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IMMERSED BOUNDARY MODELS FOR BIOFILM SPREAD AND RESPONSE TO ANTIBIOTICS

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We propose an immersed boundary approach to simulate the spread of bacterial biofilms on interfaces including bacterial metabolism and the action of antibiotics [2]. We represent bacterial membranes by boundaries immersed in a fluid matrix, subject to interaction forces. We implement dynamic energy budget rules to describe the metabolism of each bacterium (growth, division and death) informed by environmental concentrations of nutrients, toxicants and substances released by the cells. The interaction between cells, and their interaction with the environment is represented by appropriate forces. Numerical simulations illustrate the behavior of small aggregates of spherical and rod-like bacteria. The immersed boundary approach allows us to investigate geometrical arrangements as bacteria divide and die, competition of different shapes and the formation of porous structures [1, 3, 4]. The dynamic energy budget framework allows us to incorcoporate antibiotic effects on the biofilm and resistance mechanisms. We show that cocktails of antibiotics targeting dormant and active bacteria can entirely eradicate a biofilm [1, 2].

References

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