Robust periodic patterning in the Drosophila eye

Naama Barkai

Department of Computational Molecular Genetics, Weizmann Institute of Science, Israel

Periodic patterns emerge during the development of multiple tissues and organs. How such patterns are generated in a robust way is still an open question. The *Drosophila* eye is comprised of ~750 eye units, named ommatidia, whose crystalline order is defined during eye disc patterning through a dynamic process involving a traveling activation wave sweeping across the disc, followed by a lateral-inhibition based refinement. Using mathematical modeling, we confirm that lateral inhibition can generate precise repeated patterns in a field of naïve cells, but find that it fails to do so in the presence of noise. We describe the basis for this breakdown and show that robustness is recovered under the assumption of a short-range diffusible activator. Experimentally, we identify this missing activator as Scabrous, a previously implicated inhibitor. We further predict and verify that robustness is improved by the action of apical cell constriction at the morphogenetic furrow, which effectively increases the number of cells in close proximity during signaling. We argue that mechanisms of periodic pattern formation are largely constrained by the need to buffer spatial and temporal heterogeneities.