The mixing and migration of soft and hard particles: application to cellular blood flow

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The concentration of platelets in blood is a small fraction of the red blood cells (RBC); therefore, the presence of platelets plays an insignificant role in the rheology of blood flow. However, the transport and radial migration of platelets play a significant role in the initiation and rate of growth in arterial and heart valve thrombosis and thromboembolism. The dynamical coupling between the highly flexible RBCs and rigid platelets plays a significant role in margination – the physics of this coupling is the focus of this presentation. It is shown that to various degree of significance, the margination rate depends on hematocrit, platelet shape, and viscosity ratio of plasma to cytoplasm [1]. Whole blood is modeled as a suspension of deformable red blood cells (RBCs) and rigid platelets in a viscous liquid. The fluid phase is simulated using the lattice-Boltzmann method, the RBC membranes are modeled with a coarse-grained spectrin-link method, and the dynamics of rigid particles are updated using Newton's equations of motion for axisymmetric shapes [2]. The results emphasize that an increase in hematocrit increases the rate of margination. The viscosity ratio between the interior cytoplasm and suspending fluid can considerably alter the rate of margination. The aspect ratio of surrogate platelet particles influences the rate of margination as well. Spherical particles tend to migrate more quickly than disks. Highly viscous or rigid RBCs slow down margination. The coupling and scaling for rate of margination in various size vessels depending on the relevant parameters will be presented along with ideas for global application to complex geometries.

REFERENCES

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