BIOPHYSICS OF RED BLOOD CELLS AND PLATELETS

1 Supervising staff

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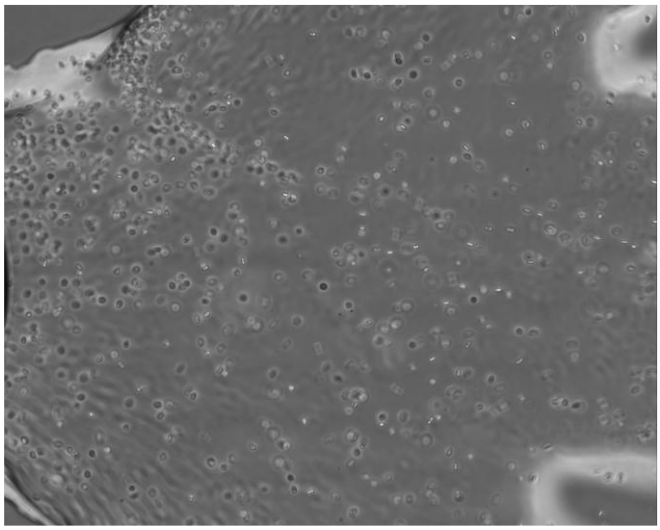
2 Context

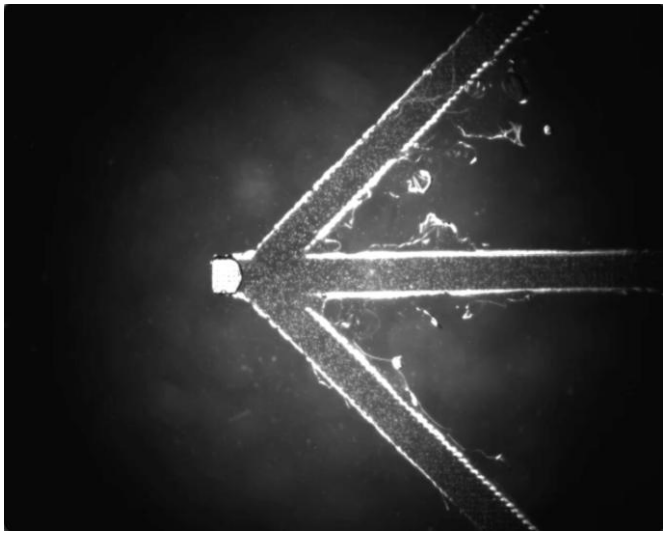
Blood is a complex fluid, composed of various cell types, mainly red blood cells (RBCs) and platelets (PLTs), which are the most abundant. Blood plays a fundamental role in the functioning of living organisms. Studying its behavior from a biophysical perspective is essential to deepen our knowledge, especially in specific clinical contexts such as thrombotic phenomena.

Among the key physiological processes, the transport of PLTs to the vessel wall is of major importance. However, this mechanism remains poorly understood on a physical level, although it has profound implications in many pathophysiological processes, such as thrombosis or hemorrhage. Due to its unique nature as a fluid carrying deformable, electrically charged cells, blood eludes a simple description and requires a multidisciplinary approach.

Experimental studies on blood are often limited by difficult observation techniques, while numerical simulations are hampered by the complexity of the system: the diversity of constituents, the deformability of cells, and the multiple physical interactions between them are important obstacles to overcome. Despite significant advances, many questions remain open, both fundamentally and in terms of medical research.



Screenshot of video showing 0.1mL/h flow rate rbc suspension, 10X zoom.



Screenshot of video showing 0.2 mL/h flow rate rbc suspension, 1X zoom

Figure 1 - First attempt from our research group.

3 Work

In this context, we propose to explore experimentally and numerically several key issues:

1. Cell shape variability: What is the role of intra-individual variability in the shape of RBCs and PLTs, and how does this variability influence their dynamic behaviors?

2. Unconventional PLT transport: We have recently shown that, under certain blood flow conditions, PLTs follow a Lévy flight rather than a classical diffusion process. We wish to further investigate this observation and identify the underlying mechanisms.
3. Cellular interactions: Interactions between RBCs and RBCs, as well as between RBCs and PLTs, remain insufficiently understood. However, they are at the heart of the transport properties of blood cells. Our goal is to rigorously quantify these interactions and to elucidate their nature.

It is this last point that we would like to address first.

RBCs are negatively charged by the presence of particular sugars carried by membrane glycoproteins called sialic acids. We would like to feed numerical models with information concerning the role that these sugars could have on RBC-RBC interactions in a first step.

To do this, it would be necessary to expose RBCs, in flow, to an electric field and study the effect of the field on the deflection of the RBCs. In this way, it will be possible to see the importance of electronegative charges on RBC behavior.