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Transport of diseased red blood cells in the spleen¹ 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 major function of the spleen is to remove old and diseased red blood cells (RBCs) with abnormal mechanical properties. We investigated this mechanical filtering mechanism by combining experiments and computational modeling, especially for red blood cells in malaria and sickle cell disease (SCD). First, utilizing a transgenic line for 3D confocal live imaging, in vitro capillary assays and 3D finite element modeling, we extracted the mechanical properties of both the RBC membrane and malaria parasites for different asexual malaria stages. Secondly, using a non-invasive laser interferometric technique, we optically measured the dynamic membrane fluctuations of SCD RBCs. By simulating the membrane fluctuation experiment using the dissipative particle dynamics (DPD) model, we retrieved mechanical properties of SCD RBCs with different shapes. Finally, based on the mechanical properties obtained from these experiments, we simulated the full fluid-structure interaction problem of diseased RBCs passing through endothelial slits in the spleen under different fluid pressure gradients using the DPD model. The effects of the mechanical properties of the lipid bilayer, the cytoskeleton and the parasite on the critical pressure of splenic passage of RBCs were investigated separately.

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