AbstractID: 11131 Title: Monte Carlo simulation for DNA damage in gold nanoparticle solution

Purpose: We used EGS4 based BEAMnrc and newly developed fast Monte Carlo damage simulation (MCDS) programs to theoretically evaluate the DNA damage yields, including single-strand breaks (SSBs) and double strand breaks (DSBs), in the simulated laboratory bench-top settings of two monolayer cell cultures when irradiated by x-ray photons.

Method and Materials: A layer of water with 10 μm in thickness and 1.0 g cm^{-3} in density was placed in a container, mimicking to the laboratory cell culture environment. The dish is square-shaped with 2.6 cm for the length, 2.6 cm for the width at the bottom, and 5 mm for the height. The cell culture dish was then irradiated by a broad parallel simulated photon beam. All these settings were precisely modeled in the EGS4 based BEAMnrc program.

Results: Our simulation results suggested that the DSB yield is the largest (9.03) when irradiated by the 30 KeV photons and lowest (8.41) when irradiated by the 1 MeV photons for the gold nanoparticle (GNP) solution. While the SSB yield is the largest (189.21) when irradiated by the 1 MeV photons and nearly the same (186.52 and 186.70) when irradiated by the 30 and 100 KeV photons for the GNP solution. When compared the damage yields between GNP and water solution, the yields were almost identical, with the exception of the irradiation case of 100 KeV photons, DSB yield in GNP solution (8.88) is less than in water (9.17) and SSB yield in GNP solution (186.7) is larger than the yield in water (186.19).

Conclusion: Among those nanotechnology applications, gold nanoparticles have been developed and progressed as an excellent x-ray imaging contrast agent for small animal model study. Our DNA damage simulation results should serve as the prior indication of biological consequences when gold nanoparticles are used in the various molecular imaging techniques.