Abstract

The production and incorporation of silver nanoparticles into consumer products and biomedical technologies has skyrocketed in recent years. Thus, it is vital that the uptake, distribution and molecular interaction of silver nanoparticles (AgNPs) with red blood cells is well studied. In this experiment, citrate capped AgNPs 5-10 nm in diameter were incubated with washed red blood cells in a 5% glucose solution for one hour. Unbound AgNPs were removed via glucose washes prior to quantification with graphite furnace atomic absorption spectroscopy and analysis via Cytoviva hyperspectral microscopy and Raman spectroscopy. It was determined that a high percentage of 48±5% of AgNPs were taken up by the cells. Approximately 70% of the AgNPs taken up were adhered to the cell membrane and the rest were found within the cells. Obvious membrane damage was observed in many of these cells. Hyperspectral data showed interaction of extracellular and intracellular AgNPs with cholesterol, phospholipids or other cell membrane components, and hemoglobin respectively. The intracellular interaction with hemoglobin was confirmed by the enhancement of characteristic hemoglobin Raman shifts. Diminished oxyhemoglobin peaks and enhanced deoxyhemoglobin peaks revealed that the AgNP exposed cells showed a decrease in oxygen binding which could have been a result of intracellular and/or extracellular AgNP interactions. After 24 hours of storage at 4°C, SERS enhancement of >400% proved extracellular AgNPs aggregated forming large clusters of cells. In addition to the proven toxicity of silver ions, the adverse effects seen in the results of this study show that exposure of AgNPs to the circulatory system could pose serious health concerns.