ACMS Applied Math Seminar

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Thursday, October 13
154 Hurley Hall
3:30- 4:30 PM

A Numerical Model For Edema Formation In Layered, Poroelastic Tissue

Edema is generalized clinical condition referring to the accumulation of excess fluid between cells, or in cavities; in the intestine the result is a loss of contractility by disrupting peristaltic activity. The canonical clinical model of edema used in the medical literature is an ordinary differential equation representing a simple balance of lymphatic and vascular fluid exchange based on the Drake Lane and Starling Landis equations. These ODE models rely on a tissue bed structure hypothesis that is too simplistic to represent the layered, heterogeneous physiology of the intestine; furthermore, they neglect the mechanical response of the tissue itself.

Recently, an approach for modeling the combined fluid/mechanical interaction based on a simplified, mixed form of Biot's equations of poroelasticity has been put forth (Young & Riviere); the model was discretized using the symmetric interior penalty discontinuous Galerkin method with piecewise linear elements. Clinical experiments conducted at the UT Health Sciences center in 2008 provided a means for verification; no error analysis was conducted.

In this talk I will present the full mixed form of the Biot model, discretization with the (non-conforming) discontinuous Galerkin SIPG/NIPG approaches, a-priori error estimates, implementation in 2D and 3D, numerical convergence results, and robustness to locking. I will then introduce a perturbed model, based on the generalization, suited for use in the context of the heterogeneous physiology of the intestine. I will share preliminary physiological computations, and ongoing work of both a clinical and mathematical nature.

The Department of Applied and Computational Mathematics and Statistics

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