The Eurasia Proceedings of Science, Technology, Engineering & Mathematics (EPSTEM)
ISSN: 2602-3199

The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 2025

Volume 36, Pages 73-80

ICBAST 2025: International Conference on Basic Sciences and Technology

Investigation of Red Blood Cell Microcirculation Using the DLVO Theory

Lali Kalandadze
Batumi Shota Rustaveli State University

Nugzar Gomidze
Batumi Shota Rustaveli State University

Mirian Kontselidze
Batumi Shota Rustaveli State University

Abstract: The study of blood microcirculation has revealed specific properties that distinguish blood from Newtonian and non-Newtonian fluids. These anomalies cannot be fully explained by conventional hydrodynamic or rheological models alone. While the viscous incompressible fluid model describes blood flow well in vessels with diameters exceeding 300 µm, capillaries below this threshold exhibit non-classical flow behavior, the underlying physical mechanisms of which remain an active area of investigation. In this work, blood is modeled as a multiphase physicochemical system, represented as a suspension of cellular elements in plasma. The cellular components, particularly erythrocytes, are treated as part of an electrostatic system, where their electrical characteristics are determined not by discrete surface charges, but by the zeta potential -the electrokinetic potential at the interface between the erythrocyte membrane and the plasma. Microcirculatory dynamics are analyzed through the framework of DLVO theory. A quantitative assessment of red blood cell motion in capillaries is presented, incorporating resistance forces, hydrodynamic pressure, and gradients in electrostatic potential. The results indicate that mechanical and electrical factors substantially influence microcirculatory flow, affecting erythrocyte deformation and orientation, and inducing a directional electrostatic force gradient that governs cell movement in narrow capillaries.

Keywords: Microcirculation, Erythrocyte, Hemodynamics, Two-phase systems, Zeta potential

Introduction

Blood is a unique biological fluid. It is a heterogeneous and multiphase physicochemical system. It can be represented as formed elements (red blood cells, leukocytes, thrombocytes) suspended in plasma. That is, it is a dispersed system. Many regularities established for non-biological dispersed systems can be used to study blood flow properties. However, it should be noted that during the study of the functioning of blood microcirculation, several features were discovered that set it apart from Newtonian and non-Newtonian fluids. The regularities of hydrodynamics or rheology alone cannot explain those peculiarities. (Yaya et al 2021, Vahidkhah et al, 2016).

The rheological properties of blood are determined primarily by the processes of hydrodynamic interaction of erythrocytes and plasma, which lead to the formation and disintegration of aggregates, rotational movements of erythrocytes, as well as their redistribution and appropriate orientation in the bloodstream (Secomb, 2017). The properties of blood significantly depend on the ability of red blood cells to deform. While moving, they change their normal shape. So, for example, Guckenberger et al. (2018) experimentally and numerically found two major shapes of red blood cells, like croissants and slippers. This ability allows red blood cells with a diameter of about 8 µm to penetrate without damage through the pores of a membrane filter with a diameter of 3 µm and a length of 12 µm. They also move freely in small capillaries with an average diameter of 10 to 2 µm (Bedggood et al., 2024). It should be noted that red blood cells completely restore their natural shape after leaving the capillaries. Free-moving healthy red blood cells never become deformed (Babaki et al., 2023). In general, the movement of blood in the vascular system is characterized by the following features:

- The decrease in hematocrit with a reduction in the diameter of the capillaries is known as the Fahraeus effect.
- The dependence of blood viscosity on the diameter of blood vessels. Viscosity remains constant when the capillary diameter exceeds 0.3 mm, but decreases with a decrease in diameters from 0.3 mm to 4-5 µm - Fahraeus-Lindqvist effect.
- The presence of a plasma layer without red blood cells near the wall of the blood vessel (acellular layer).

When capillaries are filled only with plasma, the blood flow stops, but it resumes as soon as red blood cells appear in them, and the greater the number of red blood cells there, the more intense the flow. These processes are part of the Fahraeus-Lindqvist effect (Fahraeus & Lindqvist, 1931, Köry et al., 2022, Chebbi, 2015, Ascolese et al., 2019, Farina et al 2021).

In large blood vessels with a diameter of more than 300 microns, the viscous incompressible fluid model works well; And when examining small capillaries with a diameter of less than 300 microns, abnormal properties of blood flow appear, the study of the physical basis of which is still relevant today. To explain the microcirculatory properties of blood, various theoretical models of two-phase systems are considered (Knüppel et al., 2024, Wei-Tao et al., 2014, Schenkel et al., 2021, Gracka et al., 2022). These models only quantitatively describe the movement of blood in capillaries and cannot explain its qualitative side- the features of the movement of red blood cells in small capillaries. To obtain information about changes in the physical properties of erythrocytes during blood movement in capillaries, it is important to introduce innovative methods of fluorescence spectroscopy, optical, and magneto-optical studies (gomidze et al., 2025, Kalandadze & Nakashidze 2020). These techniques will provide additional information about the complex representation of spectral and structural-dynamic changes in erythrocytes.

Understanding the microcirculation mechanism of red blood cells is very important for both medicine and biotechnology (Trejo-Soto et al., 2022, Baskaran et al., 2024, Man et al., 2023, Guven et al., 2020) since the body supplies oxygen and nutrients and removes metabolic waste products from the cells through the capillary network. To know the mechanism of microcirculation gives the ability to control the movement of red blood cells in the capillary network. Controlling the regulation of this movement is very important for the processes occurring in the body. So, for example, blocking the movement of red blood cells in the capillary network of cancer cells will lead to the “starvation” of undesirable cells and ultimately their death.

The current paper examines blood flow in capillaries with diameters of less than 10 micrometers. Microcirculatory dynamics are analyzed through the framework of the DLVO (Derjaguin–Landau–Verwey–Overbeek) theory. Erythrocytes are treated as an electrostatic system determined by the zeta potential. A quantitative assessment of red blood cell motion in capillaries is presented, incorporating resistance forces, hydrodynamic pressure, and gradients in electrostatic potential.

Some Aspects of Blood Microcirculation

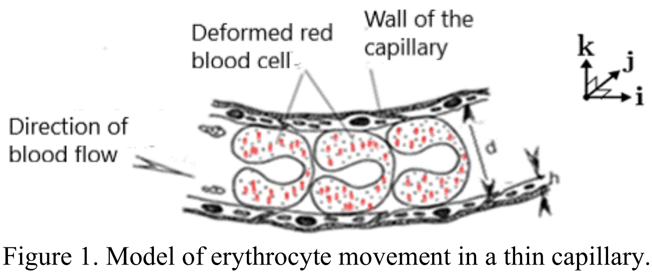

Figure 1. Model of erythrocyte movement in a thin capillary.
h - plasma layer, d - capillary diameter

As is known, neurohumoral factors control the mechanism of blood microcirculation. However, there is a second component of blood microcirculation. That is its physical aspect, according to which blood is a dispersed system with formed elements suspended in plasma, continuously moving through blood vessels of various diameters. This movement is affected by different hydrodynamic factors. In this regard, the movement of red blood cells in capillaries attracts attention, the mechanism of which requires a complex approach. Figure 1 depicts the model of deformed erythrocyte movement in a capillary.

To estimate the pressure required to move blood through small capillaries assume that the capillary length is l=1 mm, diameter d=3 μm, average blood flow velocity v=0.5 mm/s, and dynamic viscosity of blood plasma $\eta = 2 \cdot 10^{-3}$Pa·s. To use Poiseuille's equation, assume that blood plasma, which is a Newtonian fluid, moves in a capillary, and this movement is laminar. According to Poiseuille's formula:

$$Q = \frac{\pi R^4 \Delta P}{8\eta l} \quad (1)$$

where Q is the volume of fluid flowing per unit time, R is the radius of the capillary, and ΔP is the pressure drop along the length of the capillary. From Poiseuille's formula (1) we obtain:

$$\Delta P = \frac{Q 8\eta l}{\pi R^4} = \frac{\pi R^2 v 8\eta l}{\pi R^4} = \frac{v 8\eta l}{R^2} \quad (2)$$

Substituting the corresponding values into the formula (2), it is obtained that the pressure drop along the capillary is $\Delta P = 3.6 \cdot 10^3$Pa. The pressure required in the capillary is almost 1.5 times higher than the hydrodynamic pressure created by the heart during systole. This indicates that a significantly higher pressure is needed when blood moves through the capillaries with a dynamic viscosity value of $\eta = (4 - 5) \cdot 10^{-3}$ Pa·s. The findings indicate that the pressure produced by the heart during systole alone is insufficient to propel blood through the capillaries. As a result, further investigation and assessment of additional mechanisms that assist in the movement of red blood cells in small capillaries are necessary.

Zeta Potential of a Deformed Red Blood Cell

Blood cells and corpuscular elements compose the electrical system (Tokumasu et al., 2012). A double layer of charges is concentrated on their surface Figure 2. The charges are also distributed inside the morphological elements of blood membranes and organelles. These complex electrical systems move continuously in blood vessels of different diameters and, certainly, are sensitive to changes in various hydrodynamic influences.

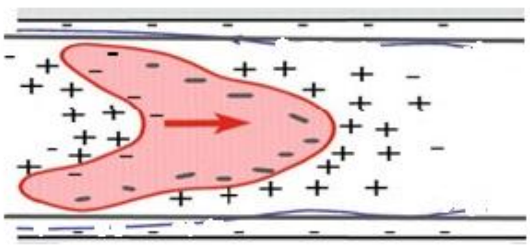

Figure 2. The electric double layer of a deformed red blood cell

It is reasonable to assume that an important role in the movement of erythrocytes in the capillary is played by the electrical forces arising between the erythrocyte membrane and the endothelial cells of the inner surface of the capillary. As is known, the electrical properties of electrolytes are expressed not by the magnitude of elementary charges, but by the zeta potential (Collini and Jackson, 2023), similarly, one can consider the electric potential at the boundary of two phases: erythrocyte and plasma. The electrical double layer causes the generation of an electrical potential, which prevents cell aggregation and therefore plays an important role in cell stabilization. Unlike the electrostatic charge of a red blood cell, which is expressed in electrostatic units, zeta potential is measured in millivolts. When its value decreases (Fontes et al., 2008, Swati et al., 2018, Karemore and Avary, 2019) the stability of the blood suspension is disrupted. Thus, the magnitude (effect) of the interaction of formed elements in the formation of red blood cell rheological properties is a function of the difference in the erythrocyte and plasma surface potential.

The surface charge of blood cell membranes is directly related to the processes of physicochemical transformations occurring on cell membranes. To release oxygen, it is necessary to shift the pH towards acidity (Bohr effect) (Hilpert et al., 1963). Ions can diffuse from the red blood cell membrane into the plasma. In the layer close to the membrane, the plasma pH decreases. Ions shield the electrostatic field of negative charges on the membrane's outer surface. Screening leads to a decrease in the electrical double layer. Therefore, when red blood cells move in small capillaries, the energy density of the electrostatic interaction between the membranes of the red blood cell and the endothelial cell (the inner layer of the capillaries) decreases. As a result, the pressure force opposing the movement of red blood cells in the capillaries is reduced.

A negative blood pH gradient $\frac{\partial(PH)}{\partial X} < 0$ induces a negative gradient of electric energy density along the capillary. Let's take the direction of blood movement as the positive X direction (Figure1). Due to a negative gradient, a tangential force $\vec{F}$ acts on the erythrocyte membrane in the direction of blood flow, which is equal to:

$$\vec{F} = -\frac{\partial U}{\partial X} \cdot S\vec{\imath} \tag{3}$$

where U represents the total electrostatic repulsion energy density, S denotes the erythrocyte's surface area along the capillary endothelial cell membrane, and $\vec{\imath}$ is the unit vector in the X-axis direction. The electric double layer of the erythrocyte membrane is formed due to the force of electrostatic attraction and thermal movement of ions. The first one tries to attract the opposite sign ions, and the second one distributes them throughout the volume. Therefore, the DLVO theory is used to estimate the force F. (Agmo et al., 2023). This theory combines the forces of Van der Waals attraction and electrostatic repulsion caused by the electric double layer. The DLVO theory considers the electrostatic part in the averaged field approximation in the limits of small surface potentials. According to the DLVO theory, the total interaction energy U of two particles per unit area will be equal to

$$U = U_m + U_{el} = 2\varepsilon_0 \varepsilon k \varphi_\delta^2 e^{-kh} - \frac{A^*}{12\pi h^2} \tag{4}$$

where U_m and U_{el} are the energies of attraction and repulsion between particles; In particular, U_m is determined by the forces of intermolecular attraction, and U_{el} by the forces of electrostatic repulsion; ε_0 is the electric constant, ε is the dielectric permittivity of the medium, φ_δ is the potential of the diffuse layer, A^* —Hamaker constants of the dispersed medium, h is the distance between particles, k - Debye–Huckel parameter represents the rate of charge decrease with distance, inversely proportional to the thickness of the diffuse layer, and is determined by the formula:

$$k = \sqrt{\frac{2F^2 I}{\varepsilon_0 \varepsilon RT}} \tag{5}$$

where I is the ionic strength of the solution, $I = 1/2 \sum_{i=1}^{n} c_i z_i^2$, c_i is the molar concentration of each ion, z_i is the ion charge.

Results and Discussion

Let's consider two parallel uniformly charged elementary surfaces- one on the membrane of an erythrocyte and the other on the endothelial cell opposite it. The charge density is denoted as σ_x, the radius of the capillary is R, and the thickness of the plasma between them is h. Since h<<R (see Figure 1), the curvature of the surfaces of both membranes can be neglected and they can be considered as flat parallel surfaces (Figure 3).

The electrostatic field is symmetrical to the h/2 plane. In the case of small fields, the magnitude of the electric potential of a unit surface is determined from the Gouy–Chapman equation:

$$\varphi(z=0) = \left(\frac{RT}{2\varepsilon\varepsilon_0 C_0 F_0^2}\right)^{1/2} \sigma(x) \tag{6}$$

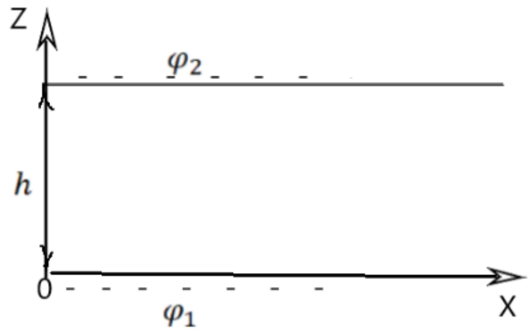

Figure3. A geometric representation of the potentials of two phases: φ_1 and φ_2 are potentials of negatively charged surfaces of the erythrocyte membrane (φ_1) and endothelial cell (φ_2); h- thickness of plasma layer

where R is the gas constant, T is the absolute temperature in the blood plasma layer, F_0 is the Faraday number, ε_0 is the electric constant, ε is the dielectric constant of the blood plasma, C_0 is the average concentration of ions in the plasma layer, $\sigma(x)$ is the surface charge density.

To determine the potential in the blood plasma layer at z=h in Debye approximation can be written:

$$\varphi(h,x) = \varphi(0,x)\, e^{-kx} \tag{7}$$

Here, k is the Debye–Huckel parameter (see equation 5).

Using formulas (12) and (14), the expression for the energy of electrostatic repulsion between units of area can be written as follows:

$$U_{el}(x) = \sigma(x) \cdot \varphi(h,x) = \sigma(x) \cdot \left(\frac{RT}{2\varepsilon\varepsilon_0 C_0 F_0^2}\right)^{1/2} \sigma(x) e^{-kx} = \sigma(x)^2 \cdot \left(\frac{RT}{2\varepsilon\varepsilon_0 C_0 F_0^2}\right)^{1/2} e^{-kx} \tag{8}$$

Considering this result (8) in formula (3), we obtain:

$$F = -\frac{\partial\left(\sigma(x)^2 \cdot \left(\frac{RT}{2\varepsilon\varepsilon_0 C_0(x) F_0^2}\right)^{1/2} e^{-kx}\right)}{\partial X} \cdot S \tag{9}$$

Then the magnitude of the tangential force will therefore be

$$F = \left\{\left[2\,\sigma(x)\frac{\partial\sigma}{\partial x}\left(\frac{RT}{2\varepsilon\varepsilon_0 C_0(x) F_0^2}\right)^{\frac{1}{2}} - \frac{1}{2}\sigma(x)^2\left(\frac{RT}{2\varepsilon\varepsilon_0 C_0(x) F_0^2}\right)^{\frac{1}{2}} \frac{1}{C_0}\frac{\partial C_0(x)}{\partial x}\right] e^{-kx} - k\sigma(x)^2\left(\frac{RT}{2\varepsilon\varepsilon_0 C_0(x) F_0^2}\right)^{1/2} e^{-kx}\right\} S \tag{10}$$

According to (10), the energy U of electrostatic repulsion depends on the concentration of ions, the permittivity of the plasma, the thickness of the plasma layer, the density of the negative charge of the membrane, and the temperature of the blood.

The ζ-potential is very sensitive to the influence of various factors. This refers to the change in pH of the blood plasma during metabolism. We assumed that σ tends to increase linearly as pH increases. At point PH=7,38 $\sigma = \sigma_0$. At the isoelectric point pH=5.8 $\sigma = 0$. Thus, the function σ(pH) can be represented as (Glaser R., 2012, Kunitsyn et al., 2007):

$$\sigma = \sigma_0 + \frac{\sigma_0}{1.62}(PH - 7.38) \tag{9}$$

The normal pH of arterial blood is 7.38-7.42, although rapid changes in pH are possible during exchange reactions. Let the length of the capillary be 1 mm, the thickness of the plasma between the membranes is 2 nm, T=310 K, σ_0=3.84·10^{-2} cells/m^2, and the concentration of anions C_0=140-150 mmol/L.

Thus, combining equations (3) and (8) we can estimate the tangential force F. As a result of calculations, we get that $F \approx 5 \cdot 10^{-11}$ N. This means that the erythrocyte exerts additional pressure in the capillary: $\Delta P = \frac{F}{\pi r^2} = \frac{5 \cdot 10^{-11}}{3{,}14 \cdot 10^{-12}} = 16$ Pa. A maximum of 44 red blood cells ($\frac{1\,mm}{23 \cdot 10^{-3} mm} = 43{,}5$) can be placed simultaneously in a 1 mm length capillary. The sum of these red blood cells creates additional pressure $\Delta P = 44 \cdot 16 = 704$ Pa, which helps the blood move in the capillaries. This phenomenon is similar to the creep of the wetting fluid upward in thin capillaries, but the mechanism of these two phenomena is different.

Electrostatic tangential force F depends on the square of the surface charge density of the membrane $\sigma(x)^2$. If the surface charge density decreases, and consequently the zeta potential of the erythrocyte, then the value of F decreases sharply. This reduces the permeability of the erythrocyte through the capillary, which leads to hypoxia and tissue necrosis.

In our calculations, we assumed that the charges on the membrane surface are uniformly distributed and independent of the azimuthal coordinate. However, if the distribution of charges is uneven, there will be an additional component of force (F). This can result in the creation of a torque around the longitudinal axis of the erythrocyte, causing it to rotate along this axis. Consequently, the erythrocyte moves through the capillary like a rotating screw.

Conclusion

The study investigated the microcirculation properties of blood flow in capillaries. The paper provides a qualitative assessment of the movement of red blood cells in capillaries using hydrodynamic pressure and changes in electrical potential coefficients along the capillary. The pressure required to move blood through small capillaries was assessed. In this regard, additional mechanisms facilitating red blood cell movement in small capillaries have been considered and evaluated. The zeta potential was used to determine the electrical properties of red blood cells. According to calculations, the electrical potential induced by the double electrical layer potentially affects the surface of erythrocytes in the small capillaries and excites an electrostatic tangential force in the direction of red blood cells flow.

Scientific Ethics Declaration

*The authors declare that the scientific ethical and legal responsibility of this article published in EPSTEM journal belongs to the authors.

Conflict of Interest

*The authors declare that they have no conflicts of interest

Funding

*This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNFG) (grant number FR-24-3101)

Acknowledgements or Notes

*This article was presented as an oral presentation at the International Conference on Basic Sciences and Technology (www.icbast.net) held in Budapest/Hungary on August 28-31, 2025.

References

Agmo, H. V. (2023). An overview of surface forces and the DLVO theory. *ChemTexts 9*, 10.

Ascolese, M., Farina, A., & Fasano, A., (2019). The Fåhræus-Lindqvist effect in small blood vessels: How does it help the heart?. *J Biol Phys 45*, 379–394.

Babaki, M., Fedosov, D. A., Gholivand, A., Joeri, O., Remco, T., & Minne P. L. (2023). Competition between deformation and free volume quantified by 3D image analysis of red blood cell. *Biophysical Journal*, *122,* (9),1646-1658.

Baskaran, R. K., Rajaram, A., Link, B., Porr, B., & Franke, T. (2024). Classification of chemically modified red blood cells in microflow using machine learning video analysis, *Soft Matter*, *20*, 952.

Bedggood, P., Ding, Y., & Metha, A. (2024). Changes to the shape, orientation and packing of red cells as a function of retinal capillary size, *Biomedical Optics Express 15*, 558-578.

Chebbi, R. (2015). Dynamics of blood flow: modeling of the Fåhræus–Lindqvist effect. *J Biol Phys 41*, 313–326.

Collini, H., & Jackson, M.D. (2023). Zeta potential of crude oil in aqueous solution. *Adv. Colloid Interface Sci*., *320*, 102962.

Fahraeus, R., & Lindqvist, T. (1931). The viscosity of the blood in narrow capillary tubes, *American Journal of Physiology – Cell Physiology 96*(3), 562–568.

Farina, A., Rosso, F., & Fasano, A., (2021). A continuum mechanics model for the Fåhræus-Lindqvist effect. *Journal of Biological Physics, 47*, 253–270.

Fontes, A., Fernandes, H. P., André, A. de Thomaz, Barbosa, L. C., & Lenz, C. (2008). Measuring electrical and mechanical properties of red blood cells with double optical tweezers *Journal of Biomedical Optics, 13* (1) 014001.

Glaser, R. (2012). *Biophysics*, (2nd ed.). Springer.

Gomidze, N., Kalandadze, L., Khajishvili, M., Nakashidze, O., Jabnidze, I., Jakobia, D., & Makharadze, K. (2025). Fluorescence spectroscopy as a novel tool in hematological diagnostics. *APL Bioengineering 9* (2), 026102.

Gracka, M., Lima, R., Miranda J.M., Student, S., Melka, B., & Ostrowski, Z. (2022). Red blood cells tracking and cell-free layer formation in a microchannel with hyperbolic contraction: A CFD model validation *Computer Methods and Programs in Biomedicine, 226,* 107117.

Guckenberger, A., Kihm, A., John, T., Wagner, Ch., & Gekle, S. (2018). Numerical–experimental observation of shape bistability of red blood cells flowing in a microchannel. *Soft Matter*, *14,* 2032-2043.

Guven, G., Matthias, P. H., & Can, I. (2020). Microcirculation: Physiology, pathophysiology, and clinical application. *Blood Purification. 49*(1-2),143–150.

Hilbert, P, Fleischmann, R.G, Kempe, D., & Bartrls, H. (1963). The Bohr effect related to blood and erythrocyte PH. *American Journal of Physiology, 205*, 337-40.

Kalandadze, L., & Nakashidze, O. (2020). Influence of the size, shape and concentration of magnetic particles on the optical properties of nano-dispersive structures. *Journal of Magnetism and Magnetic Materials 500*, 166355.

Knüppel, F., Malchow, S, Sun, A, Hussong, J, Hartmann, A, Wurm, F-H., & Torner, B. (2024). Viscosity modeling for blood and blood analog fluids in narrow gap and high reynolds numbers flows. *Micromachines. 15*(6),793.

Köry J., Maini, P. K., Pitt-Francis, J. M., & Byrne, H. M. (2022). Dependence of cell-free-layer width on rheological parameters: Combining empirical data on flow separation at microvascular bifurcations with geometrical considerations, *Physical Review E, 105,* 014414.

Kunitsyn, V.G., Mokrushnikov, P.V., & Panin, L.E. (2007). Mechanism of erythrocyte microcirculation in capillary vessels at physiological changes of PH. *Bulletin of the Siberian Branch of the Russian Academy of Medical Sciences, 5,* 28–32.

Man, Y., Wu, D. H., An R., Wei Pe., Monchamp, K., Goreke, U., Sekyonda, Z., Wulftange, W. J., Federici, Ch., Bode, A., Nayak, L. V., Little, J. A., & Gurkan, U. A. (2023). Microfluidic concurrent assessment of red blood cell adhesion and microcapillary occlusion: Potential hemorheological biomarkers in sickle cell disease. *Sensors & Diagnostics, 2,* 457-467.

Megha, N., Karemore, N., M., & Avari, G., J., (2019). *Alteration in zeta potential of erythrocytes in preeclampsia patients*. IntechOpen

Schenkel, T., & Halliday, I. (2021). Continuum scale non newtonian particle transport model for hæmorheology. *Mathematics. 9*(17), 2100.

Secomb, T. W. (2017). Blood flow in the microcirculation, *Annual Review of Fluid Mechanics*. *49*(1), 443–461.

Swati, S. Gaikwad, N. Karemore, & Avari, J. G. (2018). Alterations in zeta potential and osmotic fragility of red blood cells in hyperglycemic conditions. *Pharmaceutical & Biosciences Journal*, 25-30.

Tokumasu, F., Ostera, G.R., Amaratunga, C., & Fairhurst, R.M., (2012). Modifications in erythrocyte membrane zeta potential by Plasmodium falciparum infection. *Experimental Parasitolog, 131*(2), 245-51.

Trejo-Soto, C., Lázaro, G.R., Pagonabarraga, I., & Hernández-Machado, A., (2022). Microfluidics approach to the mechanical properties of red blood cell membrane and their effect on blood rheology. *Membranes, 12*, 217.

Vahidkhah, K., Balogh, P., & Bagchi, P. (2016). Flow of red blood cells in stenosed microvessels. *Scientific Reports 6*, 28194.

Wu, W.T., Aubry, N., Massoudi, M., Kim, J., & Antaki, J. F. (2014). A numerical study of blood flow using mixture theory. *International Journal of Engineering Science*,*76*, 56-72.

Yaya, F., Römer, J., Guckenberger, A., John, T., Gekle, S., Podgorski, T., & Wagner, C. (2021). Vortical flow structures induced by red blood cells in capillaries. *Microcirculation 28*(5), e12693.

Author(s) Information

Lali Kalandadze
Batumi Shota Rustaveli State University
35 Ninoshvili Str., Batumi, Georgia
Contact e-mail: *Lali.kalandadze@bsu.edu.ge*

Nugzar Gomidze
Batumi Shota Rustaveli State University
35 Ninoshvili Str., Batumi, Georgia

Mirian Kontselidze
Batumi Shota Rustaveli State University
35 Ninoshvili Str., Batumi, Georgia

To cite this article:

Kalandadze, L., Gomidze, N. & Kontselidze, M. (2025). Investigation of red blood cell microcirculation using the DLVO theory. *The Eurasia Proceedings of Science, Technology, Engineering and Mathematics (EPSTEM), 36,* 73-80.