Abstract Submitted
for the DFD15 Meeting of
The American Physical Society

A computational model that simulates mucociliary clearance in the bronchial tree, and a concomitant study on energetics and optimality MICHAIL MANOLIDIS, Visiting Scholar, Biomedical Engineering Department, University of Michigan - Ann Arbor, DANIEL ISABEY, Professor, Cell and Respiratory Biomechanics, Université Paris Est, Créteil, France, BRUNO LOUIS, Professor, Cell and Respiratory Biomechanics, Universit Paris Est, Crteil, France, JAMES GROTBERG, Professor, Biomedical Engineering Department, University of Michigan - Ann Arbor, MARCEL FILOCHE[1], Professor, Cell and Respiratory Biomechanics, Université Paris Est, Créteil, France — Systemic deterministic models of mucociliary clearance in the bronchial tree are currently scarce. While analytical/computational efforts have focused on microscopic modeling of mucociliary propulsion, macroscopic approaches have been restricted mainly to stochastic methods. We present an analytical/computational model that simulates mucociliary clearance in macroscopic physical domains. The analytical foundations of the model are based on a Stokes flow assumption, whereby, in addition to viscous forces originating in ciliary forcing, the role of surface tension is also considered. The governing equations are solved computationally on a three-dimensional surface mesh. Flow is simulated in an anatomically/geometrically representative bifurcation of the bronchial tree. The directionality of ciliary forcing in our model is optimized in order to maintain near-uniform mucus film thickness throughout the flow field. Based on the optimized version of the model, energetic considerations, as well as aspects of optimality in nature are analyzed and presented.

[1]2nd affiliation: Professor, Physique de la Matière Condensée, Ecole Polytechnique, Palaiseau, France

Michail Manolidis
Visiting Scholar, Biomedical Engineering Department,
University of Michigan - Ann Arbor

Date submitted: 01 Aug 2015 Electronic form version 1.4