Mathematical Modeling of Cell Morphological Change Induced by Pheromone Gradient in Yeast

Cell morphogenesis is a fundamental process that underlies cell differentiation, behavior, and response to internal and external cues. Polarized morphogenesis has been established to require the rearrangement of the actin cytoskeleton, which is downstream of membrane signaling events and involved in protein, organelle and secretory vesicle transport toward the site of growth. Persistent cell polarization requires the initiation, establishment, and maintenance of the polarized site with different mechanisms being proposed to explain these steps. Based on existing evidence, cell polarization of the yeast *S. cerevisiae* during mating is likely maintained through the transport of vesicles to and from the membrane, therefore resulting in cell morphology being dependent on the balance between endocytosis and exocytosis. While our experiments show that the morphology of yeast mating projections is affected by changes in pheromone concentration, we propose that a further understanding of the underlying mechanisms can be elucidated through mathematical modeling of the system. To achieve this, we have expanded previously developed models of the yeast mating pathway to include a dynamically evolving cell membrane that is linked to the underlying molecular signaling species through endocytosis and exocytosis. Our simulation results are shown to be in good agreement with the experimental measurements, and our model thus provides a plausible explanation for the pheromone concentration dependent cell morphologies.