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Dynamics of gene expression pattern formation in growing tissues

Monday, 15 September 2025 10:00 (30 minutes)

Understanding the biophysical mechanisms that govern gene expression pattern formation is crucial for reproducible and organized organ development. Although many genetic and mechanical factors involved in pattern formation are known, we still lack a comprehensive understanding of how cellular dynamics and biomechanical feedback are orchestrated to ensure precise and reproducible patterning. In this talk, I will address this issue by presenting both a case study of ventral pattern formation in the developing spinal cord and a study of tissue development governed by mechanical factors. In the first part, I will show that after its initial establishment, the morphogen source becomes insensitive to its own signal and expands in response to tissue growth. This mechanism leads to a proportional scaling of the resulting pattern with both spinal cord size and morphogen amplitude. Such temporal decoupling of specification and growth might have implications for pattern formation in other growing organs. In the second part, I will discuss how cell elasticity, junctional tension, contractile forces, and cellular dynamics collectively affect pattern formation. Using a 2D apical vertex model, I will demonstrate how these biomechanical factors and cellular dynamics affect tissue transition from a solid-like to a fluid-like state. I will conclude by presenting results on how incorporating cell curvature can further influence pattern formation. Together, these findings identify key factors affecting patterning in growing tissues and may be broadly relevant for multiple developing tissues.

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