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Characterization of RBC mechanical properties by microfluidic techniques

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Red blood cell (RBC) deformability is postulated to be a major determinant of impaired perfusion, increase of blood viscosity and occlusion in micro-vessels. Deformability refers to the ability for the RBC shape to change in response to external mechanical stresses. We propose microfluidic tools to assess the mechanical parameters of RBCs at both suspension and single-cell level. We believe that these tools can be exploited to probe cellular-scale changes to environmental factors. We first present a physical model that enables the determination of an effective shear modulus and an effective viscosity on individual RBCs flowing in a shear flow. We then show that the entrance of RBCs in narrow channels allows characterizing the fragility of RBCs from the observation of the rupture of their membrane. We then illustrate that microfluidic techniques can be used to mimic splenic slits at a sub-micronic scale and open the way to the study of elimination of RBCs in the spleen. We also show that suspension of RBCs can be studied, and, in particular margination of the most rigid RBCS, of leukocytes and platelets in channels that mimic arterioles and venules. We illustrate this behavior in two diseases, sickle cell anemia and hereditary spherocytosis.

Biography

Annie Viallat is ingénieur of Ecole Polytechnique (Paris, France). She received her PhD in Physics in Grenoble (France) in 1987, working on polymer gels. After a postdoc on conducting polymers at UC Santa Barbara (USA), she enters CNRS (France) and moved her research to biophysics and biomechanics. In 2005 she is a group leader in Marseilles, interested in the dynamics of lipid giant vesicles and blood cells in shear flow and in biomimicking capillary networks. Since 2015, she is a group leader in CINaM (Marseilles), working on erythrocytes' mechanical properties in genetic diseases and the physics of mucociliary clearance.

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