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Vesicles in a shear and Poiseuille flows

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Vesicles, capsules and Red Blood Cells (RBCs) under flow are subject to considerable attention from theoretical, numerical and experimental point of views. Understanding their motions and dynamics is essential both at the fundamental level as a branch of biocomplex fluids, and at the technological level, such as the lab-on-chip technologies, targeted drug delivery, and blood flow diseases. First, we describe the dynamics of individual biomimetic (vesicles and capsules) and biological entities (RBCs) under a simple shear flow, and overview the current state of the knowledge. Comparison with available experiments will be provided. We then discuss the non-trivial rheology of dilute vesicle suspensions and results from experiments involving oscillatory shear with non-zero mean shear rate. Finally, we address a longstanding puzzle in the blood microcirculatory research: why do red blood cells adopt a non-symmetrical shape (called slipper shape) even in a symmetric flow? Our work shows that the symmetric shape is unstable in flow conditions encountered in microvasculature. Moreover, by adopting a slipper shape, the RBC acquires higher flow efficiency than the symmetric (parachute) shape. The extension of this study to a collection of cells will be outlined.