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Simulations of the tumbling and tank treading motions of cells immersed in fluid flow KENG-HWEE CHIAM, DUC VINH LE, A*STAR Institute of High Performance Computing — We describe the development of computational techniques to study the deformation of cells modeled as liquid capsules enclosed by thin shells suspended in fluid flow. Computations are performed for cells with spherical, ellipsoidal and biconcave unstressed shapes over a wide range of the dimensionless shear rate and for a broad range of the ratio of the internal to surrounding fluid viscosities. Results for small deformations of initially spherical capsules are in quantitative agreement with analytic predictions. Under large deformations, the results show that spherical capsules deform to stationary configurations and the membranes undergo steady tank-treading motion. For capsules of ellipsoidal and biconcave unstressed shapes, the capsules exhibit either tumbling, tank-treading of the membrane about the viscous interior with periodic oscillations of the orientation angle, or intermittent behaviour in which the two modes occur alternately depending on the viscosity, membrane elasticity and shear rate. Our method provides an efficient way to study the tank-treading-to-tumbling transition of red blood cells in shear flows as the shear rate decreases. Observations of such motions may provide a sensitive mean of assessing cell membrane properties. Finally, we also describe simulations of the long-time behavior of a dense suspension of red-blood cells in a micro-channel to illustrate the efficiency of the method.

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