

Research topic	Bacterial biofilms in porous structures: from biophysics to control.
Lab	Institute of Fluid Mechanics, Allee Camille Soula, 31400 Toulouse, France.
Salary	Master 2: monthly stipend of 500-600 euros net. PhD CNRS: 20.590 euros net / year (for 3 years).
Funding /Project	European Research Council. ERC Starting Grant. Project BEBOP.
Follow up	Funding is available for a PhD position after the master.
Main supervisor	Yohan Davit, yohan.davit@imft.fr , tel: +33 5 34 32 28 82.
Dates	Master 2: Internship of 4 to 6 months in 2020. Flexible. PhD CNRS: Applications until fulfilled.
Example publication	Cell morphology drives spatial patterning in microbial communities. PNAS (2017).
Background	Mechanics/Engineering or Biophysics or Microbiology/Bacterial ecology.
Other	For more info about research activities @ IMFT, http://yohan-davit.com

Context. This work is part of a larger project (BEBOP, 2019-2024) funded by the European Research Council. The long-term goal of BEBOP is to develop new generations of biotechnologies, such as self-repairing construction materials or self-cleaning bioreactors, that rely on the *use of bacteria to control the properties of porous structures*. The main scientific obstacle to such technologies is the lack of understanding of biophysical mechanisms associated with the growth of bacterial populations within complex porous structures. *For example, how does biological clogging of one pore affects the flow globally in a connected structure? Do bacteria communicate at long distances? How does interference competition affect growth in these complex habitats? What are the different types of feedback mechanisms and nonlinear dynamics?*

The 1st objective of BEBOP is to gain insight into how fluid flow, transport phenomena and bacterial communities interact within connected structures. To this end, we combine microfluidics and 3D printed micro-bioreactors; fluorescence and X-ray imaging; high performance computing bringing together CFD, individual-based models and pore network approaches. The 2nd objective of BEBOP is to create the primary building blocks of a control theory for bacteria in porous media and to construct a demonstrator for permeability control.

Role during the internship. The goal of the internship is to build a response surface for the permeability of a porous medium colonized by bacteria. When bacteria grow within porous media, they generate clogging that modifies the flow pattern and tends to induce a decrease of the permeability. The spatial distribution of biofilms (bacteria + polymers) and thus the permeability both depend upon a variety of parameters, such as the flowrate, concentration of nutrients, the presence of predators, or the type of porous structure. Based on experimental data (microfluidics & bioreactors) in the lab, the idea of the internship is to create a simple meta-model for the evolution of the permeability as a function of these parameters. Depending on the profile of the candidate, emphasis can be put either on the theory, experiments or even computations.

Role during the PhD. Funding is available for a PhD (3 years) following the internship. The goal of the PhD is to use existing experimental and simulation tools in order to extract general principles associated with the biophysics of bacteria in porous media and then create the first building blocks of a control theory that could be used in engineering. The PhD will be part of the BEBOP team, which involves another PhD student (3D printing, bioreactors, x-ray imaging), a theoretician/postdoc (modelling, nonlinear dynamics), and two experimenters/postdocs (microfluidics, bioreactors). The PhD is expected to be a key element in fostering discussions within the team and with biologists, including experts in Microbial Ecology at the Foster Lab (University of Oxford, <https://zoo-kfoster.zoo.ox.ac.uk/>). The focus of the work (biophysics, engineering) and the tools (microfluidics, micro-bioreactors, simulations) can be tailored to the interest of the candidate.

Background. I am looking for somebody extremely motivated who is willing to pursue this work as a PhD and who will be fully involved in the project. Background is recommended either in mechanics, engineering, biophysics, ideally with knowledge of the biology of microorganisms, or in microbiology/microbial ecology.

How to apply? Send a cover letter, a CV (highlighting your level in English) and copies of transcripts (including lectures followed and grades/rankings when available) to yohan.davit@imft.fr (please indicate ERC_BEBOP_BiophysicsControl in the e-mail title).

