MARIE SKŁODOWSKA-CURIE INDIVIDUAL FELLOWSHIPS 2019

EXPRESSION OF INTEREST FOR HOSTING MARIE CURIE FELLOWS

HOST INSTITUTION

NOVA Institute of Chemical and Biological Technology António Xavier | MOSTMICRO – Molecular, Structural and Cellular Microbiology Unit

RESEARCH GROUP AND URL

Single Molecule Microbiology Laboratory
https://zach-hensel.github.io/

SUPERVISOR (NAME AND E-MAIL)

Zach Hensel
zach.hensel@itqb.unl.pt

SHORT CV OF THE SUPERVISOR

Dr. Zach Hensel has led the Single Molecule Microbiology lab at ITQB NOVA since 2017. The lab seeks to apply single-molecule methods in living bacterial cells to answer fundamental questions about microbial gene regulation and cell biology. We primarily use fluorescence microscopy to visualize fluorescent proteins and small fluorophores at the single-molecule level, and develop custom hardware/software for data acquisition and analysis.

Zach obtained his PhD in Molecular Biophysics at Johns Hopkins, developing and applying new methods for counting the expression of protein molecules one-by-one and observing DNA looping in *E. coli* cells in Dr. Jie Xiao's laboratory. He then completed postdoctoral studies at the Okinawa Institute of Science and Technology in the Dr. Tatiana Marquez-Lago's laboratory, where he studied oscillatory bacterial gene expression and other topics.

5 SELECTED PUBLICATIONS

- JPN Silva, SV Lopes, DJ Grilo, Z Hensel. Plasmids for independently tunable, low-noise expression of two genes. mSphere 2019. https://doi.org/10.1128/mSphere.00340-19
- Z Hensel. A plasmid-based Escherichia coli gene expression system with cell-to-cell variation below the extrinsic noise limit. PLOS ONE 12, 2017. https://doi.org/10.1371/journal.pone.0187259
- Z Hensel, TT Marquez-Lago. Cell-cycle-synchronized, oscillatory expression of a negatively autoregulated gene in E. coli. arXiv 1506.08596, 2015. https://arxiv.org/abs/1506.08596
- Z Hensel, X Weng, AC Lagda, J Xiao. Transcription-factor-mediated DNA looping probed by high-resolution, single-molecule imaging in live E. coli cells. PLOS Biology 11, 2013. https://doi.org/10.1371/journal.pbio.1001591

- Z Hensel, H Feng, B Han, C Hatem, J Wang, J Xiao. Stochastic expression dynamics of a transcription factor revealed by single-molecule noise analysis. Nature Structural and Molecular Biology 19, 2012. https://doi.org/10.1038/nsmb.2336

PROJECT TITLE AND SHORT DESCRIPTION

Simultaneous single-molecule mRNA and protein imaging in E. coli

Our lab is developing improved single-molecule mRNA imaging methods in *E. coli* that make it possible to observe the production and degradation of mRNAs without "immortalization" that has limited previous experiments in bacteria (*e.g.* using the MS2-GFP system). The first goal of this project is to further improve and characterize these methods, with the possibility of developing two orthogonal methods so that two mRNA species (or two regions of the same mRNA) can be imaged simultaneously. Next, mRNA detection will be combined with established single-molecule protein detection methods, showing that bursts of protein expression correlate with mRNA expression events.

Lastly, the mRNA/protein imaging system will be used to attempt to observe two phenomena in *E. coli* gene regulation with unprecedented resolution – transcriptional bursting and "transertion" (nucleoid expansion caused by co-transcriptional translation of membrane proteins). The project can be shaped to match the interests of the fellow. Other options include developing mRNA detection methods using small-molecule fluorophores and characterizing RNA degradation at the single-molecule level.

SCIENTIFIC AREA WHERE THE PROJECT FITS BEST

Life Sciences (LIF)