Thursday Keynote Lecture

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Folding tissues across length scales: Cell-based origami

Throughout the lifespan of an organism, tissues are remodeled to shape organs and organisms and to maintain tissue integrity and homeostasis. Apical constriction is a ubiquitous cell shape change of epithelial tissues that promotes epithelia folding and cell/tissue invagination in a variety of contexts. Apical constriction promotes tissue bending by changing the shape of constituent cells from a columnar-shape to a wedge-shape. Drosophila gastrulation is one of the classic examples of apical constriction, where cells constrict to fold the primitive epithelial sheet and internalize cells that will give rise to internal organs. We have used a combination of imaging, experimental perturbation, and modeling, to determine how actomyosin organization promotes tissue folding. The actin cytoskeleton is organized in both time and space to facilitate apical constriction. We found that actomyosin contraction is pulsatile and requires dynamic regulation of upstream signaling processes. In addition, we found that actomyosin becomes organized into oriented fibers, which generates anisotropic tension that is critical for tissue shape. Furthermore, connectivity within the network of actomyosin fibers is highly redundant, promoting the robustness of folding.