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Contractile forces driving embryonic development

MATTHIAS KASCHUBE, Princeton University

Proper development of an organism requires an orchestrated interplay of large sets of components. Recent developments in live fluorescent imaging methods allow the visualization of many key proteins in cells and tissues. Developing quantitative image analysis methods to measure the dynamics of shape changes in individual cells is central for understanding how a tissue gets sculpted, what molecular machineries are driving this process, and what interactions between cells are regulating it. In this talk, I will present recent advances in our understanding of the dynamical processes during morphogenesis, focusing on the example of tissue folding and invagination at the beginning of gastrulation in *Drosophila*. I show that this process is driven by a contractile multicellular actomyosin meshwork that dynamically forms within a few minutes at the cell surfaces. In individual cells, contraction is pulsed, with phases of contraction interrupted by pauses in which the cell size is maintained, i.e. a ratchet type dynamics that reduces the surface area of cells incrementally. Measuring the dynamics of whole cell shape changes in 2-photon live imaging data reveals that contraction pulses drive cell lengthening and relocation of cell nuclei, two transformations that are essential for successful invagination of tissue. This analysis further shows that over subsequent stages of invagination, during which cells undergo an elaborate sequence of shape changes, the volume of individual cells is a preserved quantity. These results shed new light on the forces and cellular dynamics driving tissue morphogenesis and are a step towards a quantitative understanding of how an organism's shape and internal structure arises in development.