CELLULAR UPTAKE AND TOXICITY OF SURFACE MODIFIED CDS QUANTUM DOTS

Selcuk F., Celebi S., Kas R., Ozturk S. S., Yagci A.H.
Department of Chemistry, College of Arts and Sciences, Koc University, Rumelifeneri Yolu 34450, Sariyer, Istanbul, TURKEY
fselcuk@ku.edu.trl

Quantum dots with their small-uniform sizes and photophysical properties are promising particles for biological luminescent labeling and drug targeting. They have size dependent fluoresence emissions; smaller QDs emitting light with shorter wavelengths than bigger ones, due to quantum size effects. QDs usually contain Cd as the core material that is known to be toxic to living cells. The toxicity is directly related to the release of the core surface Cd atoms to the surrounding medium initiating free radical formation and interaction with intracellular components. The use of QDs for studies involving living cells and organisms is limited due to the biocompatibility of QDs. One way to increase biocompatibility and decrease toxicity of QDs is the use of surface coatings. Previously certain surface coatings, such as ZnS, BSA, polyacrylate were shown to decrease the cytotoxicity of QDs by slowing the release of Cd (1). The choose of surface coating is a critical parameter since toxicity depends not only to the core material but also to the surface coating. Hoshino *et. al.* figured out that both the physicochemical properties and the cytotoxicity of ZnS–CdSe QDs are dependent on the surface molecules rather than on the core material (2)

In this study several surface-modified CdS QDs using PAA, MAA, MPA and cysteine were developed and evaluated for their physicochemical characteristics, uptake and cytotoxicity. In order to evaluate and compare the toxicities, surface coatings and core material were also tested together with the surface modified QDs using HeLa and MCF cell lines.

HeLa and MCF cells were cultured at 5×10^4 cells on 96-well plates and incubated with different concentrations (0.025-0.15 mg/ml) of the CdS QDs for 24 and 48 hours. The cytotoxicity was evaluated by MTT viability assay and uptake levels of Cd was evaluated by using fluoresence assay. The cell viabilities were shown to differ with the coating used and cell type. A dose-dependent decrease in cell viabilities was observed with increasing incubation time while the level of Cd uptake was observed to be increasing with increasing incubation time. The lowest toxic QDs were cysteine, MAA and PAA/MAA modified QDs which may be correlated to the biocompatible properties of coating materials. Among the tested QDs MPA coated ones were the most toxic of all which is consistent with the findings showing MPA and MAA to be mildly cytotoxic at CdSe QDs (3).

Interestingly MCF cells were observed to be more resistant to QD toxicity when compared to HeLa cells. This result is consistent with a previous study showing that some cell types such as cardiomyocytes to be more sensitive to Cd when compared to other cells. It can be concluded that there may be differences in uptake and cellular handling of QDs which may contribute to different toxicities at different cells.

QDs are superior particles for imaging and drug delivery applications. It is important to select hydrophilic and biocompatible coatings to modify QDs to lessen cytotoxicity and test the QDs extensively for *in vivo* applications. Our study is on of the few studies comparing *in vitro* toxicities of a variety of QDs modified with different coatings in different cell lines.

References:

[1] Derfus A.M., Chan W.C. W., Bhatia S. N., Nano Letters, 4 (2004) 11-18.

[2] Hoshino A., Fujioka K., Oku T., Suga M., Sasaki Y.F., Ohta T., Yasuhara M., Suzuki K., Yamamoto K., Nano Letters, 4 (2004) 2163–2169.

[3] Kirchner C., Liedl T., Kudera S., Pellegrino T., Javier A.M., Gaub H.E. *et al*., Nano Letters, 5 (2005) 331-338.

Figures: