Revisiting: Shape transitions of red blood cell under oscillatory flows in microchannels

Mateus Ferreira, Tunde Tembo, Jonas Sandberg, Erik Gunnarsson

This paper aims to examine the ability to control a model of red blood cell (RBC) dynamics and the associated extracellular flow patterns in microfluidic channels via oscillatory flows. Our computational approach employs a hybrid continuum-particle coupling, in which the cell membrane and cytosol fluid are modeled using the dissipative particle dynamics method. The blood plasma is modeled as an incompressible fluid via the immersed boundary method. This coupling is novel because it provides an accurate description of RBC dynamics while the extracellular flow patterns around the RBCs are also captured in detail. Our coupling methodology is validated with available experimental and computational data in the literature and shows excellent agreement. We explore the controlling regimes by varying the shape of the oscillatory flow waveform at the channel inlet. Our simulation results show that a host of RBC morphological dynamics emerges depending on the channel geometry, the incoming flow waveform, and the RBC initial location. Complex dynamics of RBC are induced by the flow waveform. Our results show that the RBC shape is strongly dependent on its initial location. Our results suggest that the controlling of oscillatory flows can be used to induce specific morphological shapes of RBCs and the surrounding fluid patterns in bio-engineering applications.

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