Bacteria meet surfaces: from individual to collective dynamics

M2 internship -> PhD proposal (funding available)

On tissues or abiotic surfaces, adhering bacteria can form organized communities called biofilms, in which a self-produced matrix acts as glue between individuals [1,2]. Biofilm formation is linked to antibiotic resistance and chronic infection, but the signals that regulate irreversible adhesion via the secretion of the exopolysaccharide (EPS) matrix are not clear.

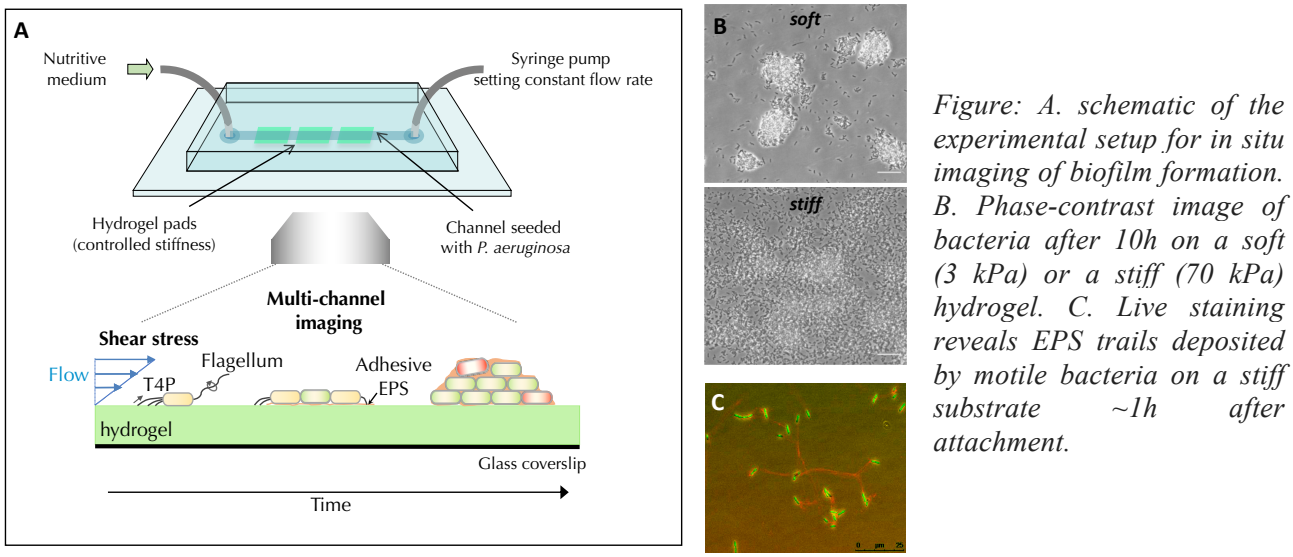

Figure: A. schematic of the experimental setup for in situ imaging of biofilm formation. B. Phase-contrast image of bacteria after 10h on a soft (3 kPa) or a stiff (70 kPa) hydrogel. C. Live staining reveals EPS trails deposited by motile bacteria on a stiff substrate ~1h after attachment.

Using an interdisciplinary approach combining microfluidics, surface design and microbiology tools, we image adhering bacteria *in situ,* and explore the spatial and temporal dynamics of irreversible adhesion. Cohesive microcolonies form via a highly collaborative process that is not fully understood [3]. For the opportunistic pathogen *Pseudomonas aeruginosa*, we observe a complex interplay between surface motility, matrix production and bacterial organization. We have recently shown that this process strongly depends on the mechanical properties of the underlying substrate [4].
The goal of this project is to understand how the micromechanical environment of adhering bacteria impacts their organization, and how in turn, this organization impacts bacterial virulence; the initial phase of the work will involve microscopy experiments and image analysis to quantify the intracellular fluorescence of adequate reporter genes, designed in close collaboration with biologists at IRIG (Grenoble), in the group of Ina Attree (DR1 CNRS, INSB).

These questions can be studied during a Master internship, and serve as a starting point for a Ph.D. thesis **(funding available)**.
A background in soft matter physics, biophysics, or experience with image processing would be a plus, but the main prerequisite is a strong interest in interdisciplinary questions.

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[1] Costerton JW, Stewart PS, Greenberg EP, "Bacterial Biofilms: A Common Cause of Persistent Infections" Science. 284 :1319-22 (1999).
[2] Trinsheck S., John K., Lecuyer S. and Thiele U., "Continuous versus Arrested Spreading of Biofilms at Solid-Gas Interfaces: The Role of Surface Forces" Phys. Rev. Lett., 119, 078003 (2017).
[3] Duvernoy MC, Mora T, Ardré M, Croquette V, Bensimon D, Quilliet C, Ghigo JM, Balland M, Beloin C, Lecuyer S, and Desprat N, "Asymmetric adhesion of rod-shaped bacteria controls microcolony morphogenesis" Nature Communications 9(1120). doi: 10.1038/s41467-018-03446-y (2018).
[4] Gomez S., Bureau L., Debarre D. and Lecuyer S., "Substrate stiffness impacts early colonization by *Pseudomonas aeruginosa* by modifying twitching motility", In preparation.