

# Description of postdoc research at the IMA (2007-2009)

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Since my arrival at the IMA last fall, I have been working with Hans Othmer on modeling different aspects of cell motility, a complex process that is essential in the life cycle of many organisms. For instance, cell motility is involved in embryonic development, wound healing, the immune response, and cancer cell metastasis. Furthermore, errors during cell migration have serious consequences including mental retardation, vascular disease, tumor formation, and metastasis. Therefore, an understanding of the mechanism by which cells migrate may lead to the development of novel therapeutic strategies for controlling, for example, invasive tumor cells.

The following four steps are involved in successful cell migration: 1) A thin lamellipodium (or “filament factory”) protrudes along the leading edge in the direction of migration and is driven by actin polymerization. 2) The protrusion adheres to the extracellular matrix (ECM) by large protein complexes referred to as “focal adhesions” (FAs). 3) Myosin II-driven actin convergence pulls on FAs at the front to generate traction. 4) This traction causes weaker FAs in the rear to detach, through contraction of actin bundles known as stress fibers, thus moving the cell body forward.

FAs play a key role in cell migration, as they serve both as mechanical links from the cell to its surroundings and as biochemical signaling hubs to concentrate and direct numerous signaling proteins within the cell. My current focus is in the development of a mathematical model to describe the dynamics of these focal adhesions in mammalian cells. At present no model exists on the early formation and clustering of FAs or on the integration of the growth of stress fibers and FAs. Therefore, my initial modeling efforts include construction of a basic model of nascent FAs to determine the necessary components and the role of each in the growth and fate of the FAs.

This modeling effort is in collaboration with Hans Othmer’s cell motility group. The overall goal of this collaboration is to develop different component models (each describing varying aspects of the four-step motility process) which can then be integrated to form a comprehensive model of cell motility.