

ANNA KUCABA-PIETAL**BLOOD. RHEOLOGY AND MODELING**

Rzeszów University of Technology , 35-959 Rzeszów, Powstańców Warszawy 12  
e-mail: anpietal@prz.edu.pl

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All biofluids are homogeneous at the macroscopic scale but possess very complicated microstructures and nanostructures over a microscopic scale, which vary each time and depend on living and health conditions. Blood is the most complicated biofluid which during flow interacts both mechanically and chemically with vessel walls. Blood is highly concentrated complex suspension of polydisperse cells. The cells are flexible, chemically and electrostatically active. They are suspended in an electric fluid (plasma) of a critical PH in which there are numerous active proteins and organic substances. The modelling of complex suspensions of flexible particles presents a difficult task to scientists and engineers. Whereas the homogeneous fluid flow is determined by the way in which the fluid is acted upon by its boundaries, the multi-component fluid flow is affected additionally by the individual suspended particles interacting with each other and with the boundaries of the flow. Under normal conditions, the body regulates the microstructure concentration of biological fluids very closely. Variations in the concentration are linked to a variety of functions and diseases both at the cellular level and at the organismal level, it can be reflected in the change of value of viscosity coefficients.

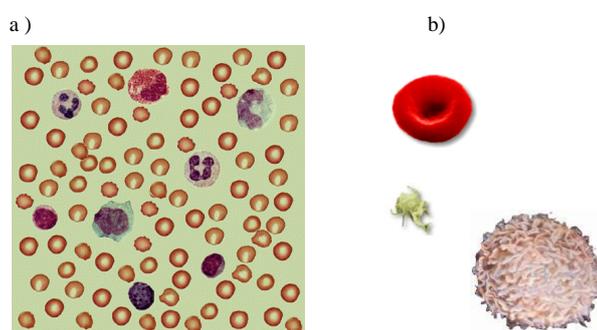


Figure 1. Microscopic view of a) whole blood, b) red blood cells c) platelet and d) white blood cell

Many fundamental issues concerning blood have still to be fully understood, for instance blood rheology and modelling. The rheological parameters of blood can be used in diagnostics of clinical disorders. The main factors affecting the rheology of blood are:

- hematocrit ( volume percentage of red blood cells in the whole blood)
- deformation and the phenomenon of aggregation of red blood cells
- biochemical properties of plasma
- temperature
- geometry and flow parameters.

Many fundamental issues concerning blood have still to be fully understood, for instance blood rheology and modelling. The rheological parameters of blood can be used in diagnostics of clinical disorders, to maintain nonbiological fluids that has rheological properties comparable to blood. Moreover the knowledge of the rheological parameters is necessary in mathematical modelling of the blood circulation due to the formulation of the blood flow equations. Rheological analysis and modelling of the blood is still incomplete.

The viscosity changes up to many pathologic conditions, but its importance has not been fully investigated because the current methods of measurement are poorly suited for clinical applications. Therefore, the study on rheological properties of blood can be helpful in detecting human diseases as well as designing suitable treatments and modeling. Obtained results in this fields can be helpful in our better understanding of diseases and in medical diagnosis and therapy. In this paper, current problems with modelling blood will be presented. The physiology of blood composition and hemorheology of blood and theirs determinants will be studied. At the end of the paper the most popular constitutive models of blood will be presented and their applicability range will be discussed.

## LITERATURE

- [1] KUCABA-PIĘTAL A.: Micromechanics of biological fluids, In: *Editor R. Bedzinski*, Biomechanics, PAS Technical Engineering Sciences Series, Volume XII, Warsaw, IPPT PAN, 2011, 179-222
- [2] BEDZINSKI R. Biomechanika inżynierska. OWPW, Wrocław 1998
- [3] MACOSKO, C.W., Rheology; Principles, Measurements, and Applications, Wiley-VCH, New York, 1994
- [4] KUCABA-PIĘTAL A.: A Blood Flow Modelling and Diagnostics, In: *Editor T. Kowalewski*, ABIOMED Lecture Notes 6, Warsaw, IPPT PAN, 2006, 1-32.
- [5] MILNOR W.R. Hemodynamics, William and Wilkins, Baltimore Maryland, 1989



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