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Multiscale Modeling of Primary Cilium Deformations Under Local Forces and Shear Flows ZHANGLI PENG, ZHE FENG, University of Notre Dame, ANDREW RESNICK, Cleveland State University, YUAN-NAN YOUNG, New Jersey Institute of Technology — We study the detailed deformations of a primary cilium under local forces and shear flows by developing a multiscale model based on the state-of-the-art understanding of its molecular structure. Most eukaryotic cells are ciliated with primary cilia. Primary cilia play important roles in chemosensation, thermosensation, and mechanosensation, but the detailed mechanism for mechanosensation is not well understood. We apply the dissipative particle dynamics (DPD) to model an entire well with a primary cilium and consider its different components, including the basal body, microtubule doublets, actin cortex, and lipid bilayer. We calibrate the mechanical properties of individual components and their interactions from experimental measurements and molecular dynamics simulations. We validate the simulations by comparing the deformation profile of the cilium and the rotation of the basal body with optical trapping experiments. After validations, we investigate the deformation of the primary cilium under shear flows. Furthermore, we calculate the membrane tensions and cytoskeleton stresses, and use them to predict the activation of mechanosensitive channels.

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