New insights into nanoparticles and dividing cells

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(PhysOrg.com) -- What happens when living cells take up nanoparticles, those tiny entities that could offer new ways of delivering drugs into the body? A new study from researchers at UCD has tracked the progress of nanoparticles as cells divide, and their findings - which were published recently in Nature Nanotechnology - will help us better understand how different tissues in the body process a dose of nanoparticles.

“Nanoparticles are engineered materials that we are producing, and what is very interesting about them is that they have a size that is in the nanometre range, so they are a bit bigger than proteins,” says Dr. Anna Salvati, a post-doctoral researcher at UCD School of Chemistry & Chemical Biology. “Their size allows them to interact with the cell in new ways.”

These nano-interactions open up potential opportunities to deliver drugs in new ways into cells, so they offer one of the most promising ways to treat currently untreatable diseases, from cancers to neurodegeneration, according to Dr. Salvati: “If we learn why nanoparticles can enter so easily and what decides where they go in the cell, then we could potentially design new delivery systems and learn how to deliver medicines,” she says.

We also need to understand bio-nano-interactions more generally from a safety perspective, she adds. “We could be exposed to nanomaterials in some cases because they are used for many applications from energy harvesting, electronics to paints. Ensuring they are safe is important.”

Dr. Salvati works on a team with Prof Kenneth A. Dawson at the Center for BioNano Interactions, the UCD-based national platform for nanosafety, nanobiology and nanomedicine, and UCD Conway Institute for Biomolecular and Biomedical Research.

Together with Jong Ah Kim and Dr. Christoffer Aberg, one strand of their research has been looking at the fate of nanoparticles during the life cycle of individual cells as they grow and divide. The UCD researchers introduced nanoscale polystyrene particles to human lung carcinoma cells growing in the lab, and used fluorescent markers to track the nanoparticles over space and time. What they identified was that nanoparticles could enter the cell easily and were not expelled during the cell cycle of growth, but rather got passed on to daughter cells as individual cells split into two.

“When a cell divides, the internalised nanoparticle dose is split between the daughter cells,” explains Dr Salvati. “This means that cells in the same population can have different amounts of internalised nanoparticles, depending on the phase of their cell cycle.”

The important observation is that a dose of nanoparticles in a cell population can be affected as cells divide, and that individual cells can end up with differing amounts of nanoparticles.

“When you give a dose of nanoparticles and a certain exposure time, you don’t have just one simple answer where every cell behaves in the same way - we have seen that individual cells behave differently and that can affect the cell’s dose of nanoparticles,” explains Dr. Salvati.

“The implications can be extended also for humans - inside the body the most specialised cells tend to have very slow cell division, while other cells divide very frequently. A cell that divides more frequently will dilute the amount of nanoparticles because every time it divides it dilutes

the load, and a cell that divides less often potentially might accumulate more nanoparticles." These findings will also help assure safety of nanoparticles, according to Dr. Salvati, and the UCD researchers are continuing to develop their understanding of the interactions.

"We are looking to describe the nanoparticle accumulation and kinetics with theoretical models so they could be used to predict how nanoparticles are going to behave in cell populations," she says.

"It would also be interesting for us to be able to design a nanoparticle able to target cells that divide rapidly, such as cancer cells, or where we could control in which stage it enters the cell, so it might enter more easily in certain phases as the cell grows. It will open up a whole new range of options in medicine."

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