110c Chemoattractant-Mediated Biofilm Growth on Surfaces

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The mechanisms that lead to microbial biofilm formation and growth on surfaces are of keen interest to chemical, environmental and biomedical engineers. For some processes, such as wastewater treatment and in situ groundwater remediation, development of a biofilm attached to particulate media is actively sought, whereas in other engineering applications, such as food processing or implantation of medical devices, methods are desired to prevent biofilm growth. The latter example in particular is of major concern to the biomedical engineering community, as bacterial attachment and growth on the surfaces of implanted medical devices can result in persistent infection or inflammation of the periprosthetic tissue, which may require device replacement or extend the patient's recovery time.

Biofilm growth on a surface must be preceded by microbial transport and adhesion to the surface. Various strategies have been adopted to promote or retard biofilm development on surfaces, including (1) nutrient delivery to the surface; (2) biocide treatment; (3) flushing the surface; or (4) surface chemical modification with anti-adhesive coatings. An alternative, and possibly complementary, strategy to regulate the biofilm growth of motile microorganisms on surfaces is to employ chemoattractants or chemorepellents to alter the rate of chemotactic migration toward or away from the surface. In this paper, we present the results of cellular dynamics simulations of the Eschereschia coli deposition rate on surfaces in the presence of concentration gradients of selected E. coli amino acid chemoattractants and chemorepellents. In the cellular dynamics simulation methodology, individual random-walk cellular trajectories are generated from a stochastic algorithm that utilizes the motion parameters of the motile cell population (i.e. the mean swimming speed, basal tumbling probability, and turn angle correlation function). For chemotactic cell populations, the random walk is biased toward regions of high chemoattractant concentration (or low chemorepellent concentration) according to the local concentration gradient and the chemotactic sensitivity coefficient of the microorganism toward the chemical compound. We report deposition rate enhancement and suppression factors calculated from cellular dynamics simulation respectively for chemoattractant-assisted and chemorepellent-deterred adhesion of motile E. coli populations on glass surfaces in rectangular channels of varying geometry and fluid shear rate.