A mesoscopic simulation of blood flows in a micro-bifurcation

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Blood consists of two parts. One is the solvent fluid called plasma, and the other is cells. Red blood cell (RBC) is the most dominant cell on blood flows, because its volume fraction is typically 40 % of blood. Since blood flows affects the effective interactions of RBC-RBC, the fluid nature of blood is changed by the flow field. Therefore, a direct simulation of blood flows is a challenging task.

Considering blood flows from the heart to capillary vessels, blood flows could be roughly classified into three scales. First is the scale of arteries, where blood may be regarded as a homogeneous visco-elastic fluid. Second is the scale of arterioles, where the assumption of homogeneity for blood has been broken down, and blood should be modeled explicitly as RBCs and the fluid. Third is the scale of capillaries, where a precise mechanical modeling on the membrane of a RBC should be required.

Most of the contributions on hemodynamics is dedicated to investigate flows in arteries and capillaries, because vascular diseases such as atherosclerosis would be occurred in the artery and the dynamics of a RBC affects its physiological function in the scale of the capillary. However we would like to emphasize that the hemodynamics of the arteriole-scale is also important and interesting from two aspects. One is the physiological aspect, that is the distribution of hematocrit in a vessel-network, which influences its oxygen-carrying function. The other is the scientific aspect. In arterioles, the dynamics of both the cluster of RBCs and the individuality of a RBC is appeared. Therefore, we can not assume that RBCs would be homogeneously distributed or isolated well in a vessel. The model of blood needs to be of explicit from the individual level of a RBC, and capable of simulating a high volume fraction.

In our talk, We shall introduce immiscible real-coded lattice gas model (IMRLG)[1] based on Malevanets-Kapral method[2], and give a preliminary result for the application of blood flows in a micro-bifurcation by using IMRLG.

References

[1] Y. Inoue, Ph. D diss. University of Tokyo (2003).
[2] A. Malevanets and R. Kapral, J. Chem. Phys. **10**, 8605 (1999).