Seminar/Talk

Collective dynamics in systems of communicating secrete-and-sense cells

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How a system of genetically identical biological cells organizes into spatially heterogeneous tissues is a central question in biology. Even when the molecular and genetic underpinnings of cell-cell interactions are known, how these lead to pattern formation at the population level is often incompletely understood. We studied the gene expression dynamics of cells that secrete and sense signaling molecules by developing a multiscale model and an open-source software for simulating mesoscopic numbers of cells (hundreds to thousands). We observed that the cells self-organized into diverse spatial patterns without external morphogen gradients. To understand our observations, we constructed a coarse-grained, population-level description of our system. This revealed a conceptual picture of our multicellular system as a particle rolling down a pseudo-energy landscape. An approximate equation for the dynamics on this landscape explains how and why the system becomes increasingly spatially ordered over time. Next, we studied how dynamic patterns such as collective oscillations and travelling waves formed when cells communicate with multiple signaling molecules. Through a computational screen and a theoretical framework I developed, we found a common structure to the gene networks characterizing the interactions between two signaling molecules that enable these dynamic patterns to form. Furthermore, they emerge through a three-stage order-fluctuate-settle process, where the final pattern forms after a long period of fluctuations and transient patterns. Our work provides a blueprint for identifying gene regulatory links that enable dynamic patterns and for building synthetic tissues.

Friday, October 18, 2019 03:00pm - 04:00pm
Mondi Seminar Room 2, Central Building

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