Bistability and Hysteresis in the Pheromone Response Pathway

Lior Vered[1], Beverly Errede[2], and Timothy Elston[3]

***Short Abstract* — Cell polarity is the asymmetric organization of cellular structures. Many mathematical models of polarity rely on bistablility, or the existence of two stable steady states. Bistable regulation of polarity has yet to be tested experimentally.**

Hysteresis is a hallmark of bistability. We tested for the existence of hysteresis in polarity establishment during the pheromone response of the *Saccharomyces cerevisiae*. Interestingly, mother cells display hysteresis, whereas in daughter cells do not. The results for daughter cells show that bistability is not a necessary condition for polarity. The hysteresis observed in mother cells opens the possibility for bistability in certain cellular contexts.

***Keywords* — Polarity, Bistability, Hysteresis, Pheromone Response, Saccharomyces cerevisiae.**

I. Introduction

Cell polarity is the asymmetric organization of cellular structures and morphology. Polarity establishment is critical for differentiation, morphogenesis and migration in all eukaryotes [1]. Many mathematical models of polarity rely on bistablility, or the existence of two stable steady states [2-6]. In the context of polarity establishment in response to an external stimulus, bistability means that cells can exist in either a polarized or unpolarized state for a range of stimulus strengths. Which steady state is observed depends on past conditions. Bistable regulation of polarity has yet to be proven or refuted experimentally.

II. Methods and Results

One of the hallmarks of a bistable process is hysteresis [7]. In the context of stimulus induced polarity, hysteresis means that the stimulus strength needed to establish polarity is greater than that needed to maintain polarity once it is established. We tested for the existence of hysteresis in polarity establishment during the pheromone response of the budding yeast Saccharomyces cerevisiae. Using a custom microfluidic system, we determined the minimum pheromone concentration required to establish polarity and compared it with the maximum concentration at which polarity is lost. Interestingly, we found that mother cells display hysteresis, whereas in daughter cells do not. Mother cells require a higher pheromone concentration to establish polarity than to lose polarity, while daughter establish and lose polarity at the same pheromone concentration.

III. Conclusion

The results for daughter cells show that bistability is not a necessary condition for polarity establishment. The hysteresis observed in mother cells opens the possibility for bistability in certain cellular contexts.

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[1]Department of Chemistry, University of North Carolina, Chapel Hill, NC, USA. E-mail: vered@live.unc.edu

[2]Department of Biochemistry and Biophysics, University of North Carolina, Chapel Hill, NC, USA. E-mail: errede@email.unc.edu

[3]Department of Pharmacology, University of North Carolina, Chapel Hill, NC, USA. E-mail: telston@med.unc.edu