Short Ligands Affect Modes of QD Uptake and Elimination in Human Cells

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Abstract:

In order to better understand nanoparticle uptake and elimination mechanisms, we designed a controlled set of small, highly fluorescent quantum dots (QDs) with nearly identical hydrodynamic size (8-10 nm) but with varied short ligand surface functionalization. The properties of functionalized QDs and their modes of uptake and elimination were investigated systematically by asymmetrical flow field-flow fractionation (AF4), confocal fluorescence microscopy, flow cytometry (FACS), and flame atomic absorption (FAA). Using specific inhibitors of cellular uptake and elimination machinery in human embryonic kidney cells (Hek 293) and human hepatocellular carcinoma cells (Hep G2), we showed that QDs of the same size but with different surface properties were predominantly taken up through lipid raft-mediated endocytosis, however, to significantly different extents. The latter observation infers the contribution of additional modes of QD internalization, which include X-AG cysteine transporter for cysteine-functionalized QDs (QD-CYS). We also investigated putative modes of QD elimination and established the contribution of P-glycoprotein (P-gp) transporter in QD efflux. Results from these studies show a strong dependence between the properties of QD-associated small ligands and modes of uptake/elimination in human cells.

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