New technique allows researchers to study cell forces in 3-D

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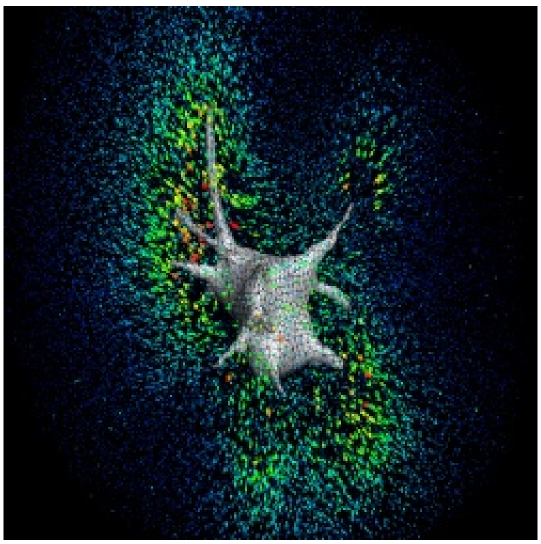

Finite element rendering of a spreading fibroblast encapsulated in an elastic hydrogel. (Art: Wesley Legant)

(PhysOrg.com) -- Researchers at the University of Pennsylvania have created a revolutionary new technique that will allow scientists to accurately measure the forces cells exert as they move through a three-dimensional environment.

This innovative technique, developed by researchers working under Christopher Chen, the Skirkanich Professor of Innovation in Bioengineering in the School of Engineering and Applied Science at Penn, represents a significant step forward for researchers interested in understanding how exactly cells migrate through their surroundings and what forces those cells exert as they move. Previously, scientists had only been able to study these cell forces on top of flat two-dimensional surfaces.

"This method allows researchers to create a 3-D map of the forces that cells exert against their surroundings — where does a cell push, where does it pull and how do these forces translate into cell movement?" said Wesley Legant, a doctoral candidate in Chen's lab and co-author of the manuscript. "Before, we could only see this in 2-D. But that view was not complete, since cells in our bodies exist and migrate predominantly in 3-D."

Understanding how cells move is important, researchers say, because cell movements play a crucial role not only in such biological processes as tissue formation but metastasis in cancer as well. But while scientists have long known that cell-generated forces are vitally important to driving cell migration, they just haven't been able to "see" these forces in three-dimensions.

Chen's team solved this problem by entrapping cells in synthetic hydrogels, jelly-like substances commonly used as biomaterials for research into cell biology and tissue engineering.

Chen and his fellow researchers tracked the displacements of small fluorescent beads, placed within the matrix surrounding the cells. By generating computational models, they were able to use these displacements to accurately measure the forces generated by different cell regions as those cells moved throughout their surrounding matrix. They also gained insights into how the tip of a migrating cell advances through its environment.

The researchers applied this technique to various cell types in order to thoroughly assess its accuracy and applicability going forward.

"This research was a first step," Legant said. "We found that cells in 3-D matrices reach out thin finger-like protrusions and then pull back inward toward their centers. Our hope is that the technique established here will be the backbone for future studies of how cells move in a variety of settings."

Provided by University of Pennsylvania