Wednesday contributed talks 2

Adriana Dawes

Ohio State University

"Dynein dynamics in the first cell cycle of the C. elegans embryo"

Asymmetric cell division, where daughter cells inherit unequal amounts of specific factors, is critical for development and cell fate specification. In polarized cells, where specific factors are segregated to opposite ends of the cell, asymmetric cell division occurs as a result of positioning the centrosomes along the polarity axis. In many systems, this positioning involves both translocation as well as rotation of the nucleus and its associated centrosomes. Using an individual-based stochastic model of centrosome-associated microtubule dynamics and experiments in early embryos of the nematode worm C. elegans, we explore the role of the motor protein dynein under both wild type and knockdown conditions. We show that dynein activity but not localization is implicated in specific centrosome movement defects in the first cell cycle.

Tracy Stepien

University of Florida

"Spreading Mechanics and Differentiation of Astrocytes During Retinal Development"

In embryonic development, formation of the retinal vasculature is critically dependent on prior establishment of a mesh of astrocytes. Astrocytes emerge from the optic nerve head and then migrate over the retinal surface in a radially symmetric manner and mature through differentiation. We develop a PDE model describing the migration and differentiation of astrocytes, and numerical simulations are compared to experimental data to assist in elucidating the mechanisms responsible for the distribution of astrocytes.

Renske Vroomans

Origins Center

"Conservative evolution of epithelial morphogenesis"

Morphogenesis is a complex process involving multiple levels of organisation. Cell differentiation within tissues is governed by extensive gene expression regulation within cells and communication via chemical signals between cells. Based on their gene expression, cells may divide and change their physical properties, leading to cell- and tissue-level physical forces which can in turn feed back on gene expression between cells. This developmental process may change over time due to Darwinian evolution, but development itself influences the course of evolution by determining the effect that mutations have on the final phenotype. Currently, it is not well-understood how the complex interactions involved in morphogenesis impact the kind of evolutionary changes that can occur. Here, we investigate the evolution of developmental mechanisms that govern morphogenesis with Embryomaker, an in silico model of 3d epithelium development. We look at short-term evolutionary changes that occur under conservative selection, meaning that the final shape of the tissue is conserved while all else -- gene expression pattern, growth pattern, developmental trajectory -- is allowed to change. We find that substantial change can occur at all levels of organisation, from the structure of the gene regulatory network to gene expression pattern, the duration of the developmental process and the course of morphogenesis. In some cases we observe an increase in the reliability of the developmental process despite not explicitly selecting for it, and show how it is caused by a non-trivial combination of mutations which on their own do not improve -- or even diminish -- fitness. Finally, we show how the coupling of gene expression regulation to morphogenesis influences which mutations are accepted, and thereby the ancestry of genes in the genome.