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The effect of viscoelasticity on the stability of the lung's liquid layer[1] DAVID HALPERN, University of Alabama, CHENG-FENG TAI, HIDEKI FUJIOKA, University of Michigan, JAMES B. GROTBERG — The lungs consist of a network of bifurcating airways that are lined with a thin liquid film. This film is a bilayer consisting of a mucus layer on top of a periciliary fluid layer. Mucus is a non-Newtonian fluid possessing viscoelastic characteristics. Surface tension induces flows within the layer which may cause the lung's airways to close due to liquid plug formation if the liquid film is sufficiently thick. The stability of the liquid layer is also influenced by the viscoelastic nature of the liquid which is modeled here as a Jeffreys fluid. To examine the role of mucus alone, we model a single layer of a visco-elastic fluid. Nonlinear evolution equations are derived using lubrication theory for the film thickness and the film flow rate. A uniform film is initially perturbed and a normal mode analysis is carried out that shows that the growth rate for a viscoelastic layer is larger than for a Newtonian fluid with the same viscosity. Solutions of the nonlinear evolution equations reveal that the closure time, defined to be the time required for a plug to form, decreases with increasing film thickness and viscoelasticity. Some results obtained from direct numerical simulations are also presented and compared with the lubrication theory model.

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David Halpern
University of Alabama

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