A Mathematical Model for Cell Membrane Deformation

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Abstract

We present a simplified model of biological cells including a first layer, corresponding to the membrane and the actin cortex and a second one, representing the cell cytoplasm. The membrane-actin set is governed by Navier equations while the cytoplasm is assimilated to a viscous fluid, described by the Navier-Stokes system. At the inner boundary, between the cortex and the cytoplasm, we match the velocity displacement with the fluid velocity. The membrane, which faces the extracellular medium, is free to move. To take into account the deformation of the initial configuration, we use the Arbitrary Lagrangian Eulerian method to develop a fluid-structure interaction model for the mesh displacement. Simulations showing the emergence of filopodium, a typical structure in cells undergoing deformation, are presented.

Keywords: Mathematical modeling, cell membrane, fluid-structure interaction, numerical simulations.