11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

ERYTHROCYTE PASSAGE THROUGH LIMITING GEOMETRIES

I. V. Pivkin[1,2], Z. Peng[3] and M. Dao[3]

[1] Institute of Computational Science, Faculty of Informatics, University of Lugano, 6904 Lugano, Switzerland
[2] Swiss Institute of Bioinformatics, 1015 Lausanne, Switzerland
[3] Department of Materials Science and Engineering, Massachusetts Institute of Technology, Cambridge, MA 02139, USA

Key words: *Red blood cell, Flow simulation, Small openings, DPD*

The red blood cell (RBC) membrane is composed of a lipid bilayer and an attached cytoskeleton, which consists primarily of spectrin proteins arranged in a network and linked by short actin filaments at junction complexes. The membrane properties of red blood cells (RBCs) control the cells ability to undergo severe deformations in the smallest limiting geometries, such as endothelial slits in the spleen.

Theoretical model as well as numerical simulations are used to estimate limiting geometries for RBC passage. The computational RBC model consists of collection of particles which are the vertices of surface triangulation. Each link in the surface triangulation possesses resistance to deformation accounting for the nonlinear force-displacement behavior of spectrin molecules, and frictional resistance accounting for the viscous behavior of the membrane. The deformation characteristics of the RBC are obtained by incorporating the effects of spontaneous curvature of the lipid bilayer material, in-plane shear energy, and geometrical constraints of fixed surface area and fixed enclosed volume. The RBC model is immersed into the Dissipative Particle Dynamics (DPD) fluid.

We will present the results of the theoretical and numerical analysis of the RBC passage through pores with smallest physiologically relevant dimensions. In particular, the implications for the RBC motion through the spleen endothelial slits and the smallest capillaries will be discussed.