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Detection of ultrafine particles in living cells

Nanotechnology is widely accepted as a future key technology with a variety of issues for medical treatment and in life sciences. When humans are exposed to nanoparticles accumulating in the environment from various technological sources as e.g. the exhaust of modern combustion processes, general health problems can be generated. This problem becomes more and more evident. A detailed understanding of the basic mechanisms of their distribution in the body after inhalation and their interaction with cells is a prerequisite for understanding health effects. Their interactions with organisms and cells and possible health effects are critically discussed. Various modern fluorescence methods based on the detection of single particles by repeated excitation of a fluorescent chromophore are applied to characterize the interactions of nanoparticles with single living cells under physiological conditions.

Our methods allow to follow the time course of the appearance of fluorescent particles in specific compartments in the cell in comparison to the distribution of the particles obtained from confocal scanning microscopy images. We could show that translocation of 20 nm polystyrene particles with negative surface charge through the cell membrane proceeds within minutes due to a non-specific adhesive interactions between particles and cell membranes but an active uptake mechanism can be detected at later times which can be reduced or delayed by drugs blocking active transport processes. These mechanisms for the uptake of particles by cells and the route of translocation into the cells depend on particle size and surface properties. For larger particles up to 200 nm diameter a similar results can be obtained but for even larger particles no passive translocation can be observed within 30 minutes. The biochemical response of the cell to the uptake of particles, e.g. immune response, induced apoptosis, etc. is examined.

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