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Orthogonal Biofunctionalization of Magnetic Nanoparticles via "Clickable" Poly-(Ethylene Glycol) Silanes: A "Universal Ligand" Strategy to Design Stealth and Target-Specific Nanocarriers

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Supporting Information

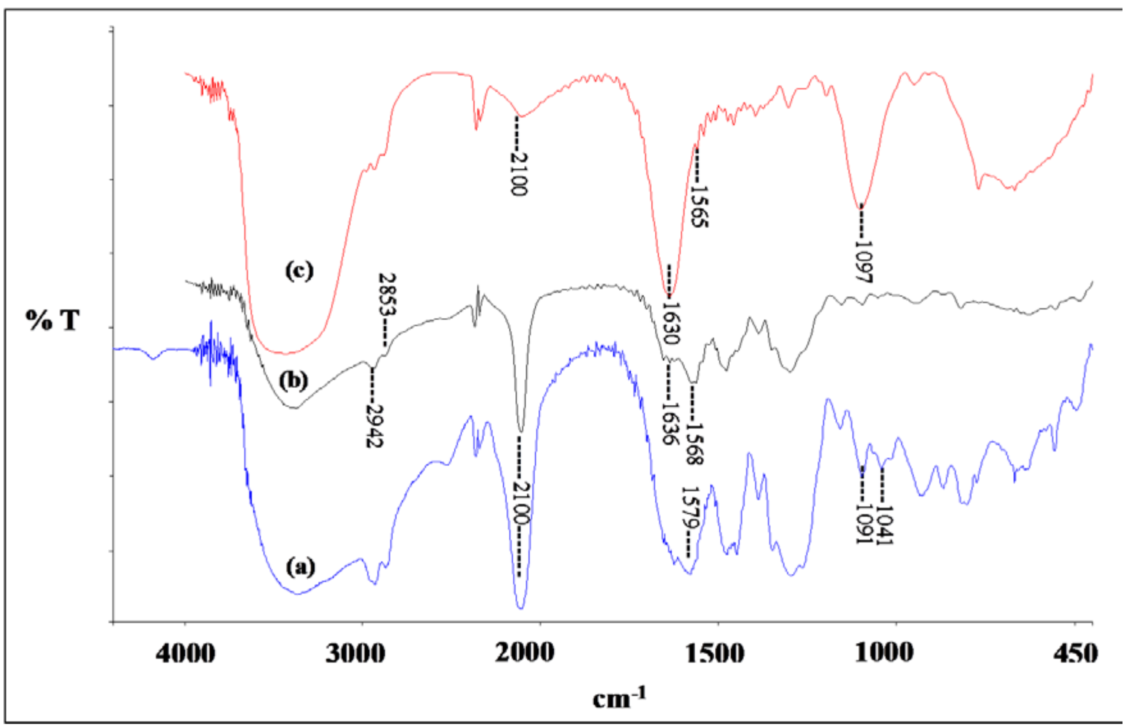

Figure S1. FTIR spectra of **(a)** PEG-diazide; **(b)** PEG-monoamine and **(c)** Azido-PEG-silane

FTIR spectrum of PEG std. exhibits prominent bands between 1020-1090 cm^{-1} due to asymmetric C-O-C stretching of the repeating –O-CH_2-CH_2-O- units of the polymer. The transformation of PEG terminal hydroxyl groups to corresponding diazide was accompanied with the appearance of a new peak at 2100 cm^{-1}. This band assigns to the asymmetric stretching of the -N=N=N bond of the azide group. Following dysymmetrization of the diazide to monoamine intermediate, a notable decrease in the intensity of 2100 cm^{-1} peak was observed, testifying the partial reduction of diazide to its corresponding azido-amino derivative. FTIR spectrum of the final product presented a broad band in the range of 1097 cm^{-1}, characteristic of Si-O stretching vibration of the PEG-silane, superimposed with asymmetric C-O-C stretching of the repeating –O-CH_2-CH_2-O- units.

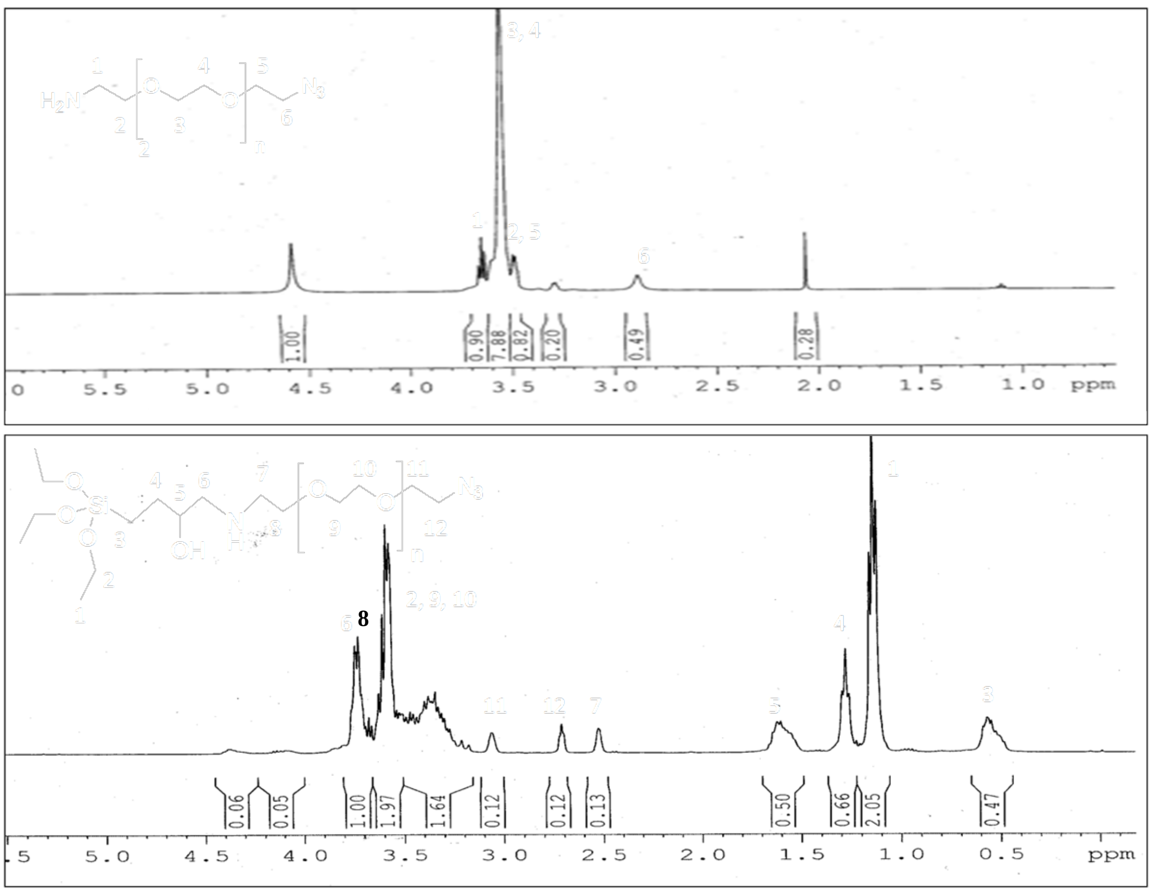

Figure S2. ^{1}H NMR spectra of α-amino ω-azido PEG and the corresponding azido-PEG-silane

The NMR spectrum of the monoamine derivative (See supporting information, Figure S1) presents the characteristic triplets of approximately 2H intensity at δ 3.66 and 3.47 ppm. These peaks may be assigned to the –O-**CH_2** and –**CH_2**-NH_2 protons of –O-**CH_2-CH_2**-NH_2 moiety of the PEG segment respectively. The broad singlet at 3.54 ppm may be assigned to the –CH_2 protons of the repeating –O-CH_2-CH_2-O units of PEG whereas the **–**CH_2 protons adjacent to the azide moiety appears at δ 2.86 ppm. The chemical shifts for protons from position 1 to 12 of the azido silane have been shown in figure **2(b)**. As expected, characteristic proton peaks of –O-CH_2-CH_2- repeating units appeared in the range of δ 3.3-3.8 ppm. Of note, a new quartet appeared in the range of δ 3.6-3.7 ppm. Superimposed with the methylene protons of PEG, this new peak may be ascribed to the –O-CH_2 protons of the –Si (OCH_2CH_3) unit. It was further interesting to observe that the triplets corresponding to –O-CH_2 and –CH_2-N_3 methylenic protons of the –O-CH_2-CH_2-N_3 terminus up-shifted to δ 3.06 and 2.71 ppm as compared to 3.47 and 2.86 ppm in the azido-amine derivative. In addition to these shifts, a highly shielded triplet was noted at 0.6 ppm. This peak was assigned to the methylene protons adjacent to >Si< centre. In line with our expectation, a sharp triplet at 1.2 ppm was observed; this new peak was assigned to the methyl protons of the –Si (OCH_2CH_3) head-group.

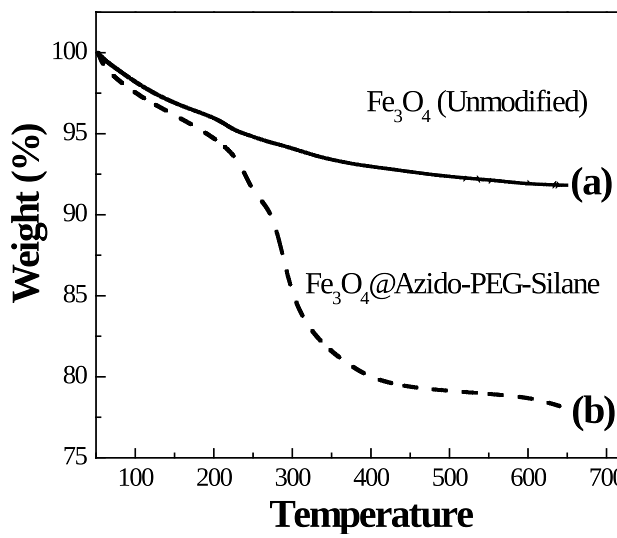

Figure S3. TG thermogram of **(a)** blank Fe_3O_4 and **(b)** azido-PEG-silane immobilized Fe_3O_4

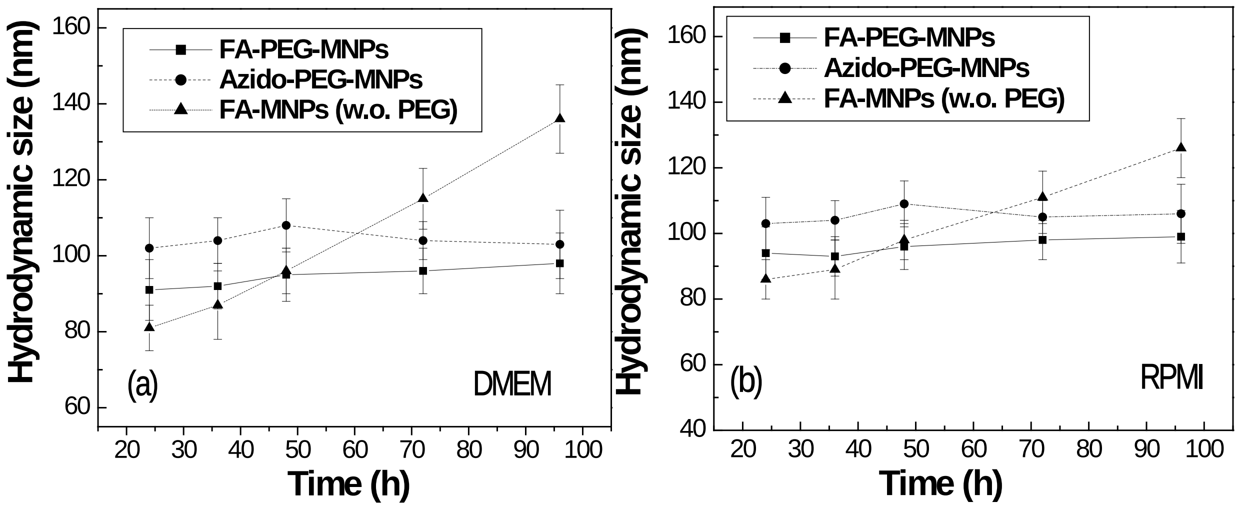

Figure S4. Effect of culture medium on the size of MNPs: **(a)** and **(b)** represents incubation in DMEM and RPMI media respectively. PEGylated MNPs showed minimal deterioration in particle size indicating lack of protein adsorption on MNP surface.

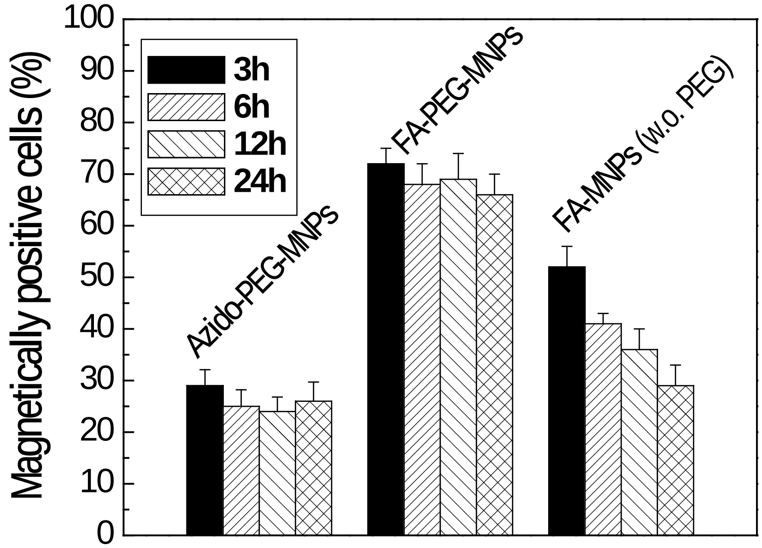

Figure S5. Time dependent uptake of PEGylated and non-PEGylated MNPs in A549 cells in presence of 10% serum containing culture media. No significant change in the cellular uptake of azido-PEG-MNPs and FA-PEG-MNPs was observed even after 24 h incubation in presence of serum. Contrastingly, uptake of FA-MNPs was significantly deteriorated when the incubation period was gradually increased from 3-24h.

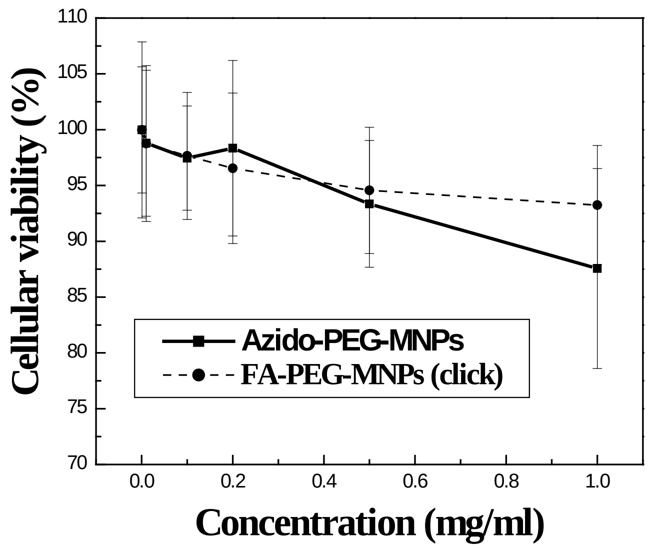

Figure S6. Cytotoxicity profile of azido-PEG-MNPs and FA-PEG-MNPs in A549 cell line

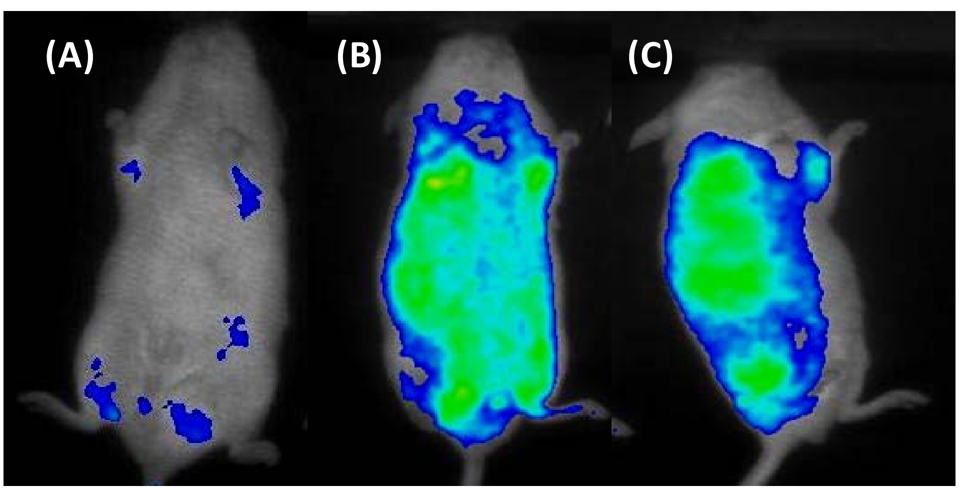

Figure S7. Photon image of **(A)** untreated animals **(B, C)** intact animals labeled with dye labeled aminosilane coated non-PEGylated MNPs (control) and FA-PEG-MNPs respectively.