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Quantum dot nanoprobe-based high-content assay for the detection of cancer stem cells induced by benzo[a]pyrene

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Introduction: Semiconductor Quantum Dots (QD) are tiny nanoscale particles that possess unique optical properties like size-tunable light emission, high brightness, photostability and simultaneous excitation and monitoring of multiple colors due to narrow emission range. High-content cell-based assay (HCA) has attracted great attention due to its ability to be used in the drug discovery-driven research and development required to understand the functions of genes and gene products at the level of the cell.HCA simultaneously measures multiple biomarkers in a single cell with multiplexing fluorescent probes. The complex intracellular responses involved in drug-induced efficacy or cytotoxicity can be observed in organ-specific cells by HCA.Despite HCA's capability it is not common to simultaneously observe many biomarkers in an intact cell. Concurrent monitoring of multiple biomarkers is practically limited due to the spectral overlap among probing materials having broad absorption and emission spectrums. QD-based HCA is very advantageous because it can provide particular wavelengths that do not overlap among the probing materials and concurrently monitor a larger number of drug targets or biomarkers. In this work, QD-based HCA has been investigated to detect cancer stem cells induced by Benzo[a]pyrene (BP).

Results: It was found that breast CSCs were producedfrom MCF-7 cells by BP-induced mutation. Breast CSCs wereobtained using magnetic bead-based sorting from MCF-7 cells and detected throughhigh-content monitoring of three different markers CD44, CD24 and aldehyde dehydrogenase1(ALDH1) using the QD-based HCA.The BP-induced mutation was quantitatively observed via absorption spectra of BPDE-DNA adducts. MCF-7 cells were treated with BP at different concentration 0.2μM, 2μM, 5μM and 10μM for 24hr. The resultant CSCs in the entire MCF-7 cellswere determined to be 0.35±0.032%, 0.45±0.038%, 0.55±0.075%, 1.02±0.28% and 1.19±0.27% in control, 0.2μM, 2μM, 5μM and 10μM respectively.

Conclusions: QD-based HCA was very advantageous for the detection of CSCs induced by carcinogens such as benzo[a]pyrene. Spectral overlap among probes of CSC biomarkers could be eliminated and diagnostic accuracy could be greatly improved, compared with the conventional FACS.

Biography:

Prof. Joon Myong Song received his Ph.D. in 1997 at Kyushu University, in Japan. He worked as a postdoctoral research fellow from 1998 to 2004 at Iowa State University, Brookhaven National Laboratory, and Oak Ridge National Laboratory in United States. At present he is a professor and head of Department of Pharmacy at College of Pharmacy, Seoul National University in South Korea. His research area includes multifunctional nanoparticle for diagnosis and therapy and high-content cell-based drug screening and diagnosis using hyper-multicolor cellular imaging. He has published 87 peer reviewed papers in the top journals, 7 book chapters, and 10 patents.