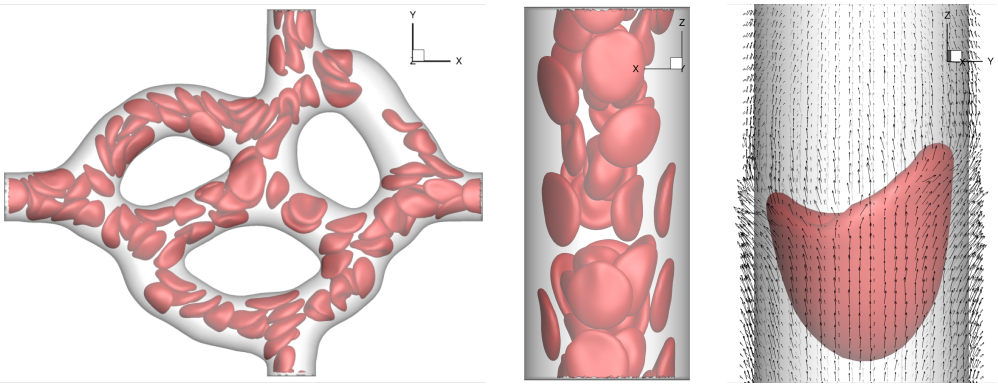
Computational micro-hemodynamics

Alberto M. Gambaruto
Dept of Computer Applications in Science and Engineering (CASE), Barcelona Supercomputing Center, Spain.
alberto.gambaruto@bsc.es

Abstract

Blood is composed of cells suspended in plasma. Plasma is mostly water, as serves as a transport medium for cells and solutes. One cubic millimetre of blood contains approximately: 4-6 million erythrocytes, 4-11 thousand leukocytes, 2-5 thousand platelets. When simulating micro-vessels, such as arterioles or capillaries, it is necessary to model blood as a multi-component fluid in which each suspended cells is discretised individually.

In this work, blood in micro-vessels is simulated using the moving particle semi-implicit (MPS) method, a Lagrangian particle method [1]. Cell membranes are modelled as body force terms in the Navier-Stokes equations, arising from internal forces of a spring network model. The MPS method is extended to include adaptive time step and implicit formulations. Results are presented for period domains, that allow the flow to develop and properties of the cells (migration and deformation) are observed.



Left: idealized retial capillary. Centre: straight vessel. Right: wall stress as an erythrocytes passes.

Keywords: Moving particle semi-implicit method, multi-body flow, rheology.

References

[1] Imai Y, Kondo H, Ishikawa T, Lim CT, Yamaguchi T. Modeling of hemodynamics arising from malaria infection. *Journal of Biomechanics*, **43**:1386-1393, 2010.