COLLECTIVE MOVEMENT IN MYXOBACTERIA:
Modeling and Experiments with Myxococcus xanthus

Abstract

By Cameran Harvey

"Myxobacteria are a fascinating example of how patterns of movement and organization in large populations of bacterial cells emerge from basic individual level interactions. How cells coordinate movement is fundamental to many important areas of study from development biology where cells must arrange into highly regulated patterns and differentiate with precise timing to topics like infectious diseases where bacterial cells use a variety of signaling mechanism to colonize surfaces and infect tissue. In this thesis, I will present a study on the biophysical mechanisms that drive pattern formation in both phases of the Myxococcus xanthus life cycle. In this study that combines experiments with computational modeling and simulation, I will present novel techniques for imaging the patterns of movement and cellular organization which, in conjunction with image analysis, reveal unique patterns of clustering. The experimental observations helped to inform the development of a cell-based biophysical model that account for the adhesive forces between cells and the elastic properties of the cells. Simulations with this model were used to study how the physical and behavioral properties impact the ability of cells to form and move as organized clusters of cells. My findings provide new insight into the three-dimensional structure of myxo fruiting bodies as well as the demonstrate the importance of both physical and behavioral properties in the role of multi-cellular coordination."