How biofilms protect themselves against bacteriophage infection and how they fail

Supervisory team:
Main supervisor: Dr Wolfram Moebius (University of Exeter)
Second supervisor: Dr Maisem Laabei (University of Bath)
Dr Daniel Kattnig (University of Exeter)

Collaborators: Prof Ben Temperton (University of Exeter), Dr Tiffany Taylor (University of Bath), Dr Seána Duggan (University of Exeter), Dr Paolo Zuliani (Newcastle University)

Host institution: University of Exeter (Streatham)

Project description:
The antibiotic resistance crisis leads to an increased interest in the use of bacteriophage, viruses of bacteria, to prevent and clear infections. But many bacteria live in biofilms, spatially extended structures of bacterial cells and extracellular polymeric substances (EPS). Although at first glance, such a dense population of cells should be particularly amenable to degradation by phages, life in the biofilm provides protection against bacteriophage predation. To develop targeted phage cocktails to prevent and clear biofilms, we need a better understanding of how biofilms are protected against phages and how this protection fails: Is the EPS too dense for phage to disperse? Is there an ideal number of adsorption sites for phage? Once a phage infection starts within a biofilm, is it contained or does it spread locally? To answer these questions you will perform a combination of simulations and experiments that draw from microbiology and biological physics. Early experiments, e.g., measuring how deeply phage T7 penetrates into a biofilm of E. coli, will allow you to build and parametrise a model of phage entering biofilms and infecting cells. The model then will make predictions about changes that occur when modifying the biofilm, which again can be tested experimentally again using E. coli and phage T7, but also S. aureus and phage K. Together, this will provide us with a quantitative understanding of how biofilms are protected against phages and which levers can be pulled to overcome this protection. You will join a supervisory team and research groups in Exeter and Bath which are dedicated to combining traditional microbiology techniques with state of the art imaging as well as model building and simulations.

The lead supervisor, Dr. Wolfram Möbius (Exeter) has a theoretical background and experience at the bench with bacteriophage T7, focusing with you on model development and simulations. The second supervisor, Dr. Maisem Laabei (Bath), is an expert in S. aureus and imaging and will guide your experimental work. Additional supervisors/ collaborators in Bath, Exeter, and Newcastle provide additional input on electron microscopy, biofilm simulations, phage cocktails and multispecies biofilms as applicable throughout the project. This ambitious project at the interface of microbiology and biophysics will provide you with a wide set of skills sought after in life science research and promises to increase our understanding of how to control biofilms.

Our aim as the SWBio DTP is to support students from a range of backgrounds and circumstances. Where needed, we will work with you to take into consideration reasonable project adaptations (for example to support caring responsibilities, disabilities, other significant personal circumstances) as well as flexible working and part-time study requests, to enable greater access to a PhD. All our supervisors support us with this aim, so please feel comfortable in discussing further with the listed PhD project supervisor to see what is feasible.