RHEOBLOOD FLAGSHIP PROJECT

LABS: IMAG, IES, LMGC, L2C

LEADERS: F. NICOUD (IMAG), S. MENDEZ (IMAG), M. ABKARIAN (CBS)

STARTED MID 2016

PARTNERS: CHU, CBS (CENTRE DE BIOCHIMIE STRUCTURALE), IGF (INSTITUT DE GENOMIQUE FONCTIONNELLE), SYS2DIAG (MEDICAL DIAGNOSTIC), LIBM (LABORATOIRE INTERUNIVERSITAIRE DE BIOLOGIE ET DE LA MOTRICITE), HORIBA MEDICAL

TRAINING: POLYTECH MECHANICAL ENGINEERING AND INTERACTIVE DESIGN, MASTER OF MECHANICS, MASTER OF PHYSICS, MASTER SCIENCES AND NUMERICS FOR HEALTH

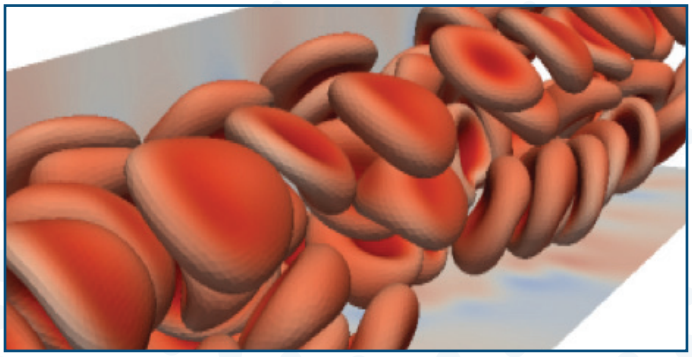
BUDGET: 410 K€ FUNDED BY NUMEV

LEVERAGE EFFECTS: SIMULATION LICENSE TRANSFER TO HORIBA MEDICAL, 3 CIFRE PHD STUDENTS FUNDED (HORIBA MEDICAL – SIM&CURE – ALARA EXPERTISE), 1 RESEARCH ENGINEER FUNDED BY SIM&CURE, 1 PHD STUDENT FUNDED BY THE GLOBULE RESEARCH PROJECT SELECTED AFTER THE FIRST MUSE CALL

INTERNATIONAL COOPERATIONS: ETH ZURICH (PR. KOUMOUTSAKOS – UNCERTAINTY QUANTIFICATION IN BLOOD FLOWS - ON GOING); PENNSTATE UNIVERSITY (PR. MANNING – THROMBUS MODELING - EXPECTED)

The **RHEOBLOOD** project will initiate the crossover from blood rheology to blood rheophysics, so that hemodynamics ceases to be a descriptive science and becomes indeed predictive. Rheophysics is used to stress that rheology is not sufficient and has to be completed by detailed microstructure description under flow. This is all the more necessary that the tremendous development of microfluidics now enables to design new biomedical devices for diagnosis and bio-engineering in general. One can mention systems to detect pathological cell, perform cell sorting, cell enrichment or phase separation. As such devices feature geometrical complexities that have never been studied before, a framework to predict blood flow in arbitrary geometries would represent a huge step further for medical applications. Currently, the development of such devices is only performed through a time and money-consuming trial and error approach.

The long-term objective is thus to provide the community with a validated constitutive model for blood. RHEOBLOOD will focus on the study of blood as a suspension of deformable cells. This point of view is different from many studies, where aggregation is considered as the most striking process in hemorheology, which is indeed the case for low shear rates (< 1 s-1, typically). In contrast, RHEOBLOOD will focus on predicting shear-thinning due to deformability and heterogeneous distribution of cells in complex geometries, which is one of the most important phenomena in microcirculation and microfluidic devices, especially at moderate to high shear rates.



RHEOBLOOD gathers 10 local academic, industrial and clinical groups with the ambition to take up the challenge of developing a constitutive model for blood. By providing Montpellier with a numerical and material platform dedicated to the study of blood rheophysics, RHEOBLOOD naturally contributes to the structuration of the local community. This scientific project goes hand in hand with a strategy aiming at making Montpellier a major site for the knowledge of blood flows, in terms of research, training and technology transfer

to the industry and the clinical practice. The early results obtained during the preparation and first year of RHEOBLOOD constitute the basis of an application for the next ERC Consolidator Grant; RHEOBLOOD is clearly seen here as a first step of an ambitious project for the community. Taking advantage of the unique potential of Montpellier regarding blood studies, an International School on hemophysics was organized in May 2018 at Genopolys (https://hemphys.sciencesconf.org/). Open to PhD students, researchers and engineers worldwide, this was the first edition of a biannual event that will gather in Montpellier world-class researchers in the field, thus promoting the international visibility, attractiveness and structuration of the site. The general idea of the creation of the Montpellier Blood Institute which would gather clinicians, biologists and engineers able to address issues as challenging as designing artificial blood or new diagnosis and biomedical devices has emerged from discussions within the consortium. More than 100 researchers/engineers disseminated in 12 laboratories, 5 clinical groups and 8 companies from the Montpellier area were identified as potential participants. A working group led by Horiba Medical is now organizing further discussions.

Few publications related to this project:

L. Lanotte, J. Mauer, S. Mendez, D. Fedosov, J.-M. Fromental, V. Claveria, F. Nicoud, G. Gompper and M. Abkarian (2016) Red cells dynamic morphologies govern blood shear thinning under microcirculatory flow conditions. Proceedings of the National Academy of Sciences of the United States of America, Vol. 113(47), pages 13289-13294, Doi: 10.1073/pnas.1608074113

R. Méndez Rojano, S. Mendez, F. Nicoud (2018) Introducing the pro-coagulant contact system in the numerical assessment of device-related thrombosis. Biomech Model Mechanobiol, First online , doi.org/10.1007/s10237-017-0994-3

J. Sigüenza, S. Mendez & F. Nicoud (2017) How should the optical tweezers experiment be used to characterize the red blood cell membrane mechanics? Biomechanics and Modeling in Mechanobiology, Vol. 16(5), pp. 1645-165, doi: 10.1007/s10237-017-0910-x

L. Lanotte, D. Laux, B. Charlot, and M. Abkarian (2017) Role of red cells and plasma composition on blood sessile droplet evaporation. Physical Review E 96, 053114, doi.org/10.1103/PhysRevE.96.053114