van Teeffelen lab
Département de Microbiologie / Institut de Génie Biomédical
Université de Montréal
vanteeffelenlab.org

Université de Montréal

M.Sc. and Ph.D. positions in physical biology / biophysics of bacteria

The van Teeffelen lab works on fundamental problems of the physics of bacterial life, with a focus on the organization of macroscopic cell shape and the control of cell size. To that end we develop and use high-precision custom microscopy, microfluidics, mechanical perturbations, image analysis, and physical modeling. These approaches are complemented with tools from synthetic and molecular biology.

We are looking for M.Sc. and Ph.D. students with education in engineering, physics, chemistry, or biology, with a keen interest in the physics of life. Experience in any of the following is a plus: microscopy, optics, image analysis, (bacterial) cell biology, microfluidics, statistical modeling. Currently open projects include**:**

- **Quantitative phase microscopy**. Our custom microscope and analysis pipeline lets us, for the first time, simultaneously measure the mass of single live bacteria and their cell shape with unprecedented precision [1]. One major goal is to understand how cells coordinate growth of cell shape with growth of biomass to maintain a high degree of intracellular macromolecular crowding. *Projects: Improving the microscope design, combination with additional single-cell investigations/perturbations, forward-convolution-based image analysis, investigation of macromolecular crowding.*
- **Single-protein tracking** in live cells and statistical analysis of single-enzyme behavior to build physical models of how cells grow and control cell shape [2,3]. *Projects: Microscopy development, single-molecule tracking (SMT) microscopy, image analysis, and physical models.*
- **Mechanics of cell shape**. We aim to understand the influence of mechanical forces on cell shape [Wong et al. *Nature Microbiology* 2017]. *Project: Mechanical perturbations (Atomic Force Microscopy, microfabrication) and single-molecule tracking.*
- **Cell-cycle control** in terms of coarse-grained physical models that relate cell division to essential cell-cycle processes [4]. *Project: Microfluidics, single-cell growth, detection of DNA replication.*
- **Other projects** ranging from noise in gene expression, to turgor pressure, macromolecular crowding, chromosome organization, and metabolism, can be discussed.

For more info and references see vanteeffelenlab.org.

To apply or discuss current possibilities contact Sven van Teeffelen (sven.vanteeffelen@umontreal.ca).

Key references:

1) Oldewurtel, E.R., Y. Kitahara, and S. van Teeffelen (2021) Robust surface-to-mass coupling and turgor-dependent cell width determine bacterial dry-mass density *Proc. Natl. Acad. Sci. U.S.A.* 118(32) e2021416118.

2) Özbaykal G., E. Wollrab, F. Simon, A. Vigouroux, B. Cordier, A. Aristov, T. Chaze, M. Matondo, and S. van Teeffelen (2020). The transpeptidase PBP2 governs initial localization and activity of the major cell-wall synthesis machinery in *E. coli*. *eLife* 9:e50629

3) Vigouroux A., B. Cordier, A. Aristov, L. Alvarez, G. Özbaykal, T. Chaze, E.R. Oldewurtel, M. Matondo, F. Cava, D. Bikard, S. van Teeffelen (2020). Class-A penicillin binding proteins do not contribute to cell shape but repair cell-wall defects. *eLife* 9:e51998

4) Colin A., G. Micali, L. Faure, M. Cosentino Lagomarsino, S. van Teeffelen (2021) Two different cell-cycle processes determine the timing of cell division in *Escherichia coli*. *BioRxiv* 2021.03.08.434443v1 (under review, *eLife*)