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Red blood cell in simple shear flow WEI CHIEN, Dept. of Physics, National Taiwan University, Taipei 106, Taiwan, YAYU HEW, Dept. of Physics,U. Texas-Arlington, TX, USA, YENG-LONG CHEN, Inst. of Physics, Academia Sinica, Taipei 11529, Taiwan — The dynamics of red blood cells (RBC) in blood flow is critical for oxygen transport, and it also influences inflammation (white blood cells), thrombosis (platelets), and circulatory tumor migration. The physical properties of a RBC can be captured by modeling RBC as lipid membrane linked to a cytoskeletal spectrin network that encapsulates cytoplasm rich in hemoglobin, with bi-concave equilibrium shape. Depending on the shear force, RBC elasticity, membrane viscosity, and cytoplasm viscosity, RBC can undergo tumbling, tank-treading, or oscillatory motion. We investigate the dynamic state diagram of RBC in shear and pressure-driven flow using a combined immersed boundary-lattice Boltzmann method with a multi-scale RBC model that accurately captures the experimentally established RBC force-deformation relation. It is found that the tumbling (TU) to tank-treading (TT) transition occurs as shear rate increases for cytoplasm/outer fluid viscosity ratio smaller than 0.67. The TU frequency is found to be half of the TT frequency, in agreement with experiment observations. Larger viscosity ratios lead to the disappearance of stable TT phase and unstable complex dynamics, including the oscillation of the symmetry axis of the bi-concave shape perpendicular to the flow direction. The dependence on RBC bending rigidity, shear modulus, the order of membrane spectrin network and fluid field in the unstable region will also be discussed.

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