CDB SEMINAR

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16:00~17:00 C1F CDB Auditorium

Physical constraints and limits to precision in early embryonic development

Summary

During embryonic development, information about spatial location is represented by the concentration of various protein gradients. The reproducibility and precision of biological pattern formation is thus limited by the accuracy with which these concentration profiles can be established and "read out" by their target pathways.

In this talk, I present a biophysical analysis of one of the most studied protein gradients in the fruit fly embryo, the Drosophila Bicoid morphogen gradient.

First, using two-photon microscopy and other biophysical instrumentation techniques, both the full spatiotemporal dynamics that lead to gradient establishment and the gradient's scaling with embryo size in closely-related species were measured and used to test a simple physical model.

Second, four functionally different measurements of precision for the protein gradient were considered; through a combination of different experiments, I showed that all of these quantities are ~10%, which is close to the physical limit set by random arrival of individual molecules at their targets.

The agreement among the different measures of accuracy indicates that the system in fact relies on precise control of absolute concentrations, and responds reliably to small changes in these concentrations, down to the limits set by basic physical principles. This contradicts previous research, which was driven by the assumption that sloppy input signals and noisy readout mechanisms govern embryonic development.

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