Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Modeling of Red Blood Cells and Related Spleen Function ZHANGLI PENG, Department of Materials Science and Engineering, Massachusetts Institute of Technology, IGOR PIVKIN, Institute of Computational Science, University of Lugano, MING DAO, Department of Materials Science and Engineering, Massachusetts Institute of Technology — A key function of the spleen is to clear red blood cells (RBCs) with abnormal mechanical properties from the circulation. These abnormal mechanical properties may be due to RBC aging or RBC diseases, e.g., malaria and sickle cell anemia. Specifically, 10% of RBCs passing through the spleen are forced to squeeze into the narrow slits between the endothelial cells, and stiffer cells which get stuck are killed and digested by macrophages. To investigate this important physiological process, we employ three different approaches to study RBCs passage through these small slits, including analytical theory, Dissipative Particle Dynamics (DPD) simulation and Multiscale Finite Element Method (MS-FEM). By applying the analytical theory, we estimate the critical limiting geometries RBCs can pass. By using the DPD method, we study the full fluid-structure interaction problem, and compute RBC deformation under different pressure gradients. By employing the MS-FEM approach, we model the lipid bilayer and the cytoskeleton as two distinct layers, and focus on the cytoskeleton deformation and the bilayer-skeleton interaction force at the molecular level. Finally the results of these three approaches are compared to each other and correlated to the experimental observations.

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Date submitted: 08 Aug 2011 Electronic form version 1.4