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A Computational Method for Simulating Electro-diffusion-Mediated Swelling of Gastric Mucus[1] OWEN LEWIS, University of New Mexico, JIAN DU, Florida Institute of Technology, AARON FOGELSON, JAMES KEENER, University of Utah — Gastric mucus is a polyelectrolyte gel that serves as the primary defense of the stomach lining against acid and digestive enzymes. Experiments show that the mucus gel may swell explosively within a short time period, accompanied by a massive transport of monovalent cations from the extracellular environment into the densely packed mucus in exchange for divalent calcium that had cross-linked the negatively-charged mucus fibers. We propose a 2D computational method for simulating mucus swelling with a two-fluid model. The model includes electro-diffusive transport of ionic species, the coupled motion of the glycoprotein network and hydrating fluid, and chemical interactions between the network and dissolved ions. Each ionic species in the solvent phase is subject to a NernstPlanck type equation. Together with the electro-neutrality constraint, these equations constitute a system of non-linear parabolic PDEs subject to an algebraic constraint. The discretized system is solved by a Schur complement reduction scheme. Numerical results indicate that the method is very efficient, robust and accurate, even for problems which exhibit large spatial variations in the concentration of ions. Computational investigation of swelling dynamics will be presented.

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