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Cellular pressure and volume regulation and implications for cell mechanics HONGYUAN JIANG, SEAN SUN, Johns Hopkins University — In eukaryotic cells, small changes in cell volume can serve as important signals for cell proliferation, death and migration. Volume and shape regulation also directly impacts the mechanics of the cell and multi-cellular tissues. Recent experiments found that during mitosis, eukaryotic cells establish a preferred steady volume and pressure, and the steady volume and pressure can robustly adapt to large osmotic shocks. Here we develop a mathematical model of cellular pressure and volume regulation, incorporating essential elements such as water permeation, mechano-sensitive channels, active ion pumps and active stresses in the actomyosin cortex. The model can fully explain the available experimental data, and predicts the cellular volume and pressure for several models of cell cortical mechanics. Furthermore, we show that when cells are subjected to an externally applied load, such as in an AFM indentation experiment, active regulation of volume and pressure leads to complex cellular response. We found the cell stiffness highly depends on the loading rate, which indicates the transport of water and ions might contribute to the observed viscoelasticity of cells.

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