



Supporting Information

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Magnetic Nanoparticle-Capped Mesoporous Silica Nanorod-Based Stimuli-Responsive Controlled Release Delivery System**

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Instrumental Methods, Conditions, and Parameters for the Structure Characterizations of Linker-MSN and Fe₃O₄-Capped MSN Materials: Powder XRD diffraction data were collected on a Scintag XRD 2000 X-ray diffractometer using Cu K α radiation. Nitrogen adsorption and desorption isotherm, surface area (SA), and median pore diameter (MPD) were measured using a Micromeritics ASAP2000 sorptometer. Sample preparation included degassing at 90 °C for 1 h. Nitrogen adsorption and desorption isotherms of these materials were obtained at -196 °C. Specific surface areas and pore size distributions were calculated using the Brunauer-Emmett-Teller (BET) and Barrett-Joyner-Halenda (BJH) method, respectively. Particle morphology of these materials was determined by scanning electron microscopy (SEM) using a JEOL 840A scanning electron microscope with 10 kV accelerating voltage and 0.005 nA of beam current for imaging. For transmission electron microscopy measurements, a small aliquot was ground with methanol in an agate mortar and pestle. A single drop of this suspension was placed on a lacey carbon coated copper TEM grid and dried in air. The TEM examination was completed on a Philips model CM-30 operated at 300 kV at 69,000 to 340,000 electron optical magnification. Study of fluorescein release kinetics and different concentrations of fluorescein released under the varying dosage concentration of reduced lipoic acid and DTT were done by recording the fluorescence emission spectra of the aliquots using fluorometer (Fluoromax-2[®]) and matching the fluorescence intensities with that of the calibrated standard results.

APTS Coated Magnetite (Fe₃O₄) Nanoparticles: Ammonium hydroxide (1.50 M) was added drop wise into a vigorously stirred deoxygenated aqueous solution (600.0 mL, pH 1.5) of iron(II) chloride tetrahydrate (498.0 mg, 2.50×10^{-3} mol) and iron(III) chloride hexahydrate (810.0 mg,

2.99×10^{-3} mol). Addition of ammonium hydroxide was continued till the pH of the solution reached 9.0 from 1.5 and black precipitate of magnetite (Fe_3O_4) formed immediately. The black precipitate was separated by magnetic decantation, washed five times with water, two times with ethanol and finally evaporated to dryness to get Fe_3O_4 powder. The obtained magnetite powder (298.0 mg) was then sonicated in 600.0 mL of ethanol with 4.00 mL of H_2O . To this suspension, 3-aminopropyl triethoxysilane (APTS, 113.0 mg, 5.11×10^{-4} mol) was added and was stirred overnight yielding APTS coated magnetite nanoparticles in the form of a brown powder which was isolated after filtering and vacuum drying the reaction mixture.

MCM-41-Type Mesoporous Silica Nanorods (Thiol-MSN): The thiol-MSN material was synthesized by the following procedure: *n*-Cetyltrimethylammonium bromide (CTAB, 1.00 g, 2.74×10^{-3} mol) was first dissolved in 480 mL of Nanopure water. NaOH(aq) (2.00 M, 3.50 mL) was added to CTAB solution, followed by adjusting the solution temperature to 353 K. TEOS (5.00 mL, 2.57×10^{-2} mol) and MPTMS (0.5 mL, 2.64×10^{-3} mol) was added to the solution simultaneously drop wise for a period of 4 min. The mixture was allowed to stir for 2 h to give rise to white precipitates (as synthesized thiol-rods). The solid product was filtered, washed with deionized water and methanol, and dried in air. To remove the surfactant template (CTAB), 1.50 g of as synthesized thiol-rod was refluxed for 24 h in a solution of 6 mL of HCl (37.4%) and 160 mL of methanol followed by extensive washes with deionized water and methanol. The resulting surfactant removed thiol-MSN material was placed under high vacuum to remove the remaining solvent in the mesopores.

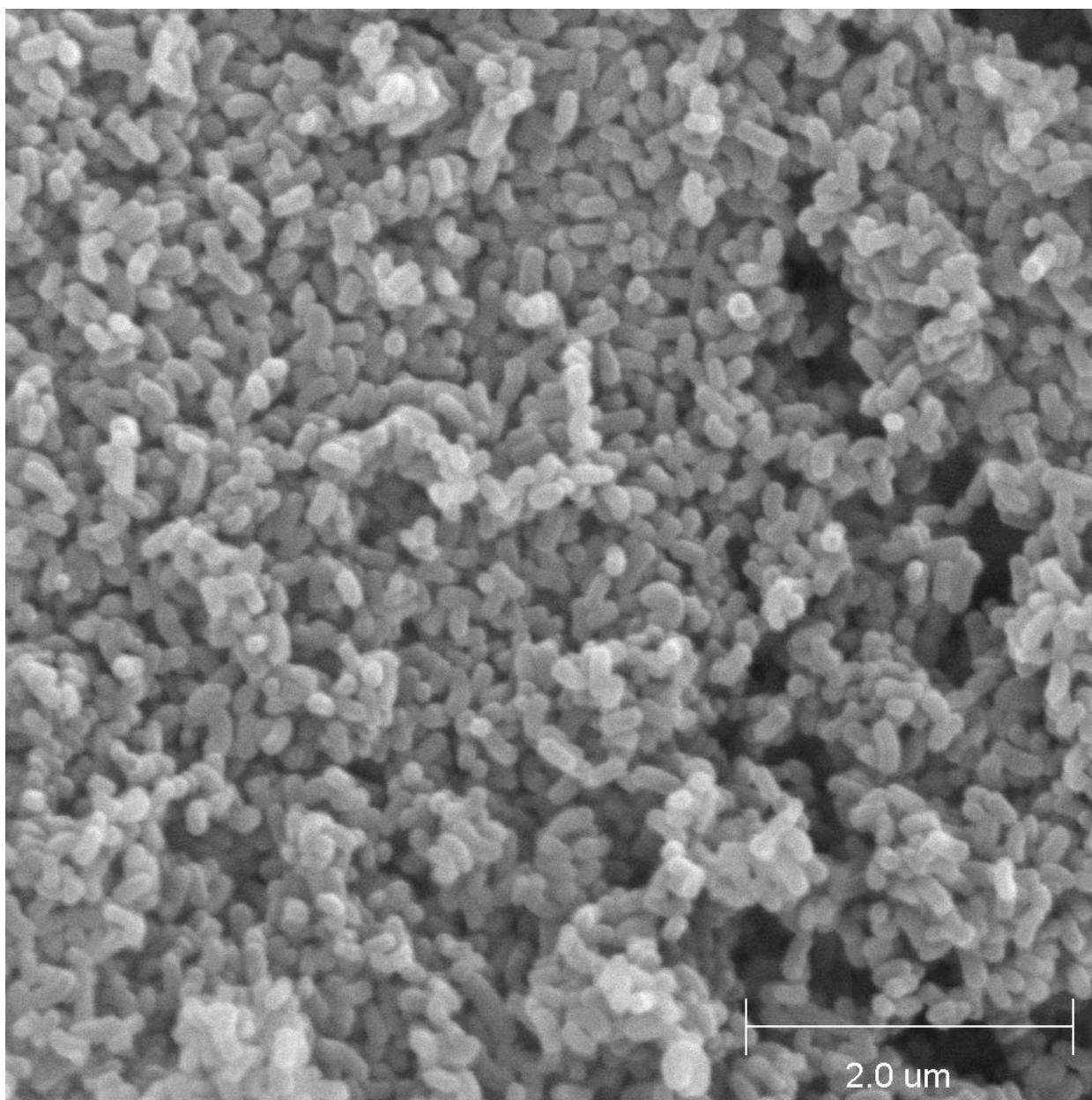


Figure S1. Scanning electron micrograph (SEM) of the rod-like Linker-MSN

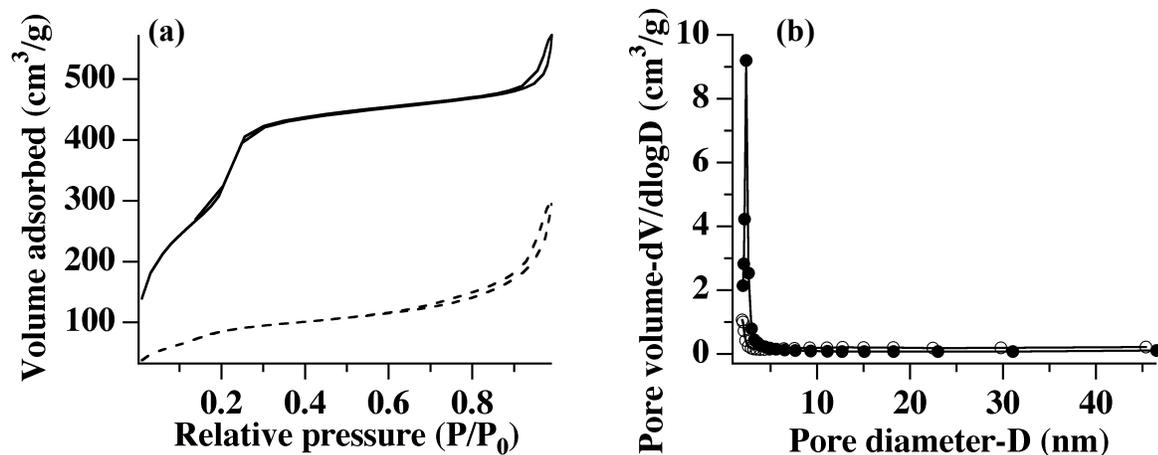


Figure S2. (a) BET nitrogen sorption isotherms of the Linker-MSN (solid line) and Magnet-MSN (dashed line) materials. (b) BJH pore size distributions for the Linker-MSN (—○—) and Magnet-MSN (—●—) materials. The decrease in surface area and the disappearing of the maximum peak in BJH pore size distribution plot indicate that the mesopores of MSN are capped by the APTS coated Fe₃O₄ nanoparticles.

Table S1. Structural parameters of the Linker-MSN and the Magnet-MSN materials

	Nitrogen Sorption Isotherms		
	BET Surface Area (m ² /g)	BET Pore Volume (mL/g)	BJH Pore Diameter (Å)
Linker-MSN	1018	0.79	30.0
Magnet- MSN	296	0.36	--

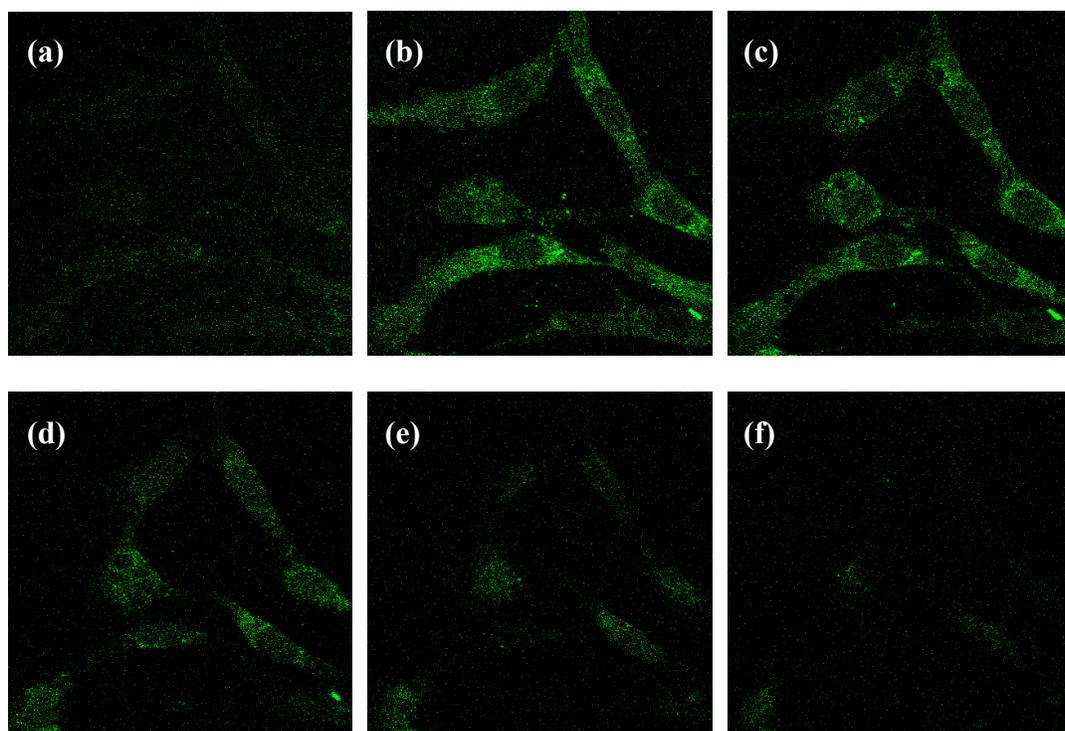


Figure S3. Fluorescence confocal micrographs of HeLa cells after 10 h incubation demonstrating endocytosis of Magnet-MSNs **(a)-(f)**. Each frame represents a focal point with 1.2 μm vertical difference.