Short- and long-term effects of SWCNT-DNA complexes on glioma cells

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SWCNT-DNA complexes at concentration of 1.5-3.0 μg/ml stimulate slightly cell proliferation. SWCNTs do not affect the cell viability at concentrations of 10 μg/ml and lower. Using Raman microscopy it is shown that SWCNTs are accumulated in the cytoplasm as small agglomerates, do not permeate nuclei and remain in cells throughout 5-8 passages. SWCNTs agglomerates are detected in cells after 2h of SWCNT-DNA complexes addition to cell culture and nanotube accumulation reaches the saturation point after 18h of the exposure of cells to SWCNTs. As saturation has been reached the SWCNT distribution becomes more uniform. Specific method for SWCNTs concentration determination in a single living cell based on Raman spectra of SWCNTs has been developed. The average number of SWCNTs per an agglomerate in a living cell that depends on both the phase of nanotube accumulation and passage number ranges from 10 to 1000. Simultaneous application of Raman microspectroscopy and confocal fluorescent microscopy shows that the process of SWCNT-DNA complexes penetration into cells is accompanied by the modification of actin cytoskeleton. During SWCNT accumulation F-actin in the cytoplasm forms a coating over SWCNT agglomerates. The cortical actin cytoskeleton contributes mainly into the parameters of the mechanical properties of the cell surface measured with AFM. Fractal analysis of the microscale areas of the cell surface shows the significant change in the distribution of their geometrical and mechanical properties after 2h incubation of glioma cells with SWCNT-DNA complexes that evidences the increase of the density of actin filament network and stiffness of the cell surface. SWCNTs are localized near mitochondria leading to the two times decrease of mitochondria membrane potential compared to that of control cells, initiate the increase in the production of superoxide, cause the changes in electron transfer in complexes I and III.