# FBS Seminar

June 25 (Thu), 2026

15:00 - 16:00

2F Seminar room, BioSystems Building


## Prof. Nikhil Malvankar

### Associate Professor, Microbial Sciences Institute, Yale University


## "Single-Cell Imaging and Control of Microbial Metabolism and Colonization by Targeting Electron Transfer via Protein Nanowires"

Every living cell needs to eliminate the surplus of electrons created by their metabolic processes. Most organisms achieve this by transferring electrons to soluble oxygen-like electron acceptors, which act as electron sinks. However, microbes that live in areas with limited or no oxygen, such as those residing in the deep ocean, in soil, or in the human body, have evolved strategies to export electrons to extracellular acceptors, including minerals or other bacteria. *Geobacter* uses long, thin, conductive filaments called "nanowires" to export electrons[1,2]. Nanowires are fundamental to global environmental processes[1,2], including methane degradation, a major greenhouse gas[3].

*Geobacter* filaments have fascinated the scientific community for their role in electron transfer since 2002. Until recently, nanowires were considered Type IV pili (T4P), polymers of the PilA-N pilin subunit, partly because T4P are required for electron transfer[4]. However, my lab showed that PilA-N pairs with a second protein, PilA-C, to form a T4P that are structurally inconsistent with electron transfer[4]. We further demonstrated that Geobacter produces additional filaments comprising outer membrane cytochrome (Omc) Z and S subunits, which can transfer electrons through a chain of heme groups[3,5]. I will present how we show that (i) these cytochrome filaments are the electron-conducting nanowires and (ii) the role of T4P in electron transfer is akin to a piston to secrete cytochrome nanowires on the bacterial surface. My team is exploring the structure, assembly, and electron transfer mechanism of nanowires, and evaluating their role in bacterial respiration, communication, and pathogenesis. By combining experimental and computational studies, our team is addressing three key questions:

- How do microbes kickstart metabolism[7] to build & use OmcS[6] & OmcZ[3] nanowires?
- How are electrons transferred from the bacterial cytoplasm to surface-displayed nanowires[8]?
- How to tune nanowire conductivity using light[9], pressure[10], temperature[11], electromagnetic fields[10], humidity[12], non-natural 'click' chemistry[13] & coherence[14] to control bacterial behavior?

**References**


1. Summers *et al.* Malvankar & Lovley, *Science* 2010
2. Malvankar *et al. Nature Nano.*, 2011 & *Nature Nano.*, 2014
3. Gu *et al.* Malvankar *Nature Micro.*, 2023
4. Gu *et al.* Malvankar *Nature*, 2021
5. Wang & Gu *et al.* Hochbaum, Egelman & Malvankar *Cell*, 2019
6. Shen *et al.* Malvankar *Cell Chemical Biology*, 2025
7. Erwin *et al.* Malvankar *Preprint*, 2024
8. Portela & Shipps *et al.* Malvankar, *Nature Comm.* 2024
9. Neu & Shipps *et al.* Malvankar, *Nature Comm.* 2022
10. Yalcin & O'Brien *et al.* Malvankar, *Nature Chem. Bio.*, 2019
11. Dahl *et al.* Malvankar, *Science Adv.*, 2022
12. Dahl *et al.* Malvankar, *Preprint*, 2024
13. Shapiro *et al.* Malvankar & Isaacs, *Nature Comm.* 2022
14. Parson *et al.* Malvankar *JPCL*, 2025



Contact : Keiichi Namba
namba.keiichi.fbs@osaka-u.ac.jp
06-6879-4625