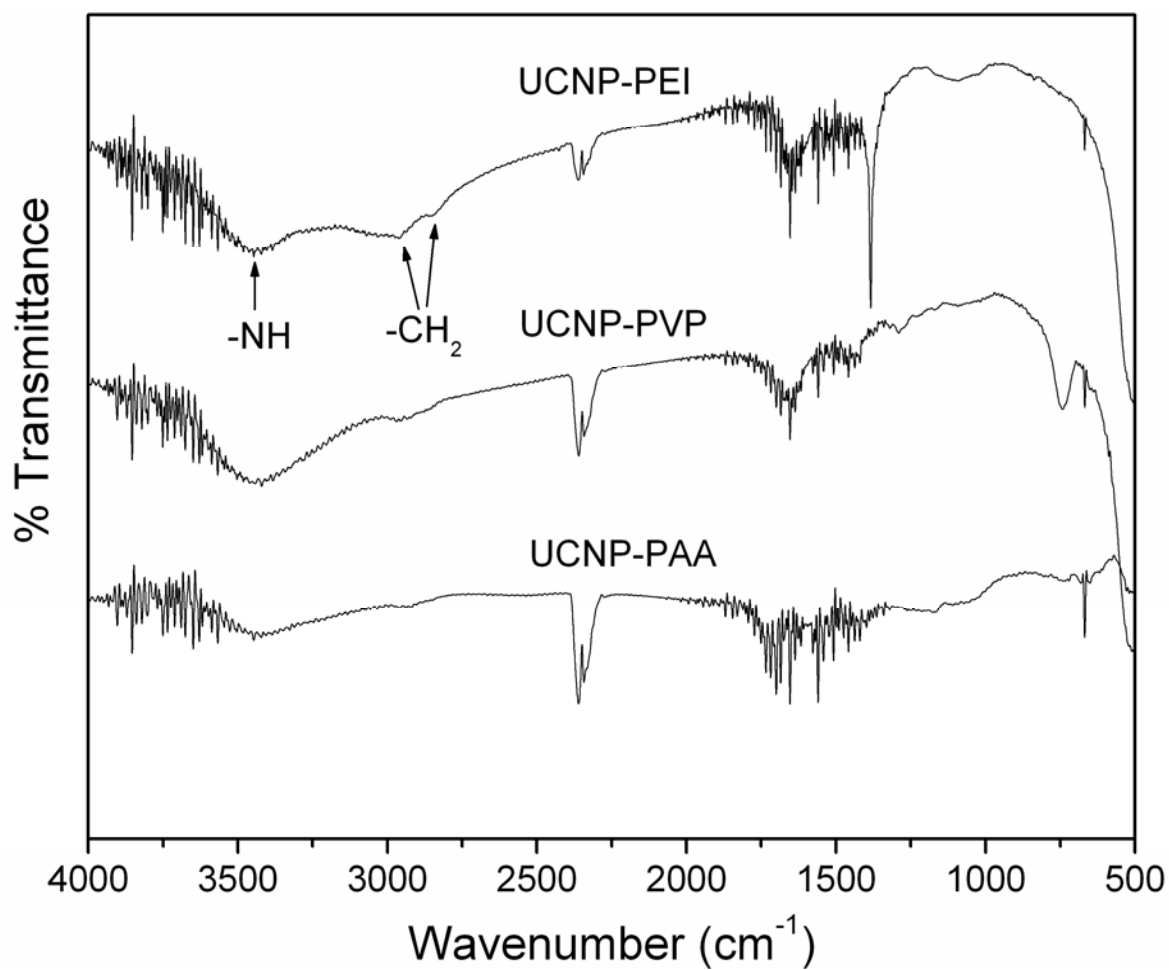


Figure S3. FT-IR spectra of NaYF₄:Yb³⁺, Er³⁺ NPs with various polymer coatings.

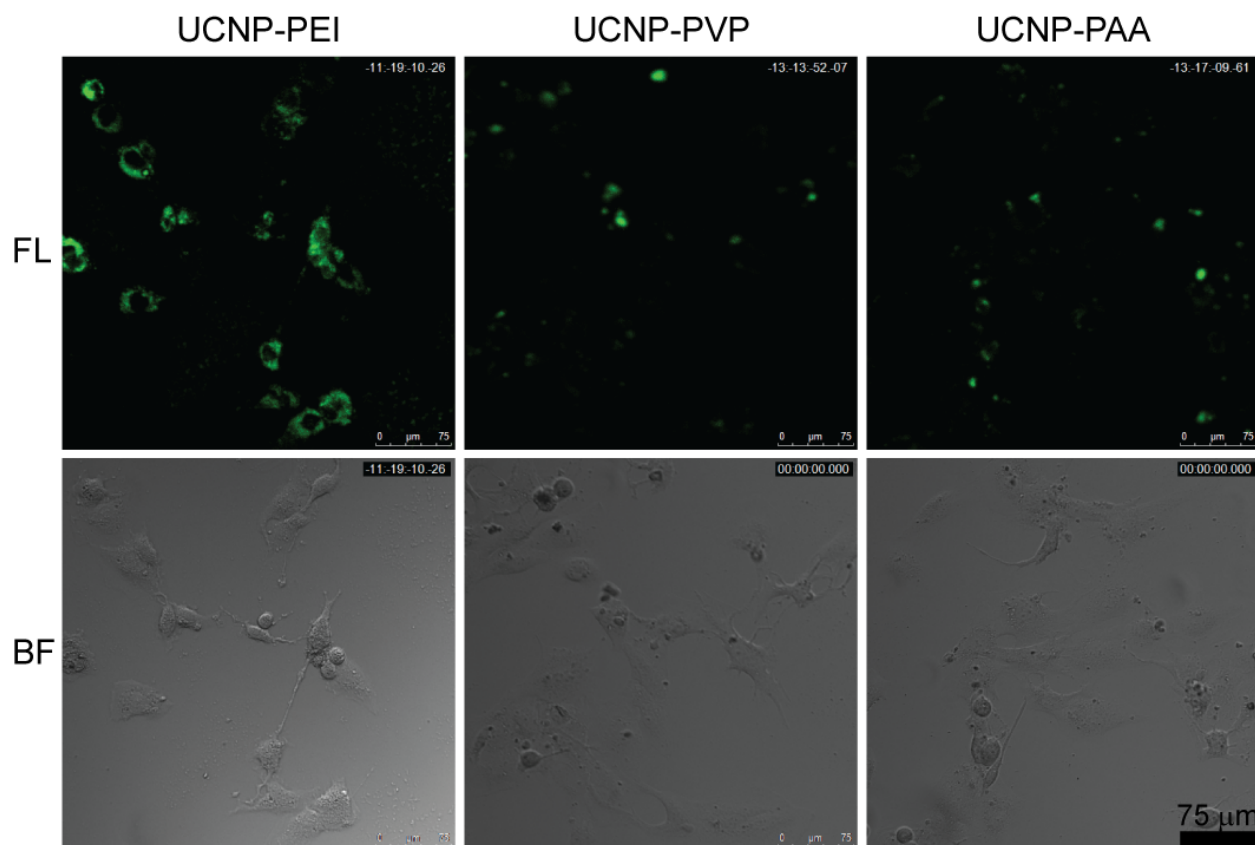


Figure S4. Multiphoton confocal fluorescent (upper) and bright field (lower) images of U87MG cells incubated with 50 $\mu\text{g/ml}$ UCNP-PEI (left panel), UCNP-PVP (middle panel) and UCNP-PAA (right panel). The 980 nm excitation was provided by a femto-second Ti:sapphire pulsed laser, and the green emissions of 540–560 nm were acquired by a PMT channel (10 \times lens, scale bar = 75 μm).

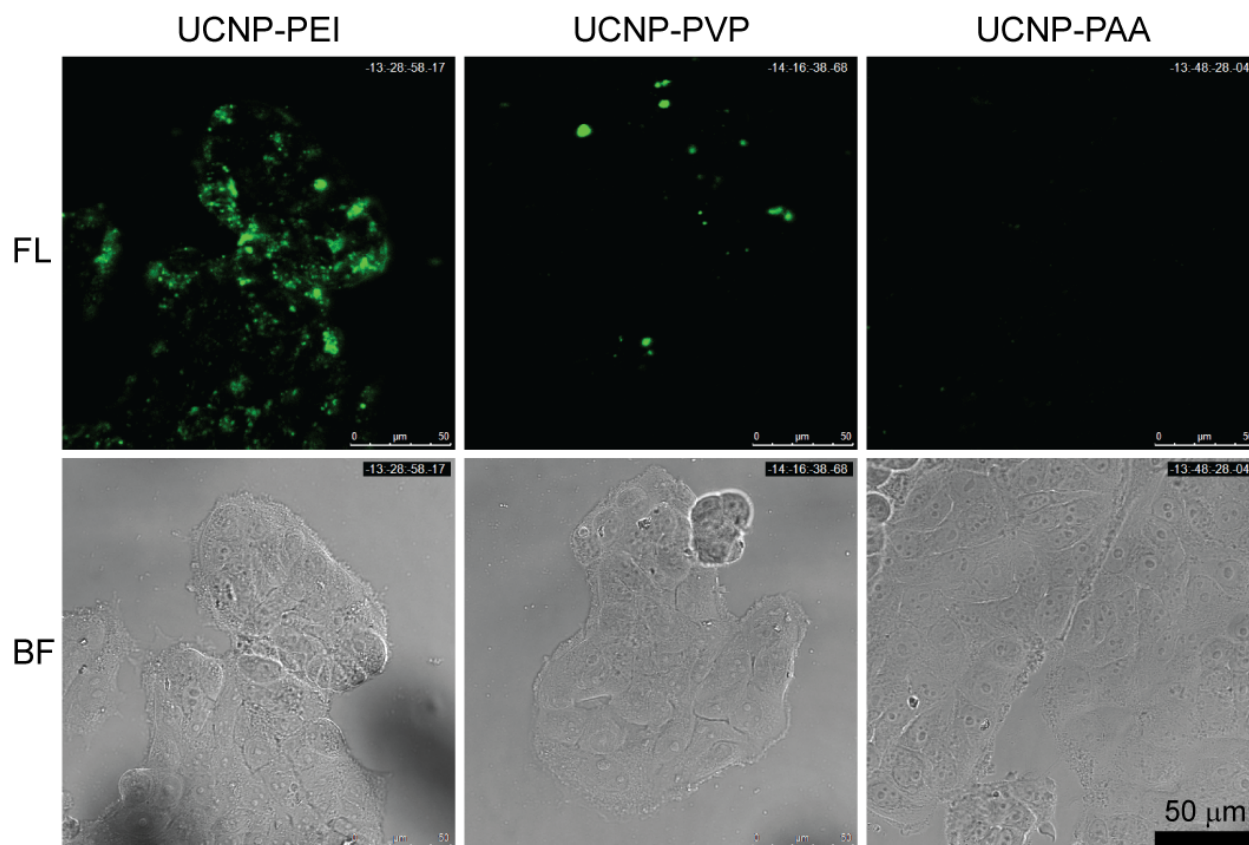


Figure S5. Multiphoton confocal fluorescent (upper) and bright field (lower) images of MCF-7 cells incubated with 50 $\mu\text{g}/\text{ml}$ UCNP-PEI (left panel), UCNP-PVP (middle panel) and UCNP-PAA (right panel). The 980 nm excitation was provided from a femto-second Ti:sapphire pulsed laser, and the green emissions of 540–560 nm were acquired by a PMT channel (40 \times oil lens, scale bar = 50 μm).

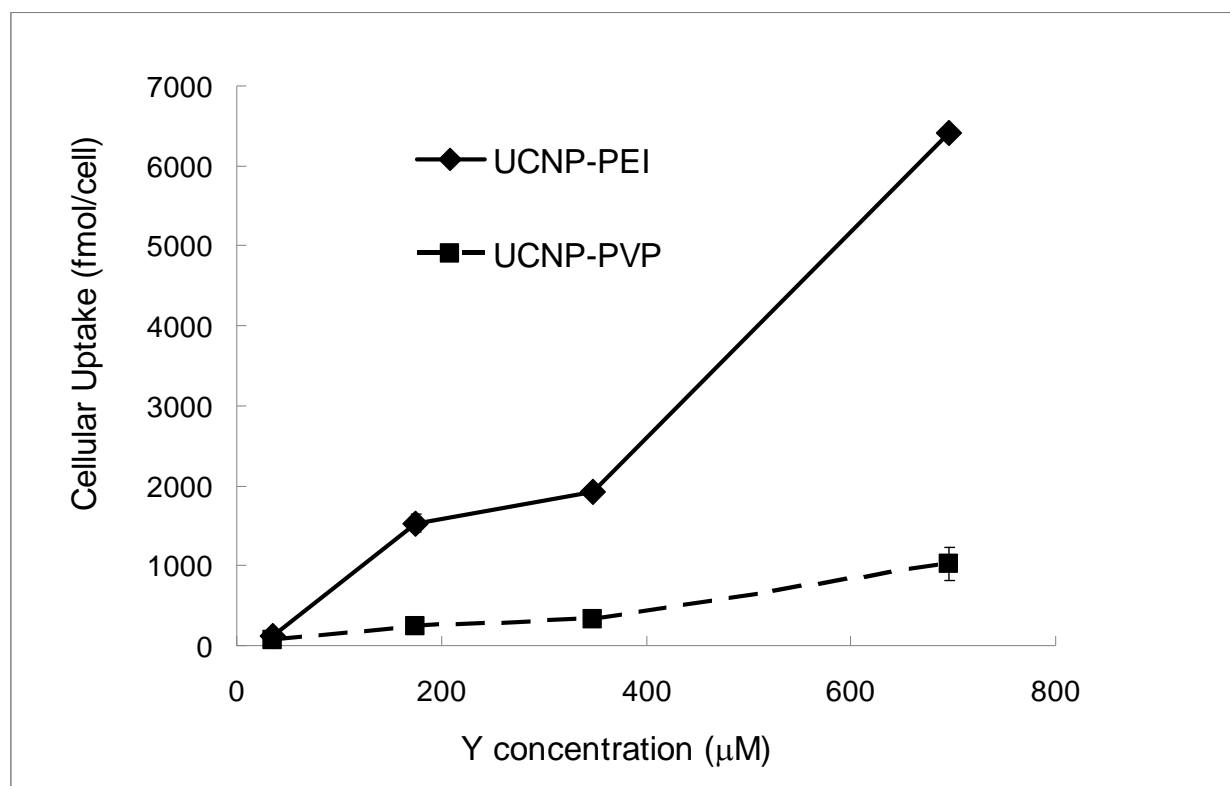


Figure S6. Average molar numbers of yttrium taken by an U87MG cell (fmol/cell) were determined by ICP-MS. U87MG cells were treated with the polymer coated UCNPs with yttrium concentrations ranging from 50 μM to 400 μM at 37 $^{\circ}\text{C}$ for 24 h. Each data point was represented as mean \pm SD from triplicate trials.

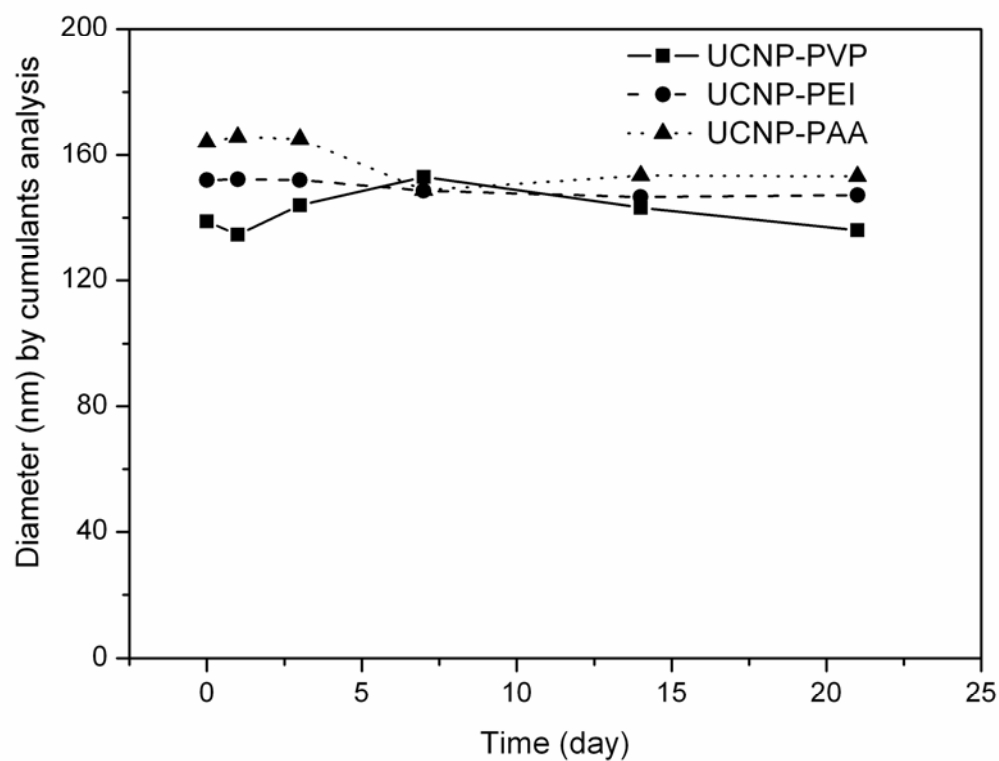


Figure S7. Long term stability test of UCNP-PVP (solid line), UCNP-PEI (dashed line) and UCNP-PAA (dotted line) with a dispersion concentration of 1 mg/mL in aqueous solution.

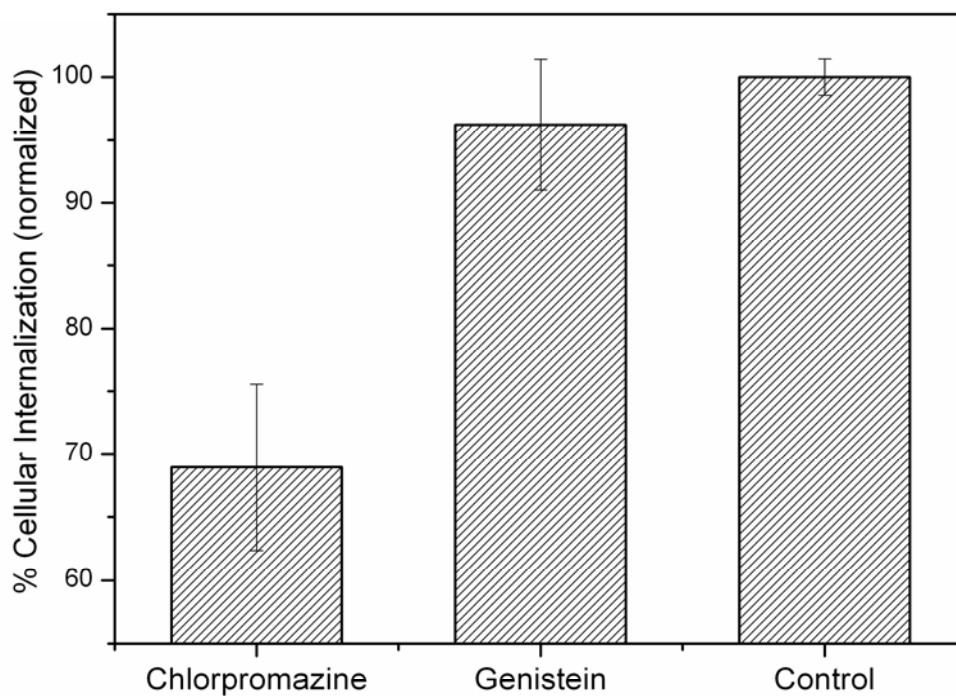


Figure S8. Probing the uptake pathways of UCNP-PEI using chemical endocytic inhibitors. HeLa cells were incubated with chlorpromazine and genistein for the inhibition of clathrin- and caveolae-mediated endocytosis, respectively. HeLa cells treated with UCNP-PEI without inhibitors were used as controls.