PhD research
Concentrated suspensions of red blood cell ghosts under flow

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Collaboration: Claude Verdier, LIPhy, UMR5588, Grenoble.

General context
The general context of this research is related to the pathologies associated with changes in the rheological characteristics of the blood such as viscosity and/or aggregation as well as variations in the diameters of the microvascular network—vasodilation and vasoconstriction.

Blood is a concentrated suspension of red blood cells (RBC), leukocytes, and platelets in a fluid plasma. The RBCs are the most important component of blood because they occupy approximately 45% of the physiological volume fraction (hematocrit, Ht). The blood can therefore be modeled as a dense suspension of RBC in plasma. The studies relating to the characterization of the blood microcirculation are thus particularly interested in the RBC behavior under flow.

Typical human RBC are flexible biconcave disks having a diameter of approximately 8 μm and a thickness of 2.2 μm. They are capable of great deformability and under low shear rate are prone to form aggregates taking the form of “rouleaux” or complex three-dimensional structures. Their characteristics give to the blood a shear thinning behavior.

Blood microcirculation is the subject of many studies, however the understanding of RBC concentrated suspension under flow is far from maturity. To our knowledge, regardless of the metrology chosen (acoustic or optical), it is not currently possible to carry out quantitative measurements to characterize the flow behavior of RBC dense suspensions (i.e Ht > 40%) in micro-channels of the order of 80 to 120μm. This point is one of the originalities of this project.

Goal
The objective of the present research project is to study the RBC behavior under flow in geometries representing the first order arterioles of the microvascular network (diameter of 80 to 120μm) in order to analyze the influence of aggregation phenomena on tissue perfusion.
The work will be mainly experimental and the metrology essentially optical in the visible domain. The work will involve (i) participating in the implementation of the flow characterization using particle image velocimetry at microscopic scale (μPIV) in micro-channels with geometrical singularities such as bifurcations (ii) determining the rheology of the different used suspensions and the mechanical behavior of ghosts.
Profile of the candidate
The candidate must have academic knowledge in the disciplinary fields related to the project: Fluid mechanics, biomechanics, biophysics or biology. He/she will have an appetite for experiments and interdisciplinarity. Skills in optical measurements will be appreciated.

Application
Candidates must submit their application before May 4, 2018. It will consist of a Curriculum Vitae, a letter of motivation, their most recent academic record and a letter of recommendation from a previous internship. The successful candidate will be invited to present his background and his motivations to the ED 353 members.
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Host team
The biomechanical team of IRPHE (https://www.irphe.fr/~biomeca) is notably interested in cardiovascular pathology modeling at both macroscopic and microscopic scales. Specialist in the bio-fluid mechanics and in the development of multi-modal and multi-physics in vitro experiments, she implements studies to understand and analyze fluid / structure / cell interactions existing in biological systems. The mechanical characterization of RBC will be performed at Grenoble in collaboration with C. Verdier (LiPhy, UMR5588).