

Modeling microtubule-based transport in the frog egg cell

Authors:

Maria-Veronica Ciocanel*, Division of Applied Mathematics, Brown University,
Email: veronica_ciocanel@brown.edu.

Björn Sandstede, Division of Applied Mathematics, Brown University,
Email: bjorn_sandstede@brown.edu.

Kimberly Mowry, Department of Molecular Biology, Cell Biology, and Biochemistry, Brown University,
Email: kimberly_mowry@brown.edu.

Abstract:

In the development of egg cells into embryos, spatial differentiation is essential in determining the role of the new embryo cells in the growing organism. This spatial patterning often relies on asymmetric accumulations and transport of proteins in the egg cell. In the frog, messenger RNA (mRNA) dynamically switches between diffusion and active transport states in its journey to the periphery of the egg cell, where it accumulates and creates a spatial axis of development. Using dynamical systems modeling and analysis, we investigate the transport of mRNA and its dependence on cytoskeleton roads in the egg cells called microtubules. Numerical studies using model microtubule structures allow us to predict that an anchoring mechanism at the cell periphery may be key in healthy development.