3D SIMULATION OF BLOOD FLOW IN THE MICROCIRCULATION

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ABSTRACT

This work concerns hemodynamics in the microcirculation [1,2]. More specifically, it studies the effect of the hematocrit, vessel diameter, and shear-rate on the relative apparent viscosity and velocity profile of blood and on the thickness of the cell-free layer in straight microvessels.

To accomplish the above, we employ the computing framework proposed by Závodszky et al. [3].On the one hand, the blood cells, here only the red blood cells (RBCs), are explicitly modeled as discrete element membranes, and their responses to force fields are dictated by the constitutive model found in [3]. On the other hand, the suspending medium, in this case, the blood plasma, is represented using the lattice Boltzmann method [3,4]. Then, the collective blood behavior emerges as a product of the coupling of the aforementioned cellular and liquid components that the immersed boundary algorithm achieves [3,4]. Last, it should be noted that all simulations concern blood flows in straight microvessels with circular cross-sections, and that the hemodynamical features are always calculated at steady flow conditions.

We present results from a systematic parametric study, including the effect of the shear-rate on the time-average value of global features as well as the microstructural configuration of the RBCs. In addition, algebraic correlations derived from the non-linear fittings on the data are proposed.

Finally, it should be highlighted that our simulations reproduce basic experimental observations. Also, the quantitative comparison demonstrates an agreement of our results with the few available data points provided in the literature [3,5].

KEYWORDS: Blood Flow, Microcirculation, Blood Viscosity, Velocity Profile, Cell-Free Layer

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