Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Mixing and Transport in the Small Intestine: A Lattice-Boltzmann Model GINO BANCO, JAMES BRASSEUR, YANXING WANG, AMIT ALIANI, ANDREW WEBB, Penn State University — The two primary functions of the small intestine are absorption of nutrients into the blood stream and transport of material along the gut for eventual evacuation. The primary transport mechanism is peristalsis. The time scales for absorption, however, rely on mixing and transport of molecules between the bulk flow and epithelial surface. Two basic motions contribute to mixing: peristalsis and repetitive segmental contraction of short segments of the gut. In this study we evaluate the relative roles of peristalsis vs. segmental contraction on the degree of mixing and time scales of nutrient transport to the epithelium using a two-dimensional model of flow and mixing in the small intestine. The model uses the lattice-Boltzmann framework with second-order moving boundary conditions and passive scalar (Sc = 10). Segmental and peristaltic contractions were parameterized using magnetic resonance imaging data from rat models. The Reynolds numbers (1.9), segment lengths (33 mm), max radii (2.75 mm) and occlusion ratios (0.33) were matched for direct comparison. Mixing is quantified by the rate of dispersion of scalar from an initial concentration in the center of the segment. We find that radial mixing is more rapid with segmental than peristaltic motion, that radial dispersion is much more rapid than axial, and that axial is comparable between the motions.

Gino Banco
Penn State University

Date submitted: 07 Aug 2007 Electronic form version 1.4