Soft Living Active and Adaptive Matter

How biology uses physics to sculpt an inner organ

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CCBM NSF-CREST CENTER FOR CELLULAR AND BIOMOLECULAR MACHINES

Abstract:

Organs are often composed of multiple laminar tissues arranged in concentric layers. During morphogenesis, visceral organs fold into complex shapes that are vital for function. Genetic signals are known to govern shape, but the dynamic and mechanical interplay of tissue layers giving rise to organs' complex shapes remains elusive. Here, we trace the dynamics and mechanical interactions of a developing visceral organ across tissue layers, from sub-cellular to organ scale. Using deep tissue light-sheet microscopy for whole-organ live imaging, we find a mechanical program folding the embryonic midgut of Drosophila: hox genes control the emergence of high-frequency calcium pulses, which trigger muscle contractions. These contractions, in turn, induce cell shape change in the adjacent tissue layer, collectively driving a pattern of convergent extension. Kinematic constraints reveal how in-plane shape change is linked to out-of-plane organ folding. These findings offer a mechanical route for gene expression to induce organ shape change: genetic patterning in one layer triggers a physical process in the adjacent layer to drive organ shape change.

Date:
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Time:
9:00 AM-10:15 AM (PT)

About the speaker:

Noah Mitchell is a Helen Hay Whitney Foundation Postdoctoral fellow at the University of California, Santa Barbara. He is interested in how biology patterns mechanical forces to sculpt the shape of visceral organs, blending experimental developmental biology approaches with analysis methods from physics.

After early research experiences in astrophysics as an undergraduate, he was drawn to the elegance of soft matter physics and completed his PhD at the University of Chicago, where he focused on the mechanical behavior of thin elastic sheets and metamaterials using experiments, simulations, and theory. In the course of his studies, he became interested in how mechanical forces are patterned to drive morphogenesis in living systems. Recent recognition includes a Yodh Prize, Springer Thesis Award, and Otis Williams Fellowship.

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