'Tumour-on-a-chip' technology offers new direction

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A two-year collaboration between the Chan and the Rocheleau labs at the Institute of Biomaterials & Biomedical Engineering (IBBME) has led to the development of a new microfluidics screening platform that can accurately predict the way nanoparticles will behave in a living body.

Nanoparticles are being eyed by scientists as a potentially powerful tool for personalized cancer treatments. The tiny particles, ranging in size from 10 to 100 nanometres (somewhere in size between a large protein to a small virus), can be deployed to outline tumours or to deliver chemotherapy drugs directly to cancer cells with more potency and less side effects than regular delivery methods.

But Associate Professor Jonathan Rocheleau, core faculty at the Institute of Biomaterials & Biomedical Engineering (IBBME), cross-appointed to the Departments of Physiology and Medicine, Division of Endocrinology & Metabolism and a corresponding author of the study released in Nature Communications last week, explained that the new platform fills some of the glaring holes in current nanotechnology research.

Often, the surfaces of these tiny particles are treated to make them stick to certain cells, an effect which tends to work very well when studying the particles in petri dish cultures. "What we showed was that the nanoparticles meet up with a cell mass and stick so strongly to the outside cells, they aren't able to penetrate into the tissue. It makes you think of designing your nanoparticles in a different way," stated Rocheleau.

Aside from petri dish cultures, live testing has been the only other method of studying the movements and interactions of nanoparticles with cell masses. But as one of the paper's lead authors, PhD candidate Alex Albanese, explained, "If we were to inject nanoparticles into mice it would be like throwing a paper airplane blindfolded. We see where it lands but we're not really sure of the flight pattern."

And until now, there has been no middle ground.

'Middle ground' is exactly what Albanese and co-author, Dr. Alan Lam, a recent graduate of IBBME, have designed. The researchers placed live spheroid tissues, tissues that mimic the properties of cancerous tumours, into a tiny, inch-long chamber through which a saline solution was constantly flowed. The flowing liquid allowed the researchers to study the spheroids in environments similar to those found in tumours. Fluorescent nanoparticles were then injected into the chamber, allowing the team to measure just how many of the nanoparticles penetrated the tissue, where they were accumulating, and the effect of the liquid's speed on the nanoparticle's movements.

The experiments predicted the way the nanoparticles would behave in larger, live models, with results available within an hour rather than weeks.

"The tumor-on-a-chip allows us to sneak a peek at the paper planes before they land," described Albanese.

Although this is just the first time microfluidics technology platform has been used to study the effects of nanoparticles on a live tumour tissue, the researchers were surprised at how simple the technology can potentially make cancer screening and treatment.

"Biopsies can be grown into these tissues and placed in the channel.

Then we can find out which nanoparticles work and put them into patients," explained Rocheleau.

The study's authors admit there is still a vast distance between this preliminary study and future studies that can perfect the design of the nanoparticles, as well as their efficacy with different tumour tissues, organs and the entire body.

"Computers have come a long way since the 1960s. Right now, we're still in the 1960s of personalized medicine," argued Albanese.

For Rocheleau, though, the study points to a breakthrough in the way researchers are tackling complex biomedical challenges.

"What makes this project unique is how multidisciplinary it is," he said. "These are very different techniques and tools coming together to address a problem, and this project wouldn't have occurred without the expertise of two unique people and labs, and how long they stuck it out."

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