Biophysicists model the behavior of a protein critical to cell motion

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(Phys.org) -- Physicists at Lehigh have created a mathematical model that could benefit researchers who study cell motion, including cancerous cell motion, tissue healing processes and human embryonic development.

Their model consists of partial-differential equations that describe the behavior of actin filaments at the cell's leading edge. The alternate accumulation and dissipation of actin drive the protrusion and retraction behavior of the cell membrane of crawling cells.

Gillian L. Ryan, a postdoctoral scientist in the physics department, and Dimitrios Vavylonis, associate professor of physics, developed the model, which hypothesizes that actin assembly is part of an excitable system. The protrusion of the actin cytoskeleton near the cell membrane along the cell's leading edge, said Ryan, represents one of three factors that contribute to cell movement. The other two are the adhesion by the cell to an outside surface and the contraction of the cell's back edge.

Ryan and Vavylonis, along with Naoki Watanabe, a professor of life sciences at Tohoku University in Japan, and Heather Petroccia, who earned a B.S. in physics from Villanova University in 2011, recently published an article in *Biophysical Journal* titled "Excitable Actin Dynamics in Lamellipodial Protrusion and Retraction."

Coordinating actin activities and cell motion

Watanabe's lab used fluorescent tags to mark actin accumulation in XTC cells from frogs. Inside the lamellipodia, which are cell extensions along the cell edges, actin polymerizes into a dense network of filaments that protrude from the cell membrane in a dynamic process. Image analysis of actin fluorescence enabled Ryan to correlate the buildup and dissipation of actin with the motion of the cell.

"Once we had a clear quantitative analysis, this enabled us to formulate and test a coarse-grained mathematical model that attempts to capture the basic features of the system," Ryan said.

A better understanding of actin behavior might affect multiple fields. Vavylonis, Ryan and members of their group are continuing their studies in cell biophysics by examining the ways in which actin filaments contribute to cell division and other cell processes.

"We hope to better understand how actin filament assembly and disassembly generate cell patterns and mechanical forces," Vavylonis said.

Watanabe is trying to apply the discovery to the medical field. "He's looking at the effects that different drugs can have on lamellipodia," Vavylonis said. Watanabe hopes to find drugs that will facilitate the activation or suppression of lamellipodial responses, because cell motion is vital both to tissue remodeling and the cancer cell invasion in humans.

The project is funded by Human Frontiers Science Program, which supports collaboration across different disciplines and in different countries.

More information: www.sciencedirect.com/science/ … ii/S0006349512002858

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