

Models of Congenital Malformation and Disease

Faculty Search Seminar



Dr. Heath Johnson

Postdoctoral Fellow
Jared Toettcher's Lab
Department of Molecular Biology
Princeton University

Optogenetic dissection of Erk-dependent cell fates during embryogenesis

Animal embryos are partitioned into spatial domains by successive patterns of intracellular signaling and gene expression. Yet in most cases it is unknown which pattern features (i.e., spatial gradients or temporal dynamics) are required to support normal development and program specific cell types. To address this question, we developed a light-inducible system to catalyze the activation of Erk in early *Drosophila* embryo. Here receptor tyrosine kinase activity forms a complex evolving gradient of Erk activity, leading to patterns of gene expression and the specification of tissues and morphogenic movements. By combining our optogenetic tool with genetic mutants, we demonstrate that optogenetic control can be used to 'paint' arbitrary signaling patterns on the embryo, recapitulating all of cell – and tissue-level responses required for normal development. Remarkably, simple all-or-none light inputs were able to completely rescue normal embryogenesis, generating viable larvae and fertile adults from this otherwise-lethal genetic mutant. Perturbations to this patterning reveal that distinct cell fate outcomes are programmed at various thresholds of Erk activity, responding to changes in either the duration or amplitude of signal. Thus, the cumulative load of Erk is used to discriminate between cell fates, while the embryo has a significant built-in tolerance to variance in the spatial domains of Erk signaling. These results open the door to the targeted design of complex morphogenetic outcomes or to correcting the patterning errors that underlie developmental defects.

Monday | January 13th | 2020 | 3 pm

PGCRL Event Room 1

Hosts: Drs. Brian Ciruna & John Brumell

Dr. Heath Johnson is being interviewed for a Scientist position at the Research Institute