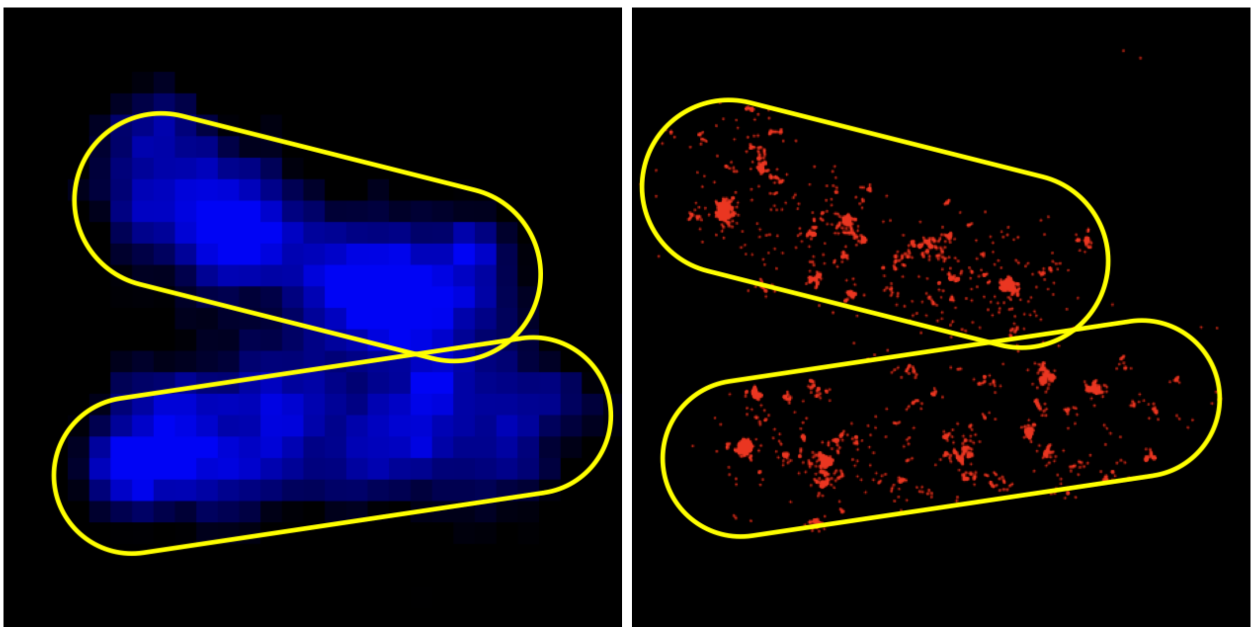
**Project Description** (Yong Wang)

**Project 1. Motion of bacteria in fluids and porous media.**

Many types of bacteria inhabit naturally in aqueous solutions, complex fluid, or fluid-filled porous media [1]. Migration and mobility of bacteria in these media play essential role for bacterial health, growth and survival [2–4]. Therefore, it is of great interest to investigate the motion and growth of bacteria in various environments [5]. Although extensive studies have been performed on the motion of bacteria in fluids, much less is known about how bacteria move in porous media [6]. This project will explore the motion of bacteria, with *E. coli* as a model system, and address this knowledge gap.

REU students in this project will learn to use fluorescence microscopy to track individual *E. coli* cells in both aqueous solutions and porous media made of soft agar. The participants will observe Levy-walk-like motions of bacteria, measure the trajectories, quantify the displacements and step sizes, estimate the diffusional behaviors of bacteria. The students will also perform statistical analysis among large number of bacteria, and compare the differences between bacteria in fluids and in porous media. This project will provide participants hands-on training on both experimental and computational/analytical skills.



**Project 2. Bacterial response to environmental changes.**

Bacteria exist naturally in human body, such as mouth, stomach and guts [7]. However, if bacteria escape from where they belong to, they might cause deadly infections [8]. How do bacteria survive when they leave their natural camp? This project explores bacterial responses to environmental changes at the cellular and molecular levels and seeks a physically based understanding on the survival of bacteria when experiencing environmental stresses.

REU students in this project will have a chance to hands-on learn super-resolution fluorescence microscopy, an advanced optical technique. The participants will measure the spatial organization of fluorescent proteins in *E. coli* cells, and observe the reorganization of the protein of interest after the bacteria are treated with sudden environmental changes, such as changes in temperature, pH, and ionic strength. The students will learn to quantify the observations by performing numerical analysis using various algorithms, including machine-learning algorithms. This project will provide participants hands-on training on both experimental and computational/analytical skills.

**References**

1. Whitman, W. B., Coleman, D. C., and Wiebe, W. J. "**Prokaryotes: The Unseen Majority**" *Proceedings of the National Academy of Sciences of the United States of America* 95, no. 12 (1998): 6578–6583.

2. Fletcher, D. A. and Theriot, J. A. "**An Introduction to Cell Motility for the Physical Scientist**" *Physical Biology* 1, no. 1 (2004): T1. doi:10.1088/1478-3967/1/1/T01

3. Manson, M. D. "**Introduction to Bacterial Motility and Chemotaxis**" *Journal of Chemical Ecology* 16, no. 1 (1990): 107–118. doi:10.1007/BF01021272

4. Elgeti, J., Winkler, R. G., and Gompper, G. "**Physics of Microswimmers—single Particle Motion and Collective Behavior: A Review**" *Reports on Progress in Physics* 78, no. 5 (2015): 56601. doi:10.1088/0034-4885/78/5/056601

5. Kearns, D. B. "**A Field Guide to Bacterial Swarming Motility**" *Nature Reviews Microbiology* 8, no. 9 (2010): 634–644. doi:10.1038/nrmicro2405

6. Licata, N. A., Mohari, B., Fuqua, C., and Setayeshgar, S. "**Diffusion of Bacterial Cells in Porous Media**" *Biophysical Journal* 110, no. 1 (2016): 247–257. doi:10.1016/j.bpj.2015.09.035

7. Turnbaugh, P. J., Ley, R. E., Hamady, M., Fraser-Liggett, C., Knight, R., and Gordon, J. I. "**The Human Microbiome Project: Exploring the Microbial Part of Ourselves in a Changing World**" *Nature* 449, no. 7164 (2007): 804–810. doi:10.1038/nature06244

8. Willey, J. M., Sherwood, L., and Woolverton, C. J. "**Prescott's Microbiology**" (2011).