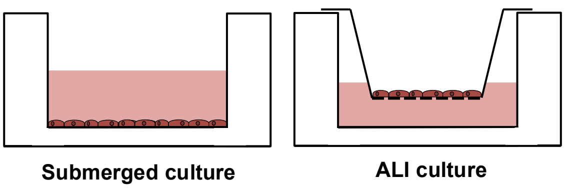
Exposure of zinc oxide nanoparticles on lung cells revealed changes in the cellular energy production

When we breathe we inhale a number of different particles present in the air, amongst these very small particles called nanoparticles. Zinc oxide nanoparticles have, in the latest research, been shown to affect the cellular energy production in a cell model resembling the lungs. Therefore there is a great need to continue to test the toxicity of these particles.

Man-made nanoparticles are becoming more and more common today. Nanoparticles are particles with a size on the nanometre scale, from 1 nm to 100 nm. Such small objects have a very large surface area in comparison to their volume. If you think of cutting an apple into smaller pieces, for each cut you make, more surface will be revealed. Therefore, nanoparticles can interact more with the cells in our bodies than larger particles. This often leads to a greater toxicity of nanoparticles when they come in contact with cells in our bodies.

One type of nanoparticles that are frequently used and produced in quite large quantities in the world is zinc oxide nanoparticles. They can be produced as dry powders, which means that employees working in the production may be unintentionally exposed to them when breathing.

To test the effects of nanoparticles, cell cultures can be used as a model for the lungs.



Two different ways to culture cells. Submerged cultures have growth media above them and air-liquid interface (ALI) cultures have growth media below them.

Often, submerged cell cultures are used. These are completely immersed in growth media, which is used to provide the cells with nutrients. In the lungs, many of the cells are in contact with the air we breathe and do not live with liquid surrounding them. Therefore, submerged cultures are not a good model for the lungs. To resemble the environment in the lungs, cells can instead be cultured at the air-liquid interface (ALI). This means that they have growth media below them and air above them.

In the present study, conducted at Lund University, zinc oxide nanoparticles were used to expose cells in a model of the lungs. The cells were cultured at the ALI and exposed to airborne zinc oxide nanoparticles with a mean size of around 40 nm. After the exposure, the energy production of the cells was studied. If cells are damaged, their energy production will change compared to non-damaged cells. The energy production can either increase, due to that the cells try to protect themself, or decrease, which is a sign of cell death. By looking at the energy production 3 hour and 24 hours after the exposure, it was found that the cell energy production had increased 3 hours after the exposure and then decreased 24 hours after the exposure. The initial increase indicates that the cells worked hard to get rid of the particles as a way of defending themselves. The following decrease means that some cells died.

In Sweden there are presently no work exposure limit values for nanoparticles, which could be a problem due to their effects in the lungs. There is however a limit value for coarse zinc oxide, which is 5 mg/m^3. In other European countries there are suggestions for nanoparticle exposure limit values based on both mass and number of particles. For example, the British Standard Institute suggests dividing the present limit value for coarse material by 15, and the Dutch Minister of Social Affairs and Employment suggest no more than 40 000 nanoparticles per cubic centimetre. The doses used in the Lund University study correspond to about two workdays in an environment where every cubic meter contains on average 5 mg zinc oxide nanoparticles. This, together with the cellular effects of the particles, suggests that there is a need to at least further investigate the effects of zinc oxide nanoparticles on the lungs.

Popular scientific summary of the master's thesis Exposure of zinc oxide nanoparticles on lung epithelium: A comparison between submerged and air-liquid interface cultures. *Julia Dobric, 2019.*