Abstract Submitted for the DFD07 Meeting of The American Physical Society

A Multiscale Lattice-Boltzmann Model of Macro-to-Micro Scale Transport Relevant to Gut Function YANXING WANG, JAMES BRASSEUR, GINO BANCO, Penn State University — Nutrient and pharmaceutical absorption in the small intestine involve coupled multiscale transport and mixing processes that span several orders of magnitude. We hypothesize that muscle-induced villi motions generate and control a "micro-mixing layer" that couples with macro-scale mixing to enhance molecular transport to and from the epithelium. In this work we developed a 2-D numerical method based on a multigrid strategy within the lattice-Boltzmann framework. We model a macro-scale cavity flow with microscale finger-like villi in pendular motion on the lower surface and evaluate the coupling between macro and micro-scale fluid motions, scalar mixing, and uptake of passive scalar at the villi surface. Preliminary results show that the moving villi can be effective mixers at the micro scale, especially when groups of villi move in a coordinated, but out-of-phase fashion. A time-evolving series of flow recirculation eddies are generated within a micro mixing layer that increase transport of passive scalar from the macro eddy to the surface by advection. Flow parameters such as frequency of pendular motion, spacing between villi and villi grouping, have strong influences on the behaviors of the micro-mixing layer and the efficiency of scalar transport. An extensive analysis is in process to quantify correlation between scalar mixing and flux, details of villi motion, and induced flow patterns.

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Date submitted: 08 Aug 2007

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