Supporting information

Experimental Section:

Synthesis of MSN-NH_2.

N-Cetyltrimethylammonium bromide (CTAB, 1.00 g, 2.74 mmol) was dissolved in 480 mL of water. Sodium hydroxide aqueous solution (2.00 M, 3.50 mL) was introduced to the CTAB solution and the temperature of the mixture was adjusted to 80 ℃. Tetraethoxysilane (TEOS, 5.00 mL, 22.4 mmol) was added dropwise to the surfactant solution under vigorous stirring. The mixture was allowed to react for 2 h to give rise to a white precipitate. This solid crude product was filtered, washed with nanopure water and methanol, and dried under high vacuum to yield the as-synthesized MSN. To remove the surfactant template (CTAB), 1.50 g of the as-synthesized MSN was refluxed for 6 h in a methanolic solution of 1.50 mL HCl (37.2%) in 150 mL methanol. The resulting material was filtered and extensively washed with nanopure water and methanol. The surfactant-free MSN material was placed under high vacuum with heating at 60 ℃ to remove the remaining solvent from the mesopores. MSN (1.00 g) was refluxed for 20 h in 80.0 mL of anhydrous toluene with 1.00 mL (5.67 mmol) of 3-aminopropyltrimethoxysilane to yield the 3-aminopropyl-functionalized MSN (MSN-NH_2) material.

Synthesis of BA-MSN.

The purified MSN-NH_2 (400 mg) was dispersed in 20 mL dimethyl sulfoxide (DMSO). 0.15g (0.90 mmol) 4-carboxyphenylboronic acid (CBA) was reacted with 0.10g (0.87 mmol) N-hydroxysuccinimide (NHS) and 0.20g (1.04 mmol) 1-ethyl-3-(3-dimethylaminopropyl) carbodiimide hydrochloride (EDC) in 5.0 mL DMSO, stirring at room temperature for 15 min before adding to the MSN-NH_2 suspension. The mixture was stirred at room temperature for another 24 h, followed by filtration and washing with DMSO, water and methanol.

Synthesis of Glucose-coated CeO_2 nanoparticles.

A solution containing 1M cerium (III) nitrate hexahydrate solution (2.17g in 5.0 mL of water) was mixed with 0.5 M solution of glucose. Under continuous stirring, the mixture was added to 30.0 mL ammonium hydroxide (Sigma Aldrich, 30%) solution. The mixture was then stirred continuously for 24 h, at this

point the solution has changed from a light yellow to a deep brown color indicating the formation of stabilized glucose coated nanoceria. The preparation was then centrifuged at 3000 rpm for two 30 minute cycles to settle down any debris and large agglomerates. The supernatant solution was purified from free glucose using centrifuging at 13000 rpm for 20 min and then washed with water. Finally, the glucose coated CeO_2 nanoparticles were dispersed in water.

Synthesis of Fluorescein Loaded G- CeO_2NP-MSN.

The purified BA-MSN (100.0 mg) was stirred in a solution of fluorescein (Flu) (1 mM) in PBS solution for 24 h in dark. Then, G-CeO_2NP (100 mg) was added to the suspension. The mixture was stirred in dark for another 24 h, following by filtration and washing extensively with PBS to remove physisorbed Flu and uncapped G-CeO_2NP from the exterior surface of the material. The resulting precipitate was isolated and dried under high vacuum.

Synthesis of CQ Loaded IgG-MSN.

The purified BA-MSN (100.0 mg) was stirred in a solution of CQ (1 mM) in methanol solution for 24 h in dark. Then, CQ filled BA-MSN was harvested by centrifugation and resuspended in PBS. G-CeO_2NP (100 mg) was added to the suspension. The mixture was stirred in dark for another 24 h, following by filtration and washing extensively with PBS and water to remove physisorbed CQ and uncapped G-CeO_2NP from the exterior surface of the material. The resulting precipitate was isolated and dried under high vacuum.

Flu Release Experiments.

Flu-loaded G-CeO_2-MSN (5 mg) material was dispersed in 10 ml of PBS buffer (10 mM, pH 7.4). Aliquots were taken from the suspension and the delivery of Flu dye from the pore to the buffer solution was monitored via the absorbance band of the dye centered at 484 nm.

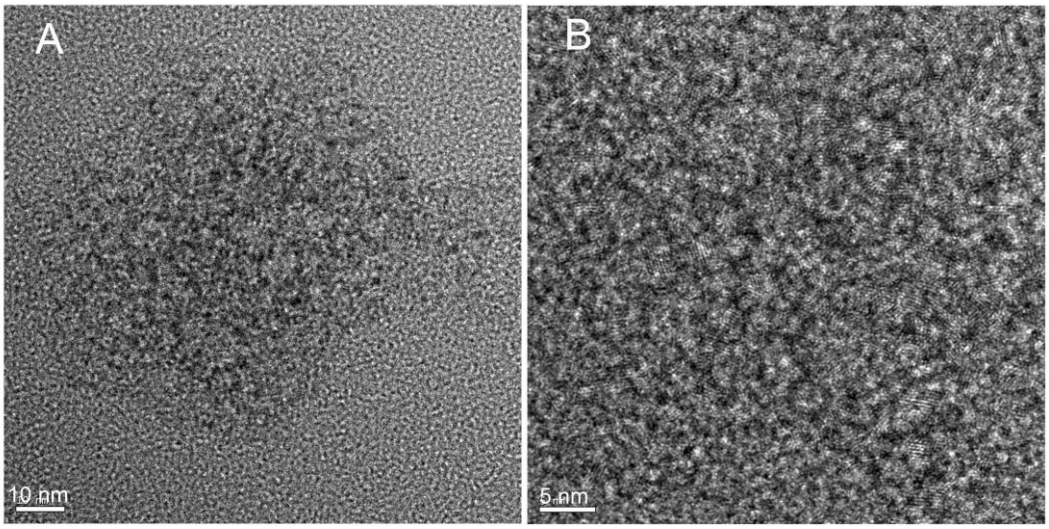


Figure S1. TEM images of the as-synthesized G-CeO_2NPs.

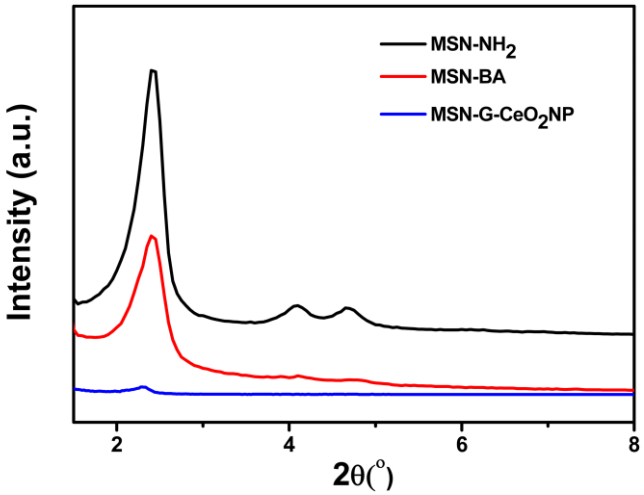


Figure S2. X-ray diffraction pattern of MSN-NH_2, MSN-BA and CQ loaded MSN-G-CeO_2NP. Both MSN-NH_2 and MSN-BA exhibit the typical diffraction patterns of MCM-41 type mesoporous silica with hexagonal symmetry. The changes in the CQ loaded MSN-G-CeO_2NP diffraction pattern might be caused by pore filling and G-CeO_2NP coating effects.

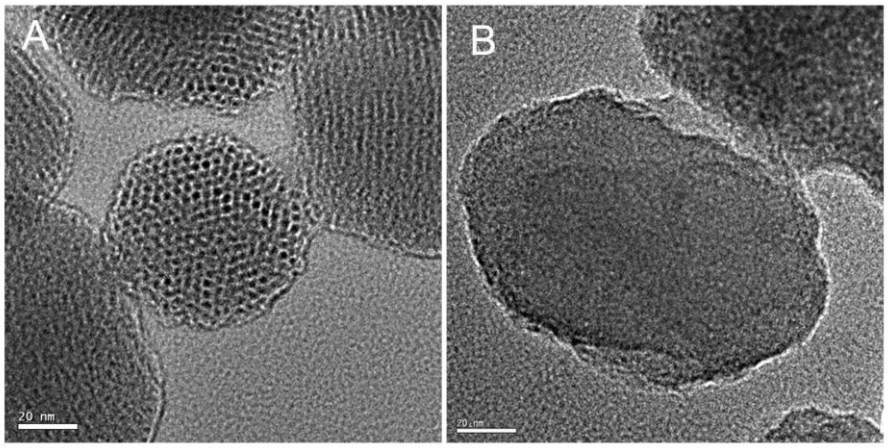
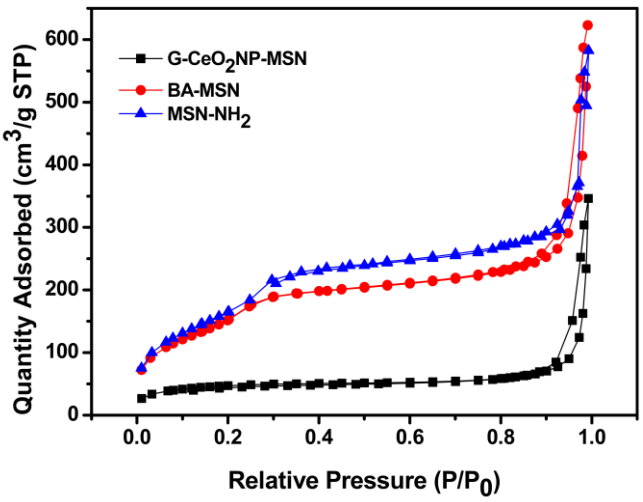


Figure S3. TEM images of as-synthesized (A) MSN-NH_2 and (B) MSN- G-CeO_2NP. Scale bars: 20 nm.



	MSN-NH_2	MSN-BA	MSN-G-CeO_2NP
S_{BET} [m^2g^{-1}]	674.31	602.72	76.61
Pore volume [cm^3g^{-1}]	0.574	0.538	0.124
Pore diameter [nm]	2.67	2.52	—

Figure S4. Top: N_2 adsorption-desorption isothermsa for a: MSN-NH_2, b: MSN-BA, and c: MSN-G-CeO_2NP. Bottom: BET specific surface values, pore volumes, and pore sizes calculated from N_2 adsorption-desorption isothermsa. The modified MSN-G-CeO_2NP shows relatively flat curves compared (at the same scale) to the MCM-41 material, indicating that there is significant pore blocking.

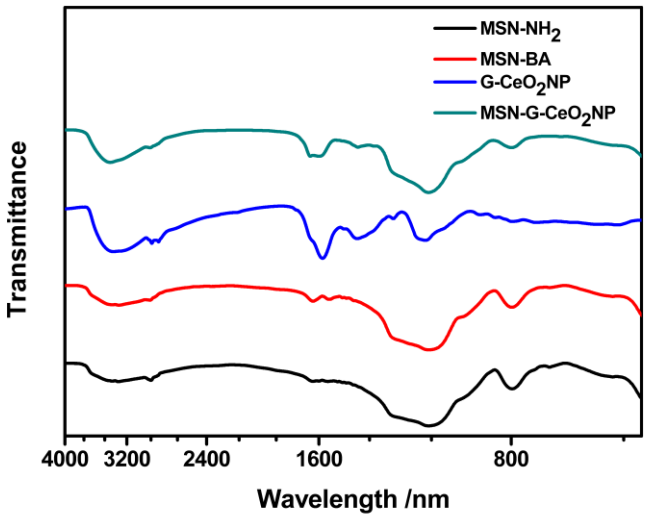


Figure S5. FTIR spectra of MSN-NH_2, MSN-BA, G-CeO_2NP and MSN-G-CeO_2NP.

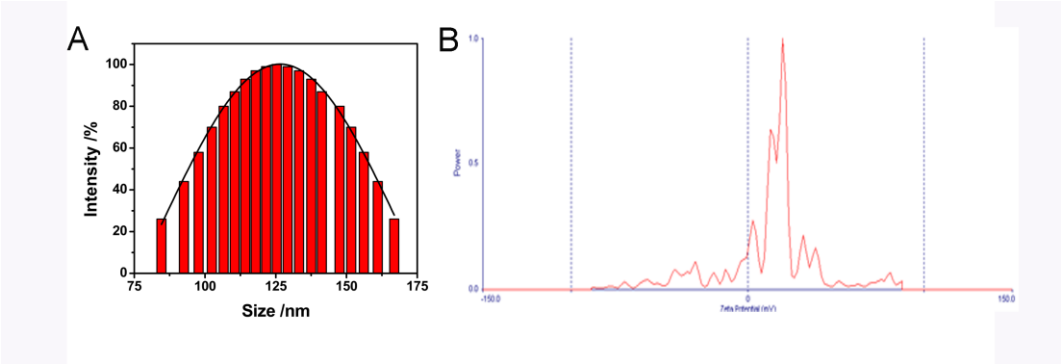


Figure S6. The hydrodynamic radius (A) and the surface charge (B) of the MSN-G-CeO_2NP.

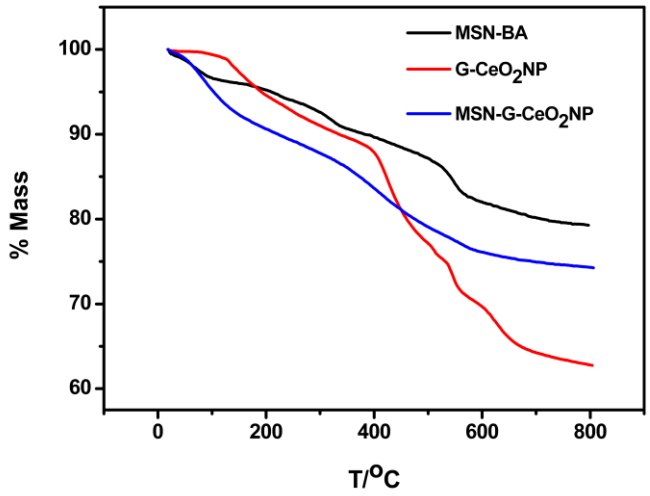


Figure S7. Thermogravimetric analysis of the samples: MSN-NH_2, MSN-BA, MSN-G-CeO_2NP.

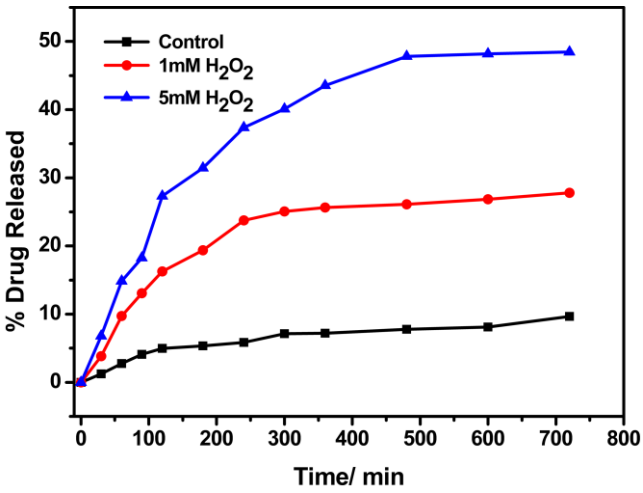


Figure S8. Release profiles of CQ from G-CeO_2NP-MSN triggered by H_2O_2 without external stimuli or with 1 mM H_2O_2 or 5 mM H_2O_2.

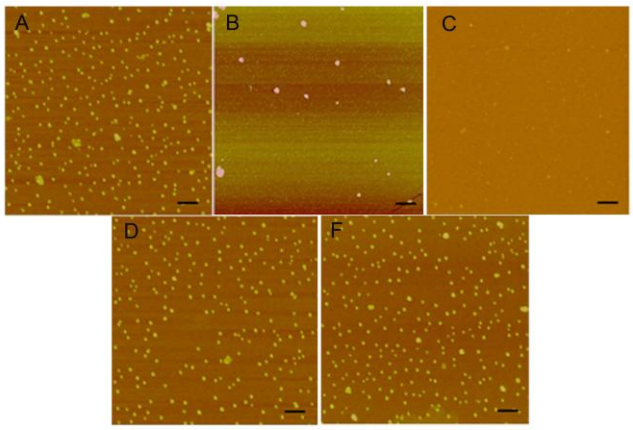


Figure S9. Determination of the inhibition effects of compounds on the Cu^{2+}-induced formation of Aβ aggregation by AFM: (A) Aβ-Cu complex, (B) Aβ-Cu complex with CQ, (C) Aβ-Cu complex with MSN-CQ-G-CeO_2NP in presence of H_2O_2, (D) Aβ-Cu complex with G-CeO_2NP, (F) Aβ-Cu complex with MSN-CQ-G-CeO_2NP in absence of H_2O_2. [Aβ] = 10 μM, [Cu^{2+}] = 10 μM, [CQ] = 20 μM, [G-CeO_2NP] = 0.1 $mgml^{-1}$, [MSN-CQ- G-CeO_2NP] = 1.2 $mgml^{-1}$, [H_2O_2] = 1 mM. Buffer: 10 mM HEPES, 150 mM NaCl, pH 6.6. (Scale bars: 200 nm)

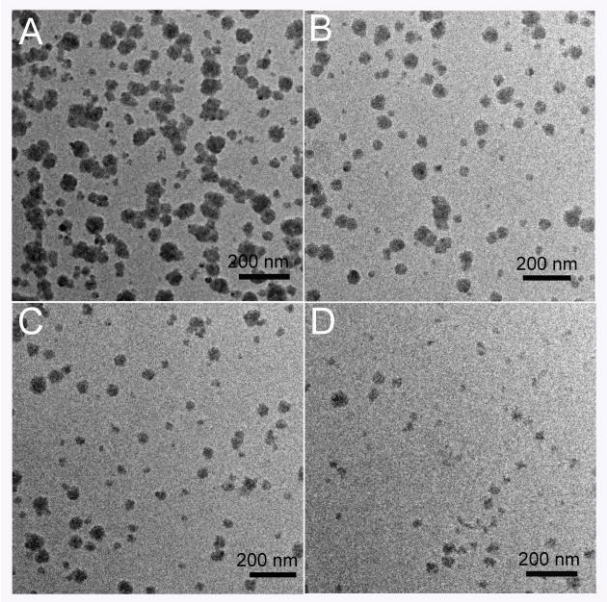


Figure S10. TEM images of samples of Cu^{2+}-induced Aβ aggregates (24 h, 37℃, no agitation) in presence of H_2O_2 followed by 24 h incubation: A: without any chelators, B: with G-CeO_2NP C: with CQ and D: with MSN-CQ-G-CeO_2NP.

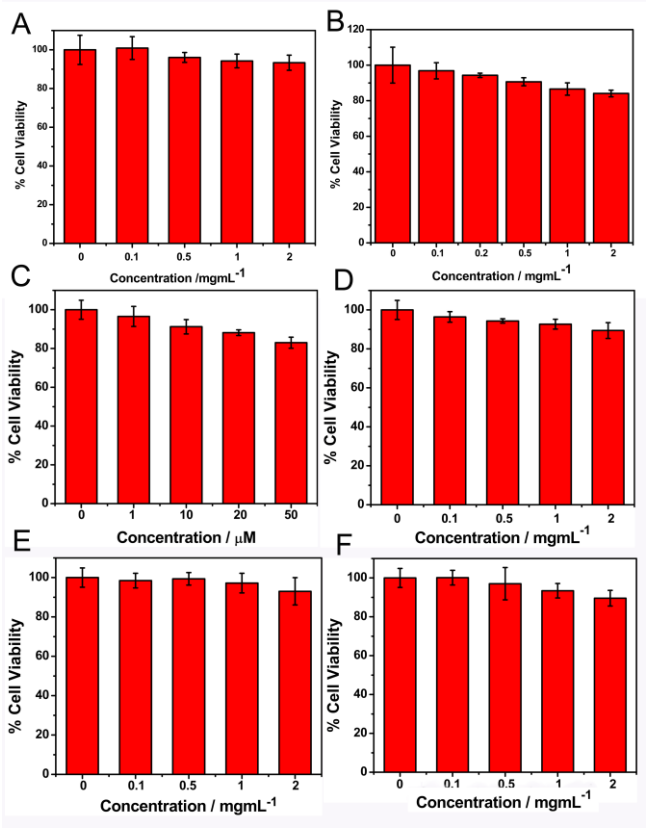


Figure S11. Effects of the functional nanoparticles on differentiated PC12 cell viability determined by MTT method. (A) MSN-CQ-G-CeO_2NP, (B) G-CeO_2NP, (C) CQ, (D) MSN-G-CeO_2NP, (E) MSN, (F) MSN pre-treated with H_2O_2.

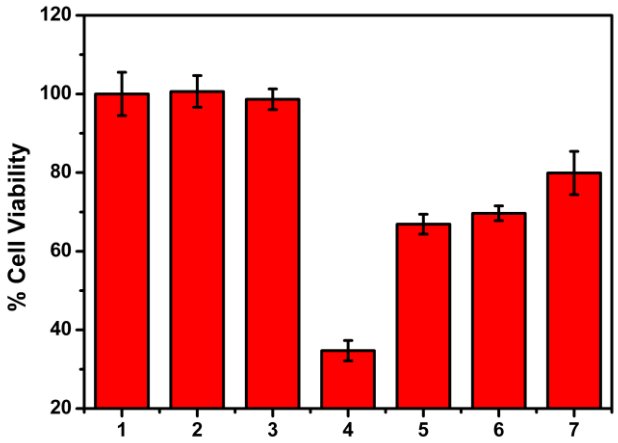


Figure S12. Protection effects of compounds on Aβ40-Cu^{2+}-induced cytotoxicity of differentiated PC12 cells: (1) Control, (2) Aβ, (3) Cu, (4) Aβ-Cu complex, (5) Aβ-Cu complex with G-CeO_2NP, (6) Aβ-Cu complex with CQ, (7) Aβ-Cu complex with MSN-CQ- G-CeO_2NP. Cell viability was determined using the MTT method and data points shown are the mean values ±SEM from three independent experiments. Control: Aβ-Cu-untreated cells, [Aβ] =5 μM, [Cu^{2+}] = 5 μM, [CQ] = 10 μM, [G-CeO_2NP] = 0.1 $mgml^{-1}$, [MSN-CQ-G-CeO_2NP] = 1 $mgml^{-1}$.

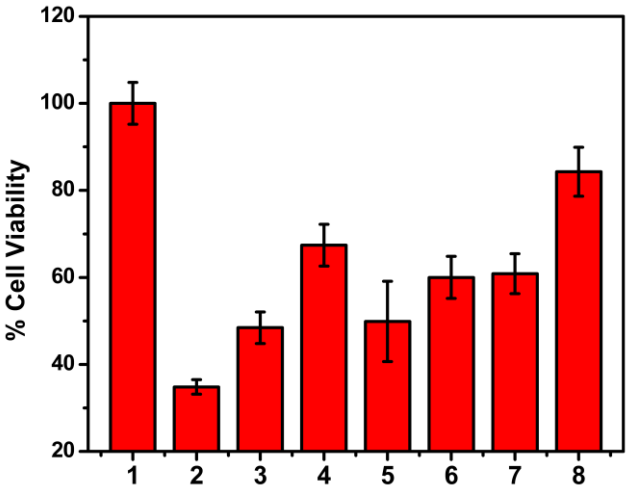


Figure S13. Protection effects of compounds on Aβ40-Cu^{2+}-induced cytotoxicity of differentiated PC12 cells: (1) control, (2) Aβ-Cu complex, (3) Aβ-Cu complex with 1 μM CQ, (4) Aβ-Cu complex with 10 μM CQ, (5) Aβ-Cu complex with 0.01 $mgmL^{-1}$ G-CeO_2NPs, (6) Aβ-Cu complex with 0.1$mgmL^{-1}$ G-CeO_2NPs, (7) Aβ-Cu complex with 0.1 $mgmL^{-1}$ G-CeO_2NP-CQ-MSN, (8) Aβ-Cu complex with 1$mgmL^{-1}$ G-CeO_2NP-CQ-MSN. Cell viability was determined using the MTT method and data points shown are the mean values ±SEM from three independent experiments. Control: Aβ-Cu-untreated cells, [Aβ] = 5 μM, [Cu^{2+}] = 5 μM.

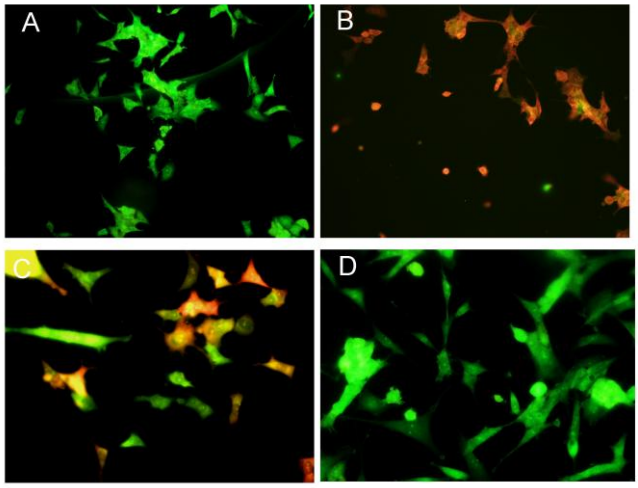


Figure S14. Fluorescence microscopy images of differentiated PC12 cells (A) control, (B) incubated with Aβ-Cu complex, (C) incubated with Aβ-Cu complex in presence of G-CeO_2NP, (D) incubated with Aβ-Cu complex in presence of MSN-CQ-G-CeO_2NP. Viable cells were stained green with acridine orange (AO), dead cells were stained red with ethidium bromide (EB).