Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Micro-Macro Scale Mixing Interactions by Intestinal Villi Enhance Absorption: a 3D Lattice-Boltzmann Model YANXING WANG, JAMES BRASSEUR, GINO BANCO, Penn State University — Muscle-induced villi motions may create a micro-scale flow that couples with a lumen-scale macro flow to enhance nutrient transport and absorption in the intestine. Using a 3D multiscale lattice Boltzmann model of a lid-driven cavity flow with microscale 3-D leaf and finger-like villi in pendular motion at the lower surface, we analyze the coupling between micro and macro-scale nutrient mixing and absorption at the villi surfaces. RESULTS: The villi motions enhance absorption by creating a micro-mixing layer (MML) that pumps low concentration fluid from between villi groups and attracts fluid with high concentration from the macro flow. The MML couples with the macro flow via a diffusion layer. Leaf-like villi create the strongest MML and, consequently, the highest absorption rates. The finger-like villi create a weaker MML due to the existence of flow between villi. The strength of the MML and nutrient absorption increases with villus frequency. The absorption rate also increases with villus length; however the simulations predict an optimal length close to the physiological length of villi in humans. The complex flow structure will be discussed. We conclude that the interaction between micro-scale villi-induced fluid motions and macro-scale motility-induced flow may play a significant role in intestinal absorption. *Supported by NSF Grant CTS-056215.*

James Brasseur
Penn State university

Date submitted: 07 Aug 2010 Electronic form version 1.4