Gehr P. / University Berne

The fate of nanoparticles after deposition in the lung

There is increasing evidence that the uptake of inhaled and deposited ultrafine particles (UFP) (< 100 nm) in the lung is postulated to cause lung and other diseases. However, the mechanisms involved are not known. Particle uptake by pulmonary cells may occur by specific means, i.e. ligand-receptor mediated and actin based or by non-specific means, i.e. adhesive interactions. So far, little is known about the interaction of UFP with lung cells and the subsequent uptake mechanisms. Since UFP are of the size of small cell components, their identification in cells is difficult. Therefore, we have combined different microscopic techniques to visualize the UFP.
We have used an in vitro model to study the uptake mechanism of UFP by cells. Human red blood cells (RBC) are used, since they are non-phagocytic cells. They do not have receptors on their surface and their sub-membranous actin network is very specifically arranged. The uptake of a variety of types of UFP was analysed with different techniques. (1) Fluorescently labelled polystyrene particles of a diameter of 78 nm and 20 nm were studied with confocal scanning microscopy, (2) gold particles (25 nm) with conventional transmission electron microscopy and (3) ultrafine titanium dioxide particles (32 nm) with analytical (energy filtering) electron microscopy using EELS (electron energy-loss spectroscopy).
We found that all investigated particle types, although varying in their physical and chemical properties were taken up by the non-phagocytic RBC. Hence, we postulate the non-specific mechanism of adhesive interaction for the uptake of such small size particles by cells in general. Surface forces may drive the particles to penetrate into the cell when interacting with the cell membrane. We hypothesise that this is the process by which particles can quickly and easily cross the epithelial barrier and enter other tissue compartments including cells of the defence system, nerves and blood vessels. We conclude that pulmonary diseases which may be caused by UFP are due to the rapid penetration of these particles into all compartments of lung tissue, and that this can lead to systemic translocation.

back to index