BP 41: Franco-German Session: Bacterial Biophysics II

Time: Friday 11:30–12:45 Location: BAR/0205

Invited Talk BP 41.1 Fri 11:30 BAR/0205

Probing spatiotemporal electrochemical dynamics on single bacterial cells — Anaïs Biquet-Bisquert[1], Baptiste Carrio[1], Nathan Meyer[1], Thales Fernandes[1], Manouk Abkarian[1], Farida Seduk[2], Axel Magalon[2], •Ashley Nord[1], and Francesco Pedaci[1] — [1]Centre de Biologie Structurale, Université de Montpellier, CNRS, INSERM. Montpellier, France. — [2]Aix Marseille Université, CNRS, Laboratoire de Chimie Bactérienne (UMR7283), IMM, IM2B, 13402 Marseille, France.

Electrochemical gradients across biological membranes are fundamental to cellular bioenergetics. In bacteria, the proton motive force (PMF) drives critical functions such as ATP synthesis and motility. Although historically regarded as temporally and spatially stable, recent studies have revealed dynamic PMF behaviors at single-cell and community levels, which are implicated in processes like intracellular communication and coordination. The bacterial flagellar motor, a rotary nanomachine directly powered by the PMF, provides a unique and sensitive tool for probing these dynamics. By employing light-activated proton pumps and monitoring changes in flagellar motor activity, we perturb and investigate the PMF at the single-cell level. This approach reveals millisecond-scale temporal fluctuations and rapid lateral homogenization of the PMF, reminiscent of the electrotonic potential spread observed in passive neurons.

BP 41.2 Fri 12:00 BAR/0205

Cable Bacteria as Conductive Interfaces: Towards Scalable, Bacteria-derived Electronics — •Hannah Ferenz[1,2], Rakesh Nair[2], and Hans Kleemann[2] — [1]Sächsisches Landesgymnasium Sankt Afra zu Meißen, 01662 Meißen, Germany — [2]Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute for Applied Physics, Technische Universität Dresden, 01187 Dresden, Germany.

Cable bacteria (Electrothecera and Electronema spp.) are multicellular filamentous bacteria that perform centimeter-scale electron transport via parallel conductive fibers embedded in their cell envelope, achieving conductivities up to 30 S cm^-1, rivaling synthetic conjugated polymers. We present a robust bioprocess using controlled oxygen-sulfide gradients in natural sediments to produce mechanically coherent, dense biofilms (>10^5 filaments cm^-2). These living conductive networks self-assemble, remain stable for months in-culture, and self-repair via continued growth after damage.

We demonstrate how these bacterial cultures can be used for the development of bio-derived electrodes based on their inherent nickel-sulfur complexes. These results establish cable bacteria as the first genetically tractable, self-growing biological conductor suitable for integration into transient and sustainable electronics, offering a path toward low-cost, environmentally benign bioelectronic interfaces for sensing, energy harvesting, and wearable devices.

BP 41.3 Fri 12:15 BAR/0205

Biophysics of bacterial survival during starvation — •Severin Schink — LMU München, Fakultät für Biologie

Most bacteria live in nutrient-limited states, yet the physical principles that set their lifespan and govern loss of viability during starvation remain poorly understood. I present a framework that links death dynamics, proteome adaptation and competition under starvation in E. coli.

Using time-lapse microscopy, we show that starving cells maintain a plasmolysed state and typically die via a rapid collapse of ion homeostasis. A coarse-grained model of ion transport maps death to a Kramers-like escape process set by nutrient recycling. The model predicts how death rates scale with permeability, ionic strength and cell geometry, and how modified media extend lifespan by lowering maintenance costs.

Proteome-wide analysis reveals that envelope proteins are key for survival: reallocating proteome into the envelope lowers ion permeability and death rate but constrains growth, generating a trade-off between proliferation and starvation survival. Co-cultures of physiologically distinct populations reveal cross-feed feedback: nutrients released by dying cells are recaptured by survivors, amplifying small differences in maintenance and uptake into large fitness advantages. Together, these results identify a minimal set of physical parameters ion gradients, permeability, recycling yield and uptake capacity that control lifespan and selection under starvation.

BP 41.4 Fri 12:30 BAR/0205

Selective inhibition of microbial methanogenesis - a shortcut toward climate change mitigation — •Benedikt Sabass — TU Dortmund — LMU München

In a world that is increasingly affected by climate change, new solutions are urgently needed to reduce greenhouse gas emissions. One of the most effective measures to limit global warming is to reduce methane emissions, a significant proportion of which is produced in the rumen of cattle. Rumen methanogenesis is a complex process that involves various biochemical pathways and cooperation among species from all three domains of life.

A reduction of methane emissions through feed additives has been shown to be feasible in principle, but effective and economical solutions are not yet available. Here, I present an overview of our research on compounds that selectively inhibit methanogenesis. I summarize existing strategies, describe our in-vitro screening assay, and present results from animal tests. Finally, I outline basic open questions regarding the molecular mechanisms of methanogenesis from a biological physics perspective.