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A simple polymeric model describes cell nuclear mechanical response EDWARD BANIGAN, Department of Physics & Astronomy, Northwestern University, ANDREW STEPHENS, Department of Molecular Biosciences, Northwestern University, JOHN MARKO, Departments of Physics & Astronomy and Molecular Biosciences, Northwestern University — The cell nucleus must continually resist inter- and intracellular mechanical forces, and proper mechanical response is essential to basic cell biological functions as diverse as migration, differentiation, and gene regulation. Experiments probing nuclear mechanics reveal that the nucleus stiffens under strain, leading to two characteristic regimes of force response. This behavior depends sensitively on the intermediate filament protein lamin A, which comprises the outer layer of the nucleus, and the properties of the chromatin interior. To understand these mechanics, we study a simulation model of a polymeric shell encapsulating a semiflexible polymer. This minimalistic model qualitatively captures the typical experimental nuclear force-extension relation and observed nuclear morphologies. Using a Flory-like theory, we explain the simulation results and mathematically estimate the force-extension relation. The model and experiments suggest that chromatin organization is a dominant contributor to nuclear mechanics, while the lamina protects cell nuclei from large deformations.

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