MEMBRANE INTERACTION OF PEGYLATED SUPERPARAMAGNETIC NANOPARTICLES

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Iron oxide core-shell nanoparticles are gaining ever increasing interest for separation and imaging in biotechnology and biomedicine[1,2], due to supposed low cytotoxicity and their superparamagnetic properties. Hydrophilic polymer-coated nanoparticles are believed to have low nonspecific interactions in biological systems, but much additional work in-vitro and in-vivo is needed to understand their detailed interactions with proteins, membranes and cells. We investigated monodisperse (SD<5%), single-crystalline and superparamagnetic magnetite nanoparticles of different core size and densely grafted with poly(ethylene glycol) (Mw=5kDa), with particular emphasis on their interaction with biological membranes. Membrane interactions will determine nonspecific recognition and uptake by cells. These nanoparticles demonstrated no cytotoxicity and low cell uptake in in-vitro culture of HeLa and HEK cell lines.

However, using Quartz Crystal Microbalance (QCM) a strong DLVO-type interaction could be demonstrated with anionic membranes that simulate eukaryote membranes. This interaction was only present in nonphysiological buffer with low ionic strength. Only low, weak and transient binding was observed to zwiterionic phosphocholine membranes. Core size seems to have an effect, with the smallest core size (3.3nm) yielding the strongest interactions while 8nm cores displayed almost no interaction. These results imply that dense polymer grafting and nanoparticle curvature are crucial parameters to control interactions between biomedical core-shell nanoparticles and their biomolecular environment, in particular cell membranes. The interaction between nanoparticle and membrane was furthermore shown to not perturb membrane structure by Differential Scanning Calorimetry (DSC).

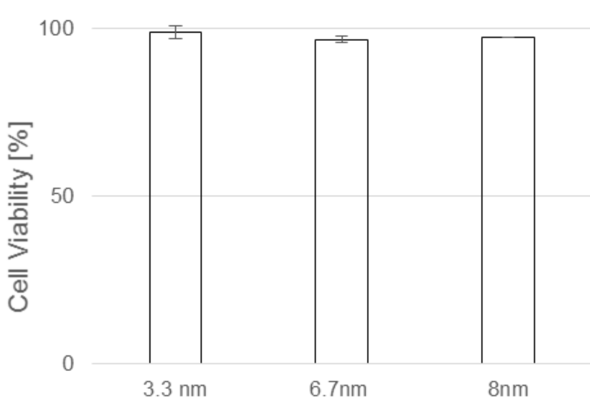

Figure 1: Viability of HeLa cells after 24h incubation with PEGylated iron oxide nanoparticles at 0.09mg/ml Fe concertation

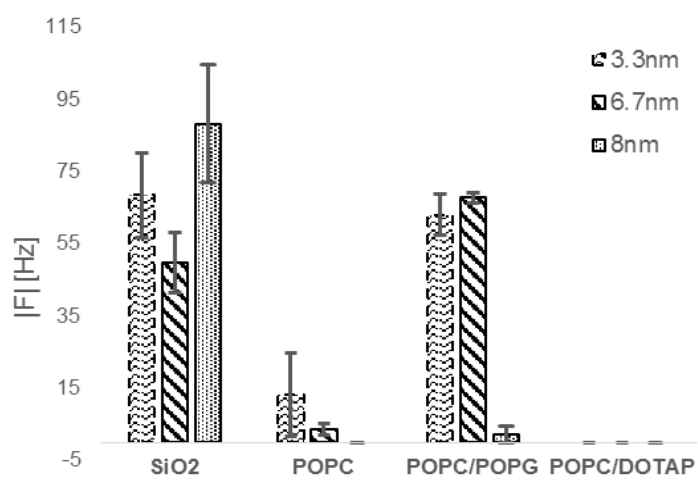

Figure 2: Nanoparticle binding to model membranes measured by QCM for different core size in MQ water

References:

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2. A. Kumar; Gupta, M. Gupta, Biomaterials, 2005, 26, 3995–4021