Modelling the role of specific biology in biofilm formation and activity

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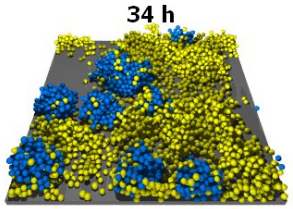
Project description

Biofilms are of utmost significance in the medical field, where they cause serious infections persistent to antibiotic treatment. Biofilms are also present in nearly all technical systems where they cause biofouling, biodeterioration and biocorrosion. It is therefore extremely important to understand the structure and function of biofilm communities as well as the mechanisms regulating biofilm processes. The best tool available for integrating the overwhelming amount of dispersed experimental observations in a rational environment is mathematical modelling.

In this context, the project proposes the development and validation of a completely new fourth generation of computational biofilm models. Specific biological mechanisms will be introduced in models for explaining biofilm spatial structure formation, its function and activity.

Based on a complementary use of novel computational techniques, advanced microscopic tools, biofilm/solute image analysis techniques, and innovative bio-mathematical approaches, we will develop and validate, for the first time, predictive and mechanism-based mathematical models for surface attached microbial communities (biofilms) including advanced biological processes such as cell-cell communication, quorum sensing, microbial motility and microbial morphology.



Simulation of biofilm development with the individual-based biofilm model extended with motile (yellow) and non-motile (blue) bacteria.

A most important application of the new modelling approach is to rationally design strategies for removal of pathogenic biofilms, whose inherent resistance to antimicrobial agents are the cause of many persistent and chronic infections. Use of quorum-sensing inhibitory agents for biofilm suppression is highly attractive because such anti-pathogenic agents are less likely to pose a selective pressure for development of resistant mutants. In industrial applications, this approach will reduce reliance on toxic antimicrobial agents whose use is fundamentally at odds with the increasingly restrictive environmental regulations

References

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[2] Xavier JB, Picioreanu C, Van Loosdrecht MCM (2005) A framework for multidimensional modelling of activity and structure of multispecies biofilms. *Environ Microbiol* **7(8)**:1085-1103.