Reconstruction the Mechanical Behaviors of Cells in Silico

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Auditorium, Geddes Hall

Actin cytoskeleton is a dynamic structural scaffold used by eukaryotic cells to provide mechanical integrity and resistance to deformation, while simultaneously remodeling itself and adapting to diverse extracellular stimuli. The actin cytoskeleton utilizes these properties to play crucial roles in essential cellular processes such as cell migration and division. However, despite its known mechanical role in cell behaviors, a clear understanding of the mechanical properties of actin cytoskeleton and the molecular origin of these properties still lacks, partly due to experimental limitations. Computer simulations can access time and length scales inaccessible by experiments, and thus aid in creating a descriptive model of the molecular interactions that evolve into the mechanical properties observed on cellular scales. To this end, we have developed a cutting-edge computational model which is designed to reproduce the mechanical and dynamic behaviors of actin cytoskeleton within cells. Guided by explicit experimental data, we systematically explored, via simulation, how the mechanics and dynamics of actins and actin-binding proteins determine the deformation, flow, and stiffness of the passive actin cytoskeleton. We also investigated how interactions between the passive cytoskeletal constituents and active molecular motors lead to force generation, contraction, and morphological changes in the active actin cytoskeleton.

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