A mechanical perspective on cell motility and chemotaxis

Chiara Giverso
Department of Mathematical Sciences, Politecnico di Torino
chiara.giverso@polito.it

Abstract

Cell motility is a complex process which is essential for many physiological and pathological conditions and it requires the activation of numerous intracellular mechanical and chemical mechanisms to achieve cell polarization and dynamic assembly and reorganization of the actin network. The cascade of processes leading to cell motility can be either triggered by various external physical or chemical stimuli (such as in *chemotaxis*), or self-regulated (i.e. spontaneous). Independently from its origin, the stimulus is converted into internal gradients of signaling molecules (the *polymerizing factors*), that in turn guide the cytoskeleton mechanisms performing the motile response.

In order to bridge the gap between the mathematical models focusing on the mechanics of cell motion and the one describing the overall motion of the cell in response to the external chemical field, we developed a one-dimensional continuous model representing cell migration, taking into account the mechanical stress inside the cell, the intracellular signaling molecules possibly triggered by external factors, such as an external chemical field, and the actin dynamics during polymerization and depolymerization [1]. The proposed model is solved numerically to simulate cell behavior during biologically relevant conditions and to study different mechanisms of conversion of the external chemical field onto the intracellular polymerizing factor. The model is able to reproduce the transitions from the non-migrating to the migrating regime, possibly triggered by the external chemotactic gradient, which is amplified by the internal chemical dynamics. More complex migratory behaviours can be described, as well, by including intracellular regulatory pathways of the polymerizing factor. Thus, the proposed model, even though kept as simple as possible, provides an interesting insight onto possible mathematical laws defining cell migratory velocity inside external chemical field gradients. .

References

[1] C. Giverso and L. Preziosi, Mechanical perspective on chemotaxis, *Physical Review E*, 98(6): 062402, 2018.