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Computer simulation of radiation damage mechanisms in the structure of brain cells

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Investigation of the effects of ionizing radiation on cells of the central nervous system is a challenging topic in modern radiation research, as well as treatment planning in radiation therapy and predicting the space radiation health risk for exploration cosmonauts. To contribute in understanding radiation damage mechanisms in complex morphology of brain cells, it is necessary to investigate the stochastic nature of particle tracks in critical structures of mature and immature neurons. In this work, we studied the processes of degradation of dendritic branches and spines, reduction in their number depending on the radiation dose of different particles using Monte Carlo simulations (Geant4). It is also estimated that energy and dose depositions, number of particle traversals, the neuronal cell hits and the formation of direct and indirect molecular damages as a function of LET, and dose-dependent survival of undifferentiated cells in the rat hippocampus following irradiation. Our simulation results for protons and heavy ions are consistent with the experimental results.

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