Margination dynamics of arbitrarily shaped particles in shear flows

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ABSTRACT

Understanding the margination dynamics of particles transported in fluids is a crucial aspect in the treatment and early-detection of cancer, having a direct relation with the number of the injected particles that reach the target tissue. A particle transported in a channel that laterally marginates toward the wall during its motion has an enhanced probability of an efficient binding to specific targeted sites. This is a complicated dynamical process, in which the fluid dynamics plays an important role, including rolling events that are critical to the search process of particles near target, and strongly depend on the particle geometry [1]. In order to study the near wall dynamics of particles transported by the flow, a coupled Eulerian-Lagrangian approach is presented. The flow field is solved by means of a Lattice Boltzmann (LB) method [2] on a fixed Eulerianmesh, relying on a suitable Immersed Boundary (IB) technique to take into account the presence of moving and deforming bodies [3], while the suspended cells/particles are treated as Lagrangian solid domains immersed in the Eulerian fluid mesh. Individual particles will be modeled as membranes enclosing an incompressible fluid, and discretized by means of an unstructured triangular mesh [3]. A weakly coupled fluid-structures interaction is employed, imposing the no-slip boundary condition on the surface of the solids and, after evaluating the hydrodynamic forces on the moving bodies, solving the rigid-body dynamic equations. Numerical simulations will be performed to study the particle margination dynamics varying particle-related parameters, namely shape (sherical, ellipsoidal – either prolate or oblate –, discoidal, bi- concave, biconvex), size and density, as well as flow-related parameters, such as shear rate, Reynolds number (at low values) and ratio between the channel height and particle main length. The main objective will be the evaluation of the effective lateral migration coefficient for the transported particles along with its rotation rate and equilibrium orientation with respect to the channel walls.

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