Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

Simulation of metachronal wave in a model of pulmonary cilia[1]

SORIN MITRAN, UNC — A simulation of the formation of metachronal waves in carpets of pulmonary cilia is presented. The cilia move in a two-layer fluid model. The fluid layer adjacent to the cilia base is purely viscous while the tips of the cilia move through a viscoelastic fluid. An overlapping fixed-moving grid formulation is employed to capture the effect of the cilia on the surrounding fluid. The 9+2 internal microtubule structure of an individual cilium is modeled using large-deflection, curved, finite-element beams. Realistic models of the forces exerted by dynein molecules are extracted from measurements of observed cilia shapes. The possibility of formation of metachronal waves under different assumptions of boundary conditions is investigated and shown to be dependent on the surrounding geometry.

[1]Work performed under the auspices of the UNC "Virtual Lung" Project

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Date submitted: 30 Nov 2005 Electronic form version 1.4