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Rheological characterization of cellular blood via a hybrid lattice-Boltzmann / coarse-grained spectrin-link method DANIEL REASOR, Georgia Institute of Technology, JONATHAN CLAUSEN, Sandia National Labs, CYRUS AIDUN, Georgia Institute of Technology — In small vessels, the cellular nature of blood is of utmost importance. The investigation of the non-Newtonian effects of blood for a complete range of hematocrit values and shear rates requires the direct numerical simulation (DNS) of individual red blood cells (RBCs) immersed in Newtonian blood plasma with hemoglobin within. Consequently, a coarse-grained spectrin-link (SL) RBC membrane model is coupled with a highly scalable lattice-Boltzmann (LB) flow solver to capture RBC dynamics in isolation and in dense suspensions of $\mathcal{O}(1,000)$ RBCs at realistic hematocrit values. Validation results include experimental comparisons with results for isolated RBCs tumbling, tank-treading, deforming in the wheel configuration, and parachuting in a microvessel-sized rigid tube. The rheology of blood is analyzed via LB-SL simulations of RBC suspensions at physiological concentrations. The results characterize the effect of the RBC deformation on the viscosity, normal stress differences, and particle pressure. Also, a demonstration of the Fåhraeus effect is included which correlates the cell-depleted wall layer thickness with tube diameter for a variety of rigid microvessel-sized tube sizes. Lastly, the Fåhraeus–Lindqvist effect is demonstrated using the apparent viscosity obtained from these simulations.

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