INDIAN INSTITUTE OF TECHNOLOGY DELHI
DEPARTMENT OF BIOCHEMICAL ENGINEERING & BIOTECHNOLOGY

2018-19 Seminar Series

Thursday, 6th December, 2018

Dr. Yamini Jangir
Post-doctoral Scholar
California Institute of Technology, Pasadena, USA

Title: Wired Life: Investigating the Microbe-Mineral Interactions with Bioelectrochemical Techniques

Electron transfer is a fundamental aspect of life, driving key biological energy conversion processes such as respiration and photosynthesis. Microbes can interact with minerals associated with sediments and rocks, to derive energy from the environment. Extracellular electron transfer (EET) is the capability of microorganisms to transport electrons to and from insoluble substrates outside of the cell. Despite its environmental importance and technological promise, EET is mechanistically characterized in only two model dissimilatory metal-reducing bacteria (DMRB) *Shewanella* and *Geobacter*. Firstly, I will focus on disentangling the EET strategies employed by *S. oneidensis* MR- 1. Secondly, I will describe bioelectrochemical cultivation platforms, applied both in-situ and ex- situ at NASA Astrobiology Institute field sites, that mimic interfacial electron transport as a central mechanism for microbe-mineral energy transfer in the subsurface to reveal the full diversity of subsurface microorganisms. Lastly, I will present our ongoing efforts to enrich a stable microbial community capable of degrading N-acetylglucosamine on poised electrodes. Here, we aim to tease apart the mass and energy flux within the electrode-attached biofilm with varying environments temperature, substrate concentration, and electrode potential). While these hidden cycling of redox species through EET are recognized in a wide variety of habitats, this is the first study demonstrating the robustness of employing bioelectrochemical techniques to enrich for and quantify the activities of subsurface microbes.

All are welcome

Seminar will be held in DBEB Seminar room at Block I, Room 223 at 4 pm
For additional information, contact Seminar coordinator Dr. Preeti Srivastava at preeti@dbeb.iitd.ac.in or Dr. D. Sundar at sundar@dbeb.iitd.ac.in

YAMINI JANGIR

Email: jangir@caltech.edu • **Phone**: +1-6263951786
Address MC 100-23, 1200 E California Blvd, Pasadena, CA 91125.

Academic Qualification

2018 - present	Postdoctoral Scholar (Geobiology), California Institute of Technology, Pasadena, USA. Project: "Extracellular electron transfer in microbial consortia". Advisor: Dr. Victoria Orphan
2010–2016	Ph.D. (Physics), University of Southern California, Los Angeles, USA. Dissertation: "Electrochemical studies of subsurface microorganisms". Advisor: Dr. Mohamed Y. El-Naggar
2007–2009	M.Sc. (Physics), Indian Institute of Technology, Bombay, India. Thesis: "Structural and optical characterization of photonic crystals". Advisor: Dr. R. Vijaya
2004–2007	B.Sc. (Physics), Sri Venkateswara College, Delhi University, Delhi, India

Research Interests

Microbiology; Electrochemistry; Genomics; Sustainable Energy; Astrobiology

Publications

1. **Y. Jangir**, A. Karbelkar, N. Beedle, L. Zinke, B.K. Reese, G. Wanger, C. Anderson, J.P. Amend and M.Y. El-Naggar. *In Situ Electrochemical Studies of Subsurface Microbes at the Sanford Underground Research Facility, USA*, (submitted to AEM, 2018)
   Geological Site: Sanford Underground Research Facility (South Dakota, USA)
   First potentiostatically controlled *in situ* electrochemical colonisation (ISEC) reactor deployed for capturing indigenous subsurface microorganisms from the borehole water located at 4850 ft below the surface of the Earth. Most bacterial communities present in the borehole water were represented onto the poised electrodes. This work demonstrated that *in situ* electrochemical techniques are promising for studying subsurface bacterial communities. Furthermore, various strains from genera including *Bacillus*, *Anaerospora*, *Comamonas*, *Cupriavidus* and *Azonexus* were isolated from the electrode-associated biomass.
2. **Y. Jangir**, S. French, L.M. Momper, D.P. Moser, J.P. Amend and M.Y. El-Naggar. *Isolation and Characterization of Electrochemically Active Subsurface Delftia and Azonexus Species*, (Frontiers in Microbiology, 2016)
   Geological Site: Nevares Deep Well 2 (Death Valley, USA)
   Electrochemical enrichment of microorganisms from a deep fractured-rock aquifer on electrodes poised at electron accepting potentials. Representatives of the dominant families *Comamonadaceae* and *Rhodocyclaceae*, *Delftia* sp. WE1-13 and *Azonexus* sp. WE2-4, were isolated from the electrode-associated biomass. The extracellular electron transfer (EET) abilities of the isolated strains was confirmed. These observations suggested that additional hidden interactions with external electron acceptors were also possible in these strains.
3. S. Xu, **Y. Jangir** and M. Y. El-Naggar. *Disentangling the roles of free and cytochrome-bound flavins in extracellular electron transport from Shewanella oneidensis MR-1*, (Electrochimica Acta, 2016)
   Identified differential EET interaction between *S. oneidensis* MR-1 with the poised electrodes based on the electrode material (carbon cloth vs. custom-made ITO-based electrodes). Showed flavins accelerate EET as cytochrome bound cofactors, rather than free soluble molecular shuttles. Custom-made ITO-patterned chips were fabricated using nanofabrication techniques.
4. S. Pirbadian, S. Barchinger, K.M. Leung, H.S. Byun, **Y. Jangir**, R.A. Bouhenni, S.B. Reed, M.F. Romine, D.A. Saffarini, L. Shi, Y.A. Gorby, J. H. Golbeck, and M.Y. El-Naggar. *Shewanella oneidensis MR-1 nanowires are outer membrane and periplasmic extensions of the extracellular electron transport components*, (PNAS, 2014)
   Studied light-induced electron transfer in *S. oneidensis* MR-1 using microbial fuel cells. *S. oneidensis* MR-1 was transformed to express GFP in the periplasmic (protein transportation via TAT-pathway) and cytoplasmic region. Bacterial nanowires of *S. oneidensis* MR-1 were shown to be periplasmic extensions.

Conference and Seminar Talks

2018 International Society for Microbial Electrochemistry and Technology (North-America) "Investigating Continental Deep Subsurface Biosphere with *in situ* Electrochemical Colonization." (Conference Talk)

2017 Astrobiology Science Conference (AbSciCon) "*In Situ* Electrochemical Enrichment of Subsurface Bacteria at the Sanford Underground Research Facility." (Conference Poster)

2016 Southern California Geobiology Symposium "Electrochemical Studies of Subsurface Microorganisms" (Conference Poster)

2016 University of Oxford, Begbroke Science Park "Electrochemical Studies of Subsurface Microorganisms" (Seminar Talk)

2016 University of East Anglia, Department of Chemistry "Electrochemical Studies of Subsurface Microorganisms" (Seminar Talk)

2015 Conference on Science at the Sanford Underground Research Facility "Laboratory and *In Situ* Cultivation of Subsurface Microorganisms" (Conference Talk)

2015 Astrobiology Science Conference (AbSciCon) "Laboratory and *In Situ* Cultivation of Subsurface Microorganisms" (Conference Talk)

2014 International Symposium on Subsurface Microbiology "Electrode Cultivation of Subsurface Microorganisms" (Conference Talk)

2014 NASA Executive Council Meeting at USC "Cultivation of Novel Deep Subsurface Microbes" (Invited Talk)

2014 Goldschmidt Conference "Electrode Cultivation of Subsurface Microorganisms" (Conference Talk)

2013 USC Trustee Conference "The Search for Intraterrestrial Life" (Public-Level Talk)

Awards and Recognition

2018 Received a travel grant by Center for Environmental Microbial Interactions (CEMI), CalTech, Pasadena, USA

2016 Received Teach for India Fellowship for 2016-2018, Pune, India (Waived)

2015 Women in Science and Education (WiSE) Merit Fellowship for Current Doctoral Students, USC, Los Angeles, USA

2013 Scholarship to attend the International Summer School in Astrobiology in Santander, Spain

2009 Received a Research Scholarship by National Institute of Material Sciences, Japan and National University of Singapore, Singapore (Waived)

2009 Indian Institute of Technology Graduate Aptitude Test in Engineering Rank 96 (India-wide)

2009 Junior Research Fellowship of the Council of Scientific and Industrial Research (CSIR), India

2007 Indian Institute of Technology, M.Sc. Joint Admissions Examination Rank 40 (India-wide)

2004–2007 Scholarship from the University Grants Commission (UGC), India

Summer Schools & Workshops

2017 AbSciCon Pre-conference School at Arizona State University (Arizona, USA)

2015 Bioinformatics workshop on MOTHUR by Patrick Schloss (Detroit, MI, USA)

2014 Summer course on "Microbial Diversity" at Marine Biological Laboratory (Woods Hole, MA, USA)

2013 International Astrobiology Summer School on "Biosignatures-The Fingerprints of Life" (Santander, Cantabria, Spain)

2012 New England Biolabs Molecular Biology Summer Workshops (Smith College, MA, USA)

2009 Summer Internship Program for Indian Students (National University of Singapore, Singapore)

2008 Plasma Physics Summer School (Institute for Plasma Research, India)

Press Coverage

Understanding electrochemically active microbes

2016 Life but not as we know it (BBC Focus)
https://issuu.com/min-mag/docs/bbc_focus_2016_10/44

2016 New life found that lives off electricity (Quanta Magazine)
https://www.quantamagazine.org/20160621-electron-eating-microbes-found-in-odd-places/

2014 Meet the electric life forms that live on pure energy (New Scientist)
https://scienceofsingularity.com/2014/07/29/meet-the-electric-life-forms-that-live-on-pure-energy/

2014 Suffocating cells for science (PBS)
http://www.pbs.org/newshour/updates/suffocating-cells-science/

Teaching Experience

2016-2017 *Demonstrator, Computing Lab, Department of Physics, University of Oxford, Oxford, UK*
Introduced first-year physics undergraduate students to programming languages: R and MATLAB. Prepared MATLAB study material during Michaelmas Term. Taught students troubleshooting methods for their programming assignments and maintained their grading records.

2015 *Mentor, Physics, University of Southern California, USA*
Mentored one undergraduate student and one high school student as part of the Student Opportunities for Academic Research, SOAR-USC, and the Young Research program, YRP-USC, respectively. Guided them to successfully carry out research-level interdisciplinary projects.

2012 *Lecture Support Laboratory Assistant, Physics, University of Southern California, USA*
Assisted in setting up physics lecture demonstration and audio/video equipment. Designed new demonstrations for undergraduate-level physics courses.

2010–2012 *Teaching Assistant, Physics, University of Southern California, USA*
Led 4 sections of 20 undergraduate students to carry out physics experiments. Responsible for designing the lab instructions, introducing major physical concepts, troubleshooting experiments with students, and grading the individual reports. Held regular office hours for students. Received good comments from the students in the lab sections (scores: $\sim$4/5).

Science Outreach

2016-2017 *Volunteer, Oxford University Museum of Natural History, Oxford, UK*
Led mineralogy activity within the 'Science Saturday' volunteer group at the Natural History Museum during Oxford term time. The activities were aimed to introduce the skills needed to examine and test naturally-occurring mineral specimens for various properties and further speculate their applications.

2015 *Volunteer, Iridescent Learning, Los Angeles, USA*
Led STEM education classes themed 'Natural Disasters' at a local elementary school (32nd Street School, Los Angeles, CA, USA). Prepared lesson plans which included outlining the main objectives and developing design challenges to teach basic science/engineering concepts. Managed school authorities, engaged with the families, provided an introduction lecture and finally helped kids with the design challenges.

2015 *STEM talk, Lead Deadwood High School, South Dakota, USA*
Introduced high school students to microbe-mineral interaction research being performed at the Sanford Underground Research Facility.

2013 *California State Science Fair Judge, Los Angeles, USA*
Judged the junior material science category projects (grades 6-8).

Technical Experience

- *Field Work*: Aqueous chemistry, microbiological sampling, *in situ* reactor deployment.
- *Electrochemistry*: Galvanostatic/potentiostatic and pulse voltammetric techniques, fuel cell devices.
- *Analytical methods*: Titrations, spectrophotometry, chromatography (ion exchange, HPLC).
- *Cellular Biology*: Cell culture media design, bacterial bioreactors, anaerobic culturing, liquid and solid culture of bacteria for isolation and transformation.
- *Microscopy*: Fluorescence, optical and electron microscopy. Familiar with atomic force and scanning tunneling microscope.
- *Molecular Biology*: Nucleic acid extraction, primer design, reverse transcription, PCR, gel-analysis, building clone libraries.
- *Bioinformatics*: Next-generation sequencing and data processing using MOTHUR and QIIME.
- *Nanofabrication*: UV lithography, etching and sputtering.
- *Computer*: Microsoft Windows and Linux (Ubuntu), R, Python, Matlab.