

Supplementary Information:

New Surface Radiolabeling Schemes of Super Paramagnetic Iron Oxide Nanoparticles (SPIONs) for Biodistribution Studies

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Fig.S1: High-Resolution Transmission Electron Microscopy (HRTEM) image of iron oxide nanoparticles.

Fig.S2: Superconducting Quantum Interference Device (SQUID) measurement of magnetization of super paramagnetic iron oxide nanoparticles.

Fig.S3: Synthesis of carboxylated iron nanoparticles from chloromethyltrimethylsilane functionalized iron nanoparticles using the Grignard method.

Fig.S4: Fourier Transform Infrared Spectroscopy (FT-IR) spectra of iron oxide nanoparticles silanized with commercially available N-[(3- Trimethoxysilyl)propyl]ethylenediamine triacetic acid tripotassium salt.

Fig.S5: Synthesis of hyperbranched amine functionalized iron oxide nanoparticles from amino propyl triethyl silane functionalized iron nanoparticles using ethyleneimine as an initiator and polymerizing agent.

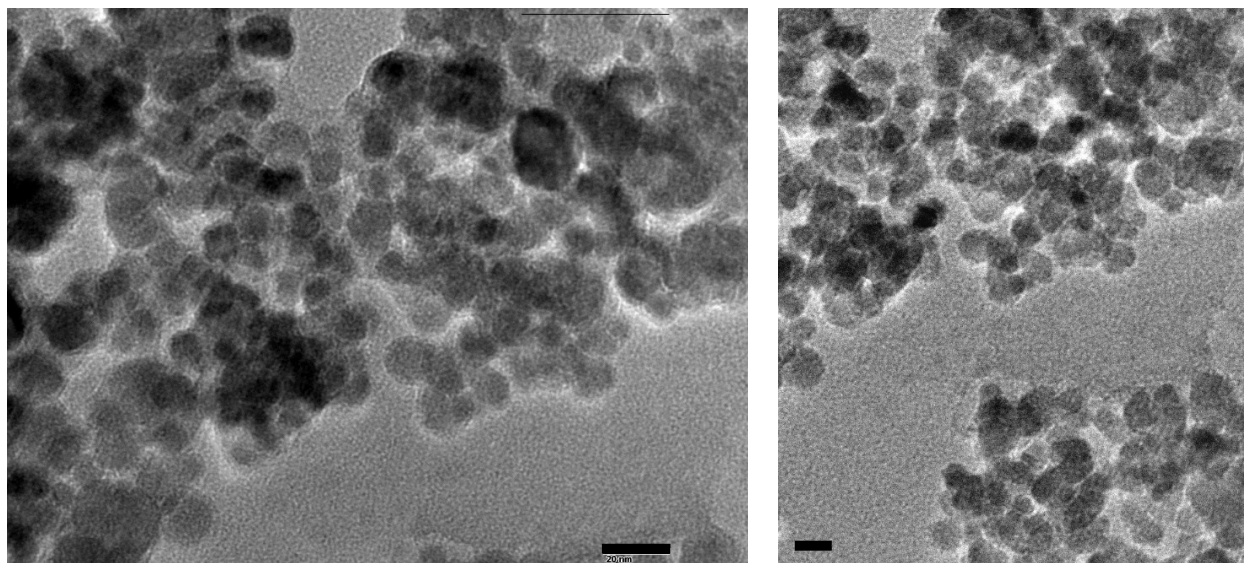


Fig. S1: HRTEM image of iron oxide nanoparticles (NPs) originally dispersed in water. The accelerating voltage was 200 keV. Scale bars are 20 nm. The oxides exhibited some clumping, but TEM-images clearly demonstrated that core size of single nanoparticles were ~ 14 nm.

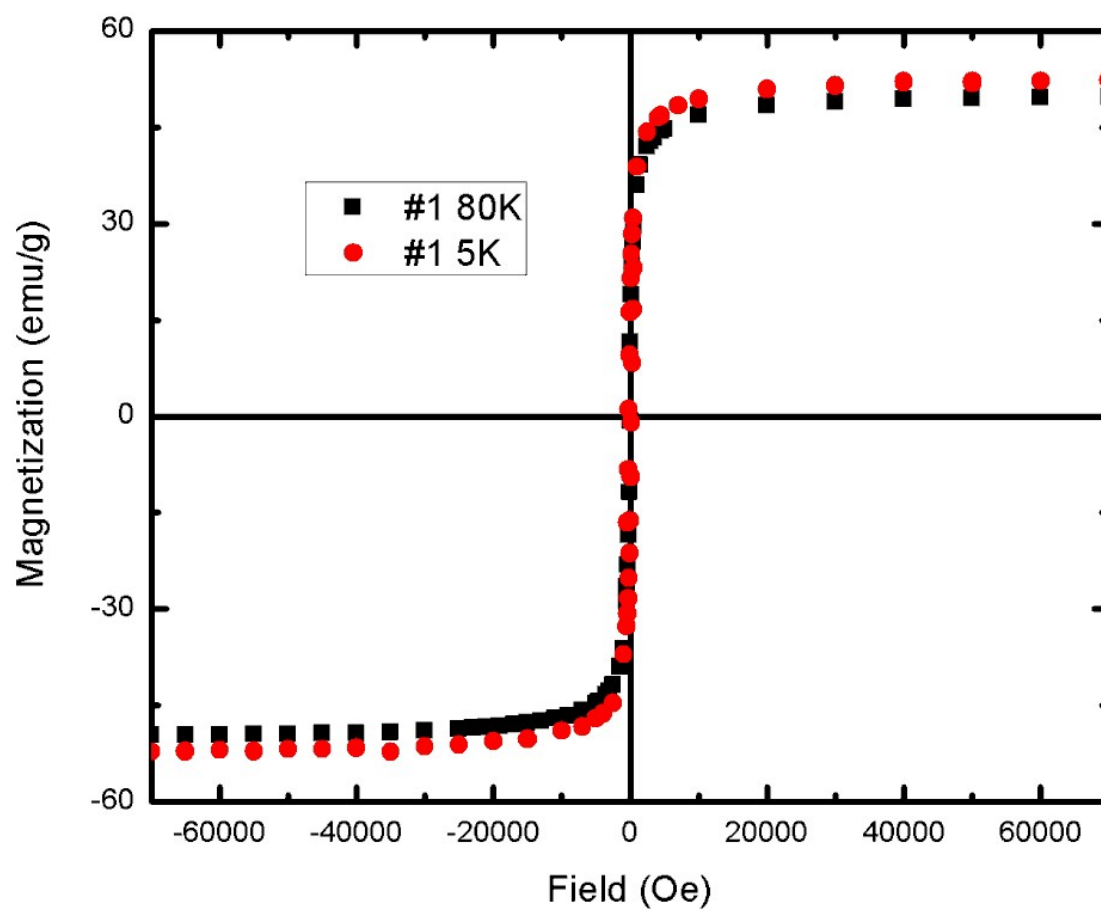


Fig. S2: Hysteresis loops of silanized Fe_3O_4 nanoparticles at 5K and 80K. The coercivity at 80K is almost zero, revealing the typical superparamagnetic behavior of the nanoparticles.

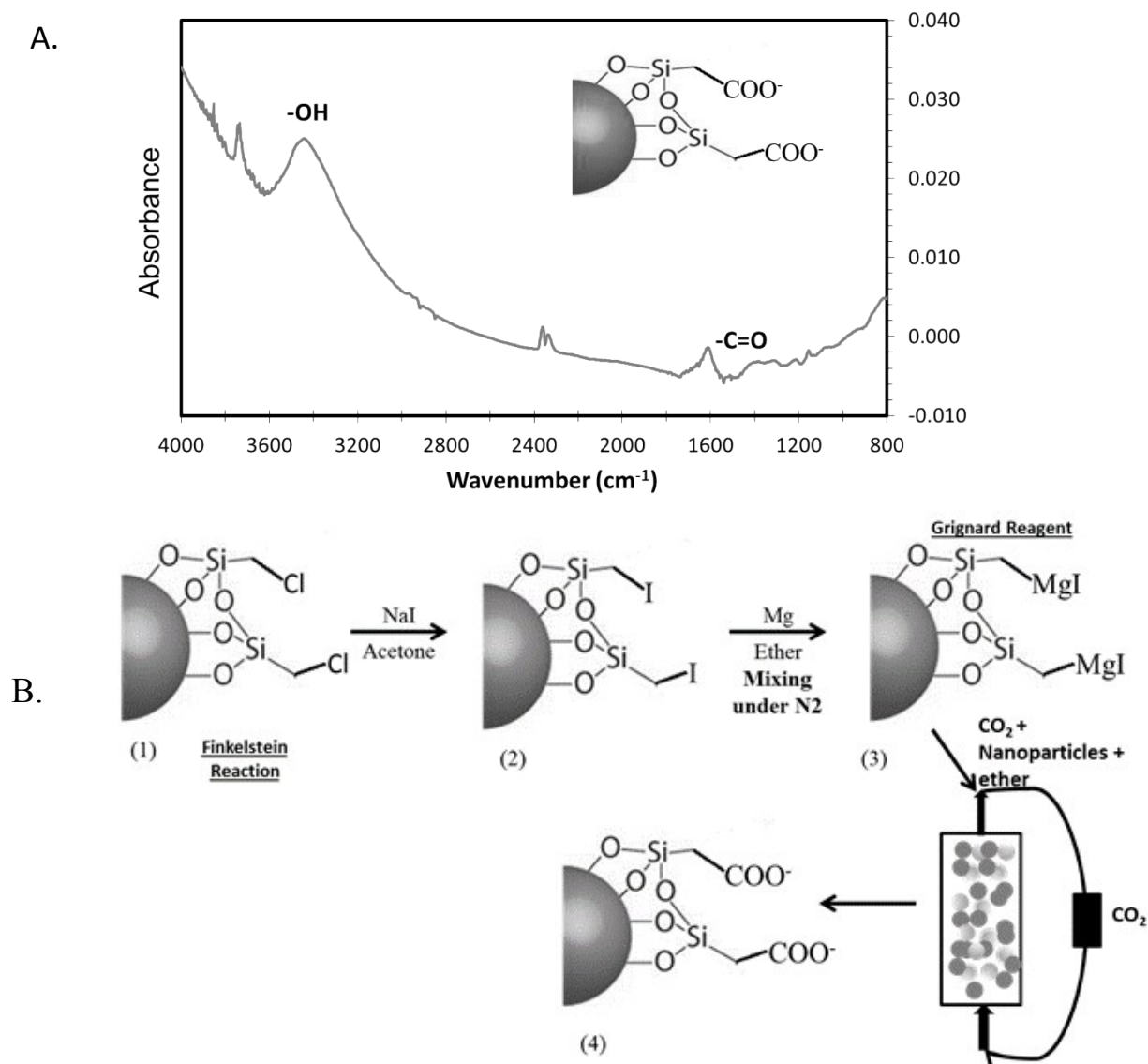


Fig. S3: (A) Schematic of synthesis of $-\text{COO}^-$ labeled iron oxide NPs. (1) The chlorine groups in chloromethyltrimethylsilane functionalized iron NPs were substituted by iodine using the Finkelstein reaction. (2) The iodine in the iodinated iron NPs was reacted with Mg in dry ether under N_2 to form the Grignard reagent[1]. (3) The Grignard reagent is then suspended in ether and CO_2 is bubbled through the mixture for 45 minutes to get the Fe-Si- COO^- NPs. The zeta potential of the NPs was -17.03 ± 2.24 mV. (B) FT-IR spectra of $-\text{COOH}$ iron oxide nanoparticles. Peaks between $1600 - 1700$ cm^{-1} from $\text{C}=\text{O}$ and the $-\text{OH}$ lines are broad and at $3400 - 3500$ cm^{-1} . The NPs had very weak signal associated with the Carboxylic group and the zeta potential was less than -20 mV which indicated that the NPs were not very stable in solution. For these reasons Fe-Si- COO^- NPs synthesized using this technique were not used for radiolabeling.

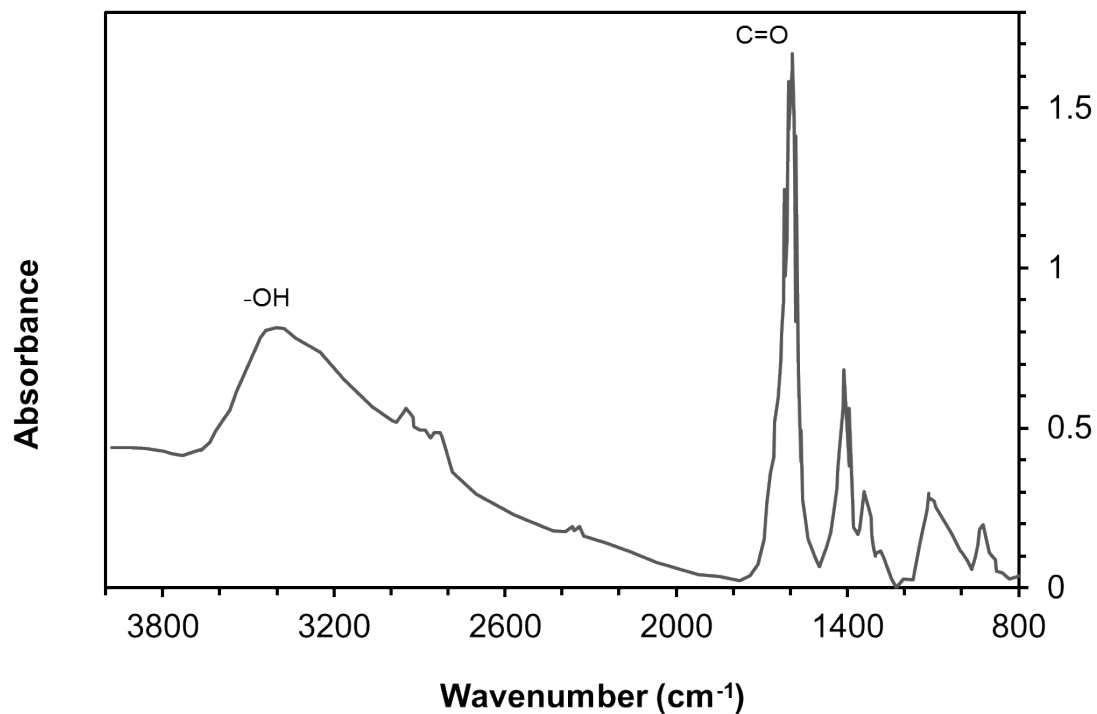


Fig. S4: FT-IR spectra of Iron oxide nanoparticles silanized with commercially available N [(3-trimethoxysilyl)propyl]ethylenediamine triacetic acid tripotassium salt. Strong peaks at 1580 cm^{-1} and 1395 cm^{-1} (C=O) and a broad peak between $3200 - 3500\text{ cm}^{-1}$ (-OH) are indicative of the presence of -COO^- groups on the surface of the nanoparticles. The FT-IR spectra matches the FT-IR spectra of Fe Si-(COO $^-$) $_3$ NPs that we synthesized in our labs.

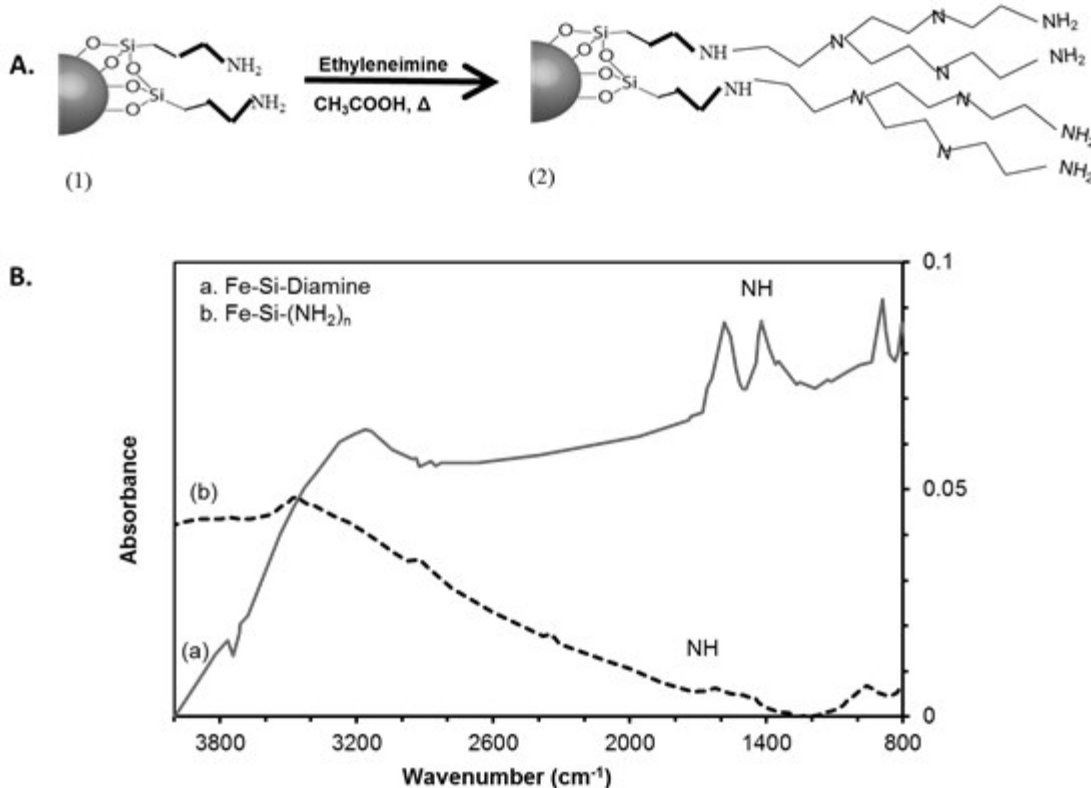


Fig. S5: (A) Schematic of synthesis of hyperbranched amine functionalized iron oxide NPs. (1) The amine in aminopropyltriethoxysilane (APTES) functionalized iron oxide NPs (Fe-Si-NH₂) reacts with ethyleneimine forming secondary amine and opens the ethyleneimine for further addition reactions with other ethyleneimine molecules resulting in the formation of tertiary amines. The reaction is carried out in dichloromethane with a catalytic amount of acetic acid. (2) When the reaction is terminated by cooling to room temperature, the end product is an iron oxide nanoparticle with hyperbranched amine groups on its surface resulting in a net positive charge[2]. The NPs are designated Fe-Si-(NH₂)_n and the zeta potential was > +40 mV. (B) FT-IR spectra of (a) Fe-Si-NH₂ NPs and (b) Fe-Si-(NH₂)_n NPs. Very broad and weak peaks corresponding to N–H bend (primary amines only) from 1650 – 1580 cm⁻¹ and N–H stretch 3400 - 3250 cm⁻¹.

References:

1. Ashby, E.C., *Grignard reagents. Compositions and mechanisms of reaction*. Quart Rev Chem Soc, 1967. **21**(2): p. 259-285.
2. Kim, H.J., et al., *A Hyperbranched Poly(ethyleneimine) Grown on Surfaces*. J of Coll and Int Sci, 2000. **227**(1): p. 247-249.