Abstract Submitted
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Flow-induced Segregation and Dynamics of Red Blood Cells in Sickle Cell Disease[1] XIAO ZHANG, University of Wisconsin-Madison, CHRISTINA CARUSO, WILBUR A. LAM, Emory University, MICHAEL D. GRAHAM, University of Wisconsin-Madison — Blood flow in sickle cell disease (SCD) can substantially differ from the normal due to significant alterations in the physical properties of sickle red blood cells (RBCs). Chronic complications, such as endothelial dysfunction, are associated with SCD, for reasons that are unclear. Direct numerical simulations are performed to investigate the dynamics of a binary suspension of flexible biconcave discoids and stiff curved prolate spheroids that represent healthy and sickle RBCs, respectively, in plane Poiseuille flow. The key observation is that the sickles exhibit a strong margination towards the walls. The marginated sickle RBCs roll like rigid bodies and may poke and damage the walls due to their stiffness and "spikiness". A simplified drift-diffusion model, which incorporates hydrodynamic migration and pair collisions, predicts a greater margination in a binary suspension containing a small fraction of stiff cells than in a pure suspension of stiff cells, which may explain the experimental observation that a heterogeneous blood sample containing healthy (flexible) RBCs with a small fraction of stiffened RBCs causes more severe endothelial inflammation and dysfunction than a homogeneous sample of stiffened RBCs.

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