Environmental Degradation of PbS and CdSe Quantum Dots and the Related Toxicity

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The growing interest in the field of engineered nanomaterials for various applications such as energy harvesting, optoelectronics, bioanalysis, nanomedicine, and cosmetics raises concerns over their toxicity and safety.[1] Lead halide perovskite and heavy metal chalcogenide nanocrystals attract attention due to their strong quantum confinement, large exciton Bohr radius, and the size-dependent tunable band gaps in the visible to near-infrared regions.[2] These nanomaterials are photoactive, and potentially could be transformed by photoetching resulting in the release of heavy metals into the environment,[3] which are generally associated with neurotoxicity, hepatotoxicity, and nephrotoxicity.[4] Here, with the help of cytotoxicity and comet assays, we conduct studies on various cultured cells treated with PbS or CuS quantum dots. We reveal significant proliferation and DNA damage to the cells exposed to cadmium or lead ions released from these quantum dots.

This study reveals higher levels of cell proliferation and DNA damage to PC12 cells than H1650 cells exposed to metal ions (Pb^{2+}, Cd^{2+}, Cu^{2+}). We find that the genotoxicity of Pb^{2+} to H1650 cells is lower than H1650 cells treated with Cd^{2+}. This result also suggests the neurotoxicity of lead due to not only a downregulation of glutathione, elevated levels of reactive oxygen and nitrogen species, and a calcium influx but also the proactivation of activator protein 1 that is correlated with protein kinase c. This research underscores the significance of cell and molecular biology studies to understand the health and environmental costs of nanomaterials.

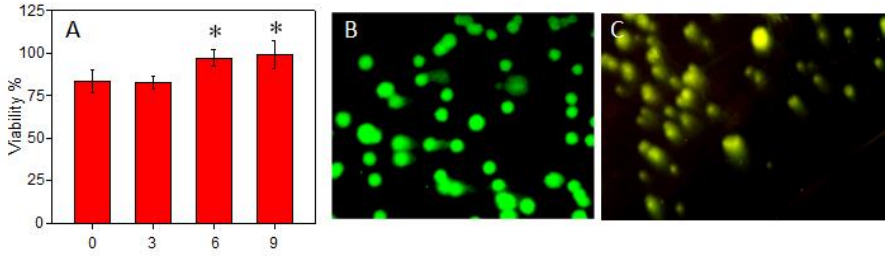

Figure 1. Cell viability histograms and comet images of H1650 cells (A) treated with photoactivated PbS quantum dots for 72 h and (B) Pb^{2+} for 72 h. (C) Comet images of PC12 cells treated with 0.1 μM Pb^{2+} for 72 h.

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