Multi-Level Studies of Developmental Morphogenesis: from Biophysics to EvoDevo

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ABSTRACT

The origin of biological form is one of the oldest and most enduring problems in biology. Embryonic tissues and organs change their size and shape during development through patterned cell activities controlled by intricate physico-chemical mechanisms. We have introduced two genetically and optically tractable arthropod species, the beetle *Tribolium castaneum* [1] and the shrimp-like crustacean *Parhyale hawaiensis* [2], as powerful and attractive model systems for biologists and biophysicists interested in the molecular, cellular and mechanical control of developmental morphogenesis. Fluorescently labeled embryos are imaged with multi-view light-sheet microscopy at high spatiotemporal resolution over several days of embryogenesis. Quantification of cell behaviors in imaged wild-type or genetically and mechanically perturbed embryos offers a bottom-up cellular perspective of various morphogenetic processes in *Tribolium* and *Parhyale*. In the case of *Tribolium*, combining also imaging of cytoskeletal actin and myosin dynamics with physical modeling has provided insights into the cell and tissue interactions and the forces contributing to widely conserved epithelial movements during animal gastrulation [3]. In the case of *Parhyale*, comprehensive reconstructions of fate maps using open-source software available as Fiji/ImageJ plugins have provided insights into the cell lineage restrictions and differential cell behaviors contributing to animal limb bud formation and elongation [4]. The comparison between *Tribolium*, *Parhyale* and the classic model systems in developmental biology, like worms, flies, fish and the mouse, will shed light on the conservation and divergence of morphogenetic mechanisms by which animal tissues take (or loose) shape during normal development (or disease).

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