Abstract Submitted
for the DFD13 Meeting of
The American Physical Society

A bioinspired pumping model for flow in a microtube with rhythmic wall contractions[1] YASSER ABOELKASSEM, Yale University, ANNE STAPLES, Virginia Tech — Inspired by respiratory systems in insects, in particular the rhythmic wall contractions found in insect tracheal tubes, we propose a bioinspired pumping model that can work particularly well in the low Reynolds number flow regime. Incompressible, viscous flow transport in a fluid-filled axisymmetric, inelastic tube with rhythmic wall contractions is modeled using lubrication theory. The wall motions are prescribed via a tube profile with two contraction sites that can move with a time lag with respect to each other. The analytical model is validated using the method of fundamental solutions based on the Stokeslets meshfree computational method. The velocity field, pressure, and time averaged net flow rate induced in a complete contraction cycle are calculated. The results demonstrate that an inelastic tube with at least two contraction regions (collapse sites) can produce unidirectional flow and working as pumping mechanism. We believe that the physical mechanism underlying the pumping observed in this model relies on the cyclical, temporally asymmetric resistance to upstream and downstream flow that the localized contraction sites exert on one another.

[1]This material is based upon work supported by the National Science Foundation under Grant No. EFRI-BSBA 0938047

Anne Staples
Virginia Tech

Date submitted: 02 Aug 2013 Electronic form version 1.4