

M2 Master's Research internship**Single-cell dynamics of DNA-mediated communication in bacteria**

A Master's research internship (6 months) is available at the Micalis Institute (UMR1319), INRAE, Jouy-en-Josas.

Project Summary

Living systems rely on communication between cells for coordination, using a diverse set of signalling molecules. Inspired by this, synthetic biology has built multicellular circuits that distribute functions across cells to enable parallel information processing. In this context, DNA-based communication via horizontal gene transfer offers high fidelity and versatility compared to small-molecule signalling, but its single-cell dynamics—the timing, variability, and physiological impacts of DNA transfer and expression—remain poorly understood. This research internship aims to develop a quantitative, microscopy-based framework for studying DNA-mediated communication in bacterial populations, using a synthetic phage-based system as a model. It will use quantitative automated time-lapse imaging to monitor the growth and the kinetics of DNA transfer and gene regulation at single-cell resolution. Transfer of DNA carrying distinct replication origins will be measured to relate single-cell behaviours to population-level measurements. Ultimately, this work will help reveal how DNA messages propagate through bacterial populations and how plasmid designs can be optimised for programmable intercellular communication, with direct relevance to understanding the natural horizontal gene transfer.

We are looking for a highly motivated candidate, with background in microbiology, molecular biology, and/or synthetic biology. Experience in bacterial microscopy is particularly desirable. Although not required, knowledge of computational modelling/bioinformatics will be an advantage. The candidate should have strong communication skills and the willingness to work collaboratively with other members of the team. The work will be carried out in the Cellular Computing Team at the Micalis Institute (UMR1319), Jouy-en-Josas, in collaboration with researchers from ENS Paris-Saclay.

Expected Start date: January 2027

Application process: Please send a cover letter outlining why you are interested in this position, together with you CV and university transcripts, to Manish.Kushwaha@inrae.fr

References

- Pujar, A., Pathania, A., Hopper, C., Pandi, A., Calderón, C. R., Függer, M., Nowak, T., & Kushwaha, M. (2025). Phage-mediated intercellular CRISPRi for biocomputation in bacterial consortia. *Nucleic Acids Research*, 53(3), 1–17. <https://doi.org/10.1093/nar/gkae1256>
- Pujar, A., Sharma, A., Jbara, H., & Kushwaha, M. (2025). An M13 phagemid toolbox for engineering tuneable DNA communication in bacterial consortia. *bioRxiv*. <https://doi.org/10.1101/2025.06.22.660937>
- Broughton, J., Fraisse, A., & El Karoui, M. (2025). Suppression of bacterial cell death underlies the antagonistic interaction between ciprofloxacin and tetracycline in *Escherichia coli*. *Molecular Systems Biology*. <https://doi.org/10.1101/2024.04.18.590101>