



Alfred M. Spormann

Professor of Civil and Environmental Engineering, of Chemical Engineering and, by courtesy, of Biology

CONTACT INFORMATION

- **Administrator**

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Bio

BIO

In our research we investigate molecular microbial metabolism and its linkage to ecological and evolutionary processes. We explore the distinguishing features of novel microbial metabolism and how molecular and biochemical differences in metabolism shape microbial fitness. We study novel microbial metabolism with relevance to bioremediation, bioenergy, and intestinal microbiology.

1) Microbial Electrosynthesis and Electron Transport between Microbes and Surfaces

Some microbes have the capacity to either derive metabolic electrons from redox-active mineral surfaces or transfer such electrons to these surfaces. These processes are of great relevance to geochemical, environmental, but also bioenergy processes. We are investigating the molecular bases of such novel electron transfer to uncover the enzymes and pathways for electron uptake. More recently, we began to explore microbial electrosynthesis as a novel means to produce CO₂-neutral biofuels and commodity chemicals.

2) Microbial Reductive Dehalogenation

Chloroethenes, such as PCE and TCE, are the most prevalent groundwater contaminants in the U.S. and the developed countries. Large scale remediation of contaminated aquifers relies largely on the activity of a group of unusual microbes (Dehalococcoides) that derive energy from reductive dehalogenation. We study reductive dehalogenases and the strictly anaerobic bacteria, such as *Dehalococcoides mccartyi* and *Shewanella*, on a biochemical, physiological, genomic, and population level to better understand the unprecedented biochemistry of the coenzyme B₁₂-containing reductive dehalogenases. We also use this information to improve chloroethene bioremediation. Population-level studies in our lab have been revealing speciation and niche adaptation in *Dehalococcoides mccartyi*. in response to subtle changes in physical-chemical environments.

3) Biofilms and the emergence of antibiotic tolerance and antibiotic resistance

For the last decade, we have been investigating the mechanism of biofilm formation in medically important microorganisms, including *Vibrio cholerae*, *Pseudomonas aeruginosa*, *Francisella tularensis*, and *Shewanella oneidensis*. We discovered that the stability of biofilms requires cellular energy, and that extracellular matrix material may have a supportive role. In more recent studies, we developed the first system to examine the pharmacokinetics and pharmacodynamics of *Pseudomonas aeruginosa* biofilms. We investigate the effect of human simulated concentrations of meropenem and tobramycin, administered singly, and in combination, on biofilms of *P. aeruginosa* PAO1 and clinical isolates from patients with CF, as well as the effect of human simulated concentrations of meropenem and tobramycin, administered singly, and in combination, on biofilms of *P. aeruginosa* PAO1 and clinical CF isolates.

4) Microbial Metabolic Processes in the Large Intestine

Irritable Bowel Syndrome (IBS) is a chronic, episodic gastrointestinal disorder that is characterized by abdominal pain and altered bowel habits. IBS prevalence is estimated to be 10-15% in Western countries comprising 25 to 50 percent of all referrals to gastroenterologists. The gastrointestinal tract harbors a complex and diverse microbial community, which plays important roles in host nutrition, immune function, health and disease, and it is hypothesized the IBS disease phenotype is associated with a change in colonic microbiota and/or host factors such as mucosal function and immunity. With our physician collaborator, we study the metabolic processes in the intestinal microbial community, and how cellular metabolism is controlled by the host mucosa.

ACADEMIC APPOINTMENTS

- Professor, Civil and Environmental Engineering
- Professor, Chemical Engineering
- Professor (By courtesy), Biology
- Member, Bio-X
- Member, Maternal & Child Health Research Institute (MCHRI)
- Affiliate, Precourt Institute for Energy

HONORS AND AWARDS

- Elected Fellow, American Academy of Microbiology (2013)
- Otto Moensted Visiting Professor, Danish Technical University, Lyngby, DK (2003)
- Research Award, Charles Lee Powell Foundation (2000)
- CAREER Award, National Science Foundation (1998)
- Visiting Professor, Department of Biochemistry and Biological Process Institute, University of Minnesota (1997)

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PROFESSIONAL EDUCATION

- Dr. rer. nat., Philipps-University, Marburg (1989)

Research & Scholarship

CURRENT RESEARCH AND SCHOLARLY INTERESTS

Metabolism of anaerobic microbes in diseases, bioenergy, and bioremediation

Teaching

COURSES

2018-19

- Advanced Seminar on Prokaryotic Molecular Biology: BIO 346, CSB 346, GENE 346 (Win, Spr)

- Environmental Microbiology I: CEE 274A, CHEMENG 174, CHEMENG 274 (Win)
- Hopkins Microbiology Course: BIO 274S, BIOHOPK 274, CEE 274S, ESS 253S (Sum)
- Microbial Bioenergy Systems: CEE 274B, CHEMENG 456 (Win)
- Special Topics in Microbial Physiology and Metabolism: CHEMENG 517 (Aut, Win, Spr, Sum)

2017-18

- Advanced Seminar on Prokaryotic Molecular Biology: BIO 346, CSB 346, GENE 346 (Win)

2016-17

- Advanced Seminar on Prokaryotic Molecular Biology: BIO 346 (Aut, Win)

2015-16

- Advanced Seminar on Prokaryotic Molecular Biology: BIO 346 (Aut, Win)

STANFORD ADVISEES

Doctoral Dissertation Reader (AC)

Kyler Lugo

Postdoctoral Faculty Sponsor

Wenyu Gu, Frauke Kracke, Ali McCully, Albert Mueller

Postdoctoral Research Mentor

Frauke Kracke, Albert Mueller

GRADUATE AND FELLOWSHIP PROGRAM AFFILIATIONS

- Biology (School of Humanities and Sciences) (Phd Program)

Publications

PUBLICATIONS

- **Quasi-2D Pd/Pt nanoclams for CO₂ reduction in tandem with microbial communities**
Wong, A., Kracke, F., Antoniuik-Pablant, A., Hahn, C., Spormann, A., Jaramillo, T.
AMER CHEMICAL SOC.2018
- **Methanococcus maripaludis Employs Three Functional Heterodisulfide Reductase Complexes for Flavin-Based Electron Bifurcation Using Hydrogen and Formate.** *Biochemistry*
Milton, R. D., Ruth, J. C., Deutzmann, J. S., Spormann, A. M.
2018
- **Homoacetogenesis in Deep-Sea Chloroflexi, as Inferred by Single-Cell Genomics, Provides a Link to Reductive Dehalogenation in Terrestrial Dehalococcoidetes (vol 8, e02022-17, 2017)** *MBIO*
Sewell, H. L., Kaster, A., Spormann, A. M.
2018; 9 (2)
- **Mediator-free enzymatic electrosynthesis of formate by the Methanococcus maripaludis heterodisulfide reductase supercomplex.** *Bioresource technology*
Lienemann, M., Deutzmann, J. S., Milton, R. D., Sahin, M., Spormann, A. M.
2018; 254: 278–83
- **Determination of Tobramycin in M-9 Medium by LC-MS/MS: Signal Enhancement by Trichloroacetic Acid** *JOURNAL OF ANALYTICAL METHODS IN CHEMISTRY*
Huang, L., Haagensen, J., Verotta, D., Cheah, V., Spormann, A. M., Aweeka, F., Yang, K.
2018: 7965124

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