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Active mechanics in living oocytes reveal molecular-scale force kinetics WYLIE AHMED, Institut Curie, ETIENNE FODOR, Universite Paris Diderot, MARIA ALMONACID, College de France, MATTHIAS BUSSONNIER, Institut Curie, MARIE-HELENE VERLHAC, College de France, NIR GOV, Weizmann Institute of Science, PAOLO VISCO, FREDERIC VAN WIJLAND, Universite Paris Diderot, TIMO BETZ, University of Muenster — Unlike traditional materials, living cells actively generate forces at the molecular scale that change their structure and mechanical properties. This nonequilibrium activity is essential for cellular function, and drives processes such as cell division. Single molecule studies have uncovered the detailed force kinetics of isolated motor proteins in-vitro, however their behavior in-vivo has been elusive due to the complex environment inside the cell. Here, we quantify active forces and intracellular mechanics in living oocytes using in-vivo optical trapping and laser interferometry of endogenous vesicles. We integrate an experimental and theoretical framework to connect mesoscopic measurements of nonequilibrium properties to the underlying molecular- scale force kinetics. Our results show that force generation by myosin-V drives the cytoplasmic-skeleton out-of-equilibrium (at frequencies below 300 Hz) and actively softens the environment. In vivo myosin-V activity generates a force of $F \sim 0.4$ pN, with a power-stroke of length $\Delta x \sim 20$ nm and duration $\tau \sim 300$ μs, that drives vesicle motion at $v_{\mathrm{v}} \sim 320$ nm/s. This framework is widely applicable to characterize living cells and other soft active materials.

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