ST. OLAF PHYSICS DEPARTMENT

COLLOQUIUM SERIES

From genes to geometry: how biology uses physics to sculpt a visceral organ

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VIn morphogenesis, tissues integrate mechanical and biochemical signals to direct organ-scale geometric transformations. Uncovering the dynamic interplay between genetic patterning, mechanical forces, and tissue geometry requires a physical understanding of how cell interactions collectively deform the tissue. A broad class of organs, including the gut and heart, form from tube-like sheets of multiple cell layers that fold into complex shapes. Specific genes have long been known to regulate organ shape, but the underlying mechanical programs remain mysterious. This talk will trace the dynamics and mechanical interactions driving organ folding using the embryonic midgut of the fruit fly as a model system. By leveraging light-sheet microscopy techniques and building a computational toolkit for covariant measurement of whole-organ dynamics, we extract cellular and tissue-scale deformations within morphing 3D geometries. These measurements reveal a simple kinematic mechanism linking in-plane and out-of-plane deformations. Merging this approach with genetic and optogenetic perturbations uncovered a muscle-driven mechanical program acting across tissue layers. Building on this quantitative framework will decode how sheets of interacting muscle and epithelial tissue layers generate complex organ shapes.