

2025 CEMI NEWSLETTER

What is CEMI?

The **Center for Environmental Microbial Interactions** was founded in 2012 as a faculty-led effort to support researchers interested in microbial science and to foster a collaborative community across campus. Now over 400 members strong, CEMI's mission is to enable Caltech researchers to tackle important problems involving microbes in bold and innovative ways.

Victoria Orphan has served as the director of CEMI since 2020. She is the James Irvine professor of Environmental Science and



Geobiology and the V.C. Allen and Lenabelle Davis Leadership Chair. Dr. Orphan is passionate about microbial metabolic interactions and their role in the biogeochemical cycling of carbon and nutrients in ocean ecosystems. Her laboratory studies a wide range of environments and the microbes that inhabit them, from methane-rich chemosynthetic ecosystems in the deep ocean to coastal seagrass beds.

SAVE THE DATE! 🎉

The Annual CEMI Symposium & Gala will be held on **April 2nd, 2026**.

Mark your calendars for an exciting day of science, celebration, and community!

Mark your calendars! 🚀

Training/Travel Grants – Applications Open Now!

CEMI supports Caltech students and postdocs by offering travel grants for conferences and summer training courses, as well as training grants for facilities training. These grants help you expand your skills and share your research. Submit your application by **December 19th, 2025**.

Don't miss CEMInar!

Join us every second Wednesday of the month from **4-5 PM in Chen 130** for two engaging 30-minute talks from different CEMI labs. After the talks, stick around for snacks and drinks – the perfect time to chat and connect with the CEMI community! CEMInar will resume January 14th, 2026!

2024 Caldwell Fellow: Jarek Kwiecinski



Soil bacteria play a critical role in agriculture by defending crops from pathogens and promoting their growth. Despite this, we know very little about how bacteria cope with desiccation, an important stress especially in dryland ecosystems that are home to ~2 billion people. Many pathogens are also highly

desiccation tolerant, allowing them to persist on medical devices and hospital surfaces. By understanding how bacteria survive and recover from this stress, we can develop new strategies to either aid or hinder microbial activity in dry environments.

In addition to losing water, bacteria also lose access to nutrients under dry conditions because nutrients must move through liquid pathways to reach cells. In salty liquid cultures, bacteria retain water by accumulating small molecules known as osmolytes, but is this resource intensive approach possible when drying causes starvation? I found that starvation actually makes bacteria more resistant to water stress, and that going dormant may be a better survival strategy than any attempt to actively retain water. I am currently working to characterize the physical properties of desiccating bacteria to understand how dormancy protects cells. Bacteria survive many stresses, including antibiotic treatment, by going dormant, so understanding how dormancy works has broad applications.

Meet the 1st Year Graduate Student Fellows of CEMI!

Say hello to the newest members of the CEMI family! We're so excited to have them on board!

Rogelio Avila Silva (BBE)

Rogelio is a PhD student in Biology who began working in microbial, environmental, and sustainability-focused research in Professor Newman's laboratory prior to starting my graduate program. During that time, he developed a strong interest in the ways microbial life can help address the climate crisis and contribute to a more sustainable society. Now, as he begins his PhD, his research focuses on the rhizosphere and agricultural systems, allowing him to take full advantage of the opportunities offered by CEMI at Caltech and to pursue a range of enriching scientific experiences.



Stella Baldwin (GPS)

Stella enjoys researching molecular mechanisms behind microbial symbiosis. In 2023, Stella was a summer Caltech WAVE Fellow in the Orphan lab visualizing the ecological lineages of anaerobic methanotrophic archaea (ANME) using fluorescence in-situ hybridization (FISH) techniques. In 2024, Stella was a summer Caltech Amgen Scholar in the McFall-Ngai lab analyzing nuclear proteomes concerning a symbiosis between the Hawaiian bobtail squid and *Vibrio fischeri*. After graduating from the University of Southern California (USC) with a B.S. in Geological Sciences in December 2024, she again joined the McFall-Ngai group and Carnegie Science as a technician. As a Geobiology Ph.D. student, Stella will be rotating with the Orphan and Newman groups, and she hopes to keep pursuing the intersections within environmental microbiology.



Olivia Ettlin (BBE)

Olivia hopes to study the relationships between microorganisms and their environments during her time as a Biology PhD student. She graduated from UCLA and earned her B.S. in Molecular, Cell, and Developmental Biology. After graduating, she interned with Heal the Bay, where she reviewed Marine Protected Area community science surveys; and with TreePeople, where she worked both in the nursery and on wilderness planting projects; all while employed by California State Parks where she helped visitors interact with nature in a responsible and sustainable way. Most recently, she's worked at Caltech as a lab technician in the Guttman Lab where she developed a novel method for single-cell RNA sequencing technology. Her detailed understanding of cellular processes and passion for field work makes her a strong scientist with a deep appreciation for research across both laboratory and natural environments.



Eli Grossman (BBE)

Prior to joining Caltech, Eli studied the elk gut microbiome and its role in migratory behavior for his undergraduate thesis work under the supervision of Tyler Kartzinel and Bethan Littleford-Colquehoun. During the summers and after graduating, he spent four seasons working as a wildland firefighter and fire effects monitor for the US Forest Service and National Park Service. Rotating with the Karthikeyan and Orphan groups, he hopes to pursue research at the intersection of microbial, soil, and fire ecology.



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Jenna Houle (BBE)

Jenna is a PhD student in biology excited about microbiome engineering for human health enhancement. As a rotation student in the Ismagilov Lab, she is developing biochemical and computational approaches to enable improved RNA sequencing of complex microbial communities. Before coming to Caltech, Jenna earned a B.S. in biological engineering and materials science and engineering from MIT. While at MIT she conducted research in several disciplines, most recently immune and cell engineering as a member of the Birnbaum Lab.



Yujia Huang (BBE)

Attracted by its interdisciplinary nature, Yujia joined Caltech and is excited to further explore microbial physiology at CEMI! Her research interests include regulatory processes at both the genetic level and within coordinated microbial communities. Through her PhD, Yujia hopes to develop and implement new methods to uncover fundamental principles that allow microbes to survive and thrive, and to apply these insights toward environmental and health applications.



Ezekiel Johnson (BBE)

Ezekiel is fascinated by biological systems and is pursuing graduate study to continue analyzing and engineering complex microbial communities using systematic, genetic, and computational tools. With the support of CEMI, he aims to push the boundaries of microbial ecosystem research through innovative and interdisciplinary approaches, with the long-term goal of addressing pressing environmental and human health challenges.



Emma Khorunzhy (CCE)

Emma Khorunzhy is a first-year PhD student studying Chemical Engineering with interests in plant-soil interactions and microbial electrochemical systems. During her undergraduate studies, her research focused on exploring new approaches to biosecurity testing in small-scale mesocosms, efficient nanofertilizer delivery in agriculture, and algal cultivation and transformation. She is currently completing rotations and has not yet decided on a lab.



Congratulations to the 2025 Pilot Grant Recipients!

A big shoutout to the recipients of the 2025 CEMI Pilot Grant Award! 🎉

PI	Student/ Postdoc leads	Project Title
Frances Arnold	Ethan Quinn	Combining machine learning and directed evolution to engineer enzymes for biodegradation of plastic additives
Pamela Bjorkman	Chengcheng Fan	Molecular Recognition Mechanisms of a pH-dependent viral Fc receptor
Bil Clemons	Angham Ahmed	MS2 and Φ X174 particles as programmable genetic delivery system
Sujit Datta and Dianne Newman	Eloise Masquelier	Physicochemical properties of the extracellular matrix tune the fate and transport of phenazines that shape microbial communities
Smruthi Karthikeyan and Niles Pierce	Sarah Garzione	Developing an integrated framework to infer and validate host-MGE associations in complex microbiomes
Sarkis Mazmanian	Yi-Ting Cheng	Effects of stress on gut physiology and the microbiome
Margaret McFall-Ngai and Ned Ruby	Xiao-Meng Hu	The effect of RNA modification in OMV-delivered small RNAs during vibrio-squid immunity and symbiosis
Victoria Orphan, Katherine Faber, Sujit Datta, and Smruthi Karthikeyan	Justus Fink, Wes Patel, Pablo Bravo, Tristan Caro, and Eli Grossman	Freeze-cast Cryolite: A tunable transparent soil matrix for investigations of microbial colonization and activity in situ
Joe Parker and Smruthi Karthikeyan	Esther Okamoto	Function of a Rickettsia endosymbiont in a social symbiosis
Rob Phillips	Kian Faizi	Nutrient colimitation: the next frontier of quantitative microbiology
Rob Phillips	Rosalind Pan	Biophysical mapping of antibiotic resistance regulatory sequences to fitness landscapes
Paul Sternberg	James Tan	The role of lysosome-related organelles in the symbiotic relationship of the entomopathogenic nematode <i>Steinernema hermaphroditum</i> and bacteria <i>Xenorhabdus griffiniae</i>

Looking Back: Reflections from 2024 Pilot Grant Recipients

We caught up with some of our 2024 Pilot Grant Recipients to hear how CEMI's support has galvanized their research adventures over the past year! ✨

Reinaldo Alcalde (Newman Lab) We recently completed construction and are undergoing performance calibration of the RhizoLightSheet, a custom light-sheet fluorescence microscope optimized for imaging live of plant roots in soil-like environments. The system provides precise 4D positioning (x, y, z, rotation), captures both green and red fluorescence signals with dual 488/561 nm excitation, and includes an LED-based brightfield path, an in-house graphical user interface, and interchangeable sample chambers to accommodate larger, optically challenging samples that are incompatible with most commercial light-sheet platforms. We are now running pilot experiments on *Brachypodium* roots colonized by *Pseudomonas synxantha* and are excited to use this capability to map microbial localization and gene expression along roots in synthetic and transparent soils. This is a collaboration between Oumeng Zhang, Zhenyu Dong, and Reinaldo Alcalde, with PIs Changhui Yang and Dianne Newman and is supported by an Ideation Grant from the Resnick Sustainability Institute, Linde Center Discovery Funds, and a 2024 Pilot Grant from CEMI.



Zahra Shivji (Karthikeyan Lab) As a second-year graduate student, the CEMI pilot grant propelled me towards generating my first major results aimed at characterizing the breadth of diversity of nitrogen-fixing organisms, or diazotrophs. Using the enzyme nitrogenase, diazotrophs are the only organisms responsible for biological nitrogen fixation. Because of this enzyme's unique ability, nitrogenase is actively being explored for sustainable ammonia production via bioelectrocatalysis or as a biological crop amendment. However, engineering nitrogenase for commercial use presents additional challenges: its low thermostability, tight regulatory control, and bulky gene set make it challenging to deploy outside native hosts. My work addresses these challenges by systematically characterizing divergent nitrogenases, particularly those recovered from environmental metagenomic datasets. This effort represents the most extensive annotation of nitrogenase to date, identifying six times more variants (~6,000 nitrogenase operons, nifHDKEN) compared to conventional approaches. These results will soon be released in a publicly available database (DiazoDB) to support the broader scientific community. Furthermore, funding from CEMI enabled me to present my work at the Applied and Environmental Microbiology Gordon Research Conference, where I received valuable feedback from leading scientists in the field. Early career support from CEMI and the Caltech microbiology community has been instrumental in helping me to gain the necessary skills to continue to pursue impactful research, and for that, I am deeply grateful!



Got questions, comments, corrections, or suggestions? Contact Esther (okamoto@caltech.edu), Jordan (jchastain@caltech.edu), Kemal (kdemirer@caltech.edu), or Yurina (ytakahag@caltech.edu) For questions about grants or events, contact Kristy Nguyen at kristyn@caltech.edu! Explore more about CEMI at <https://microbiology.caltech.edu>.



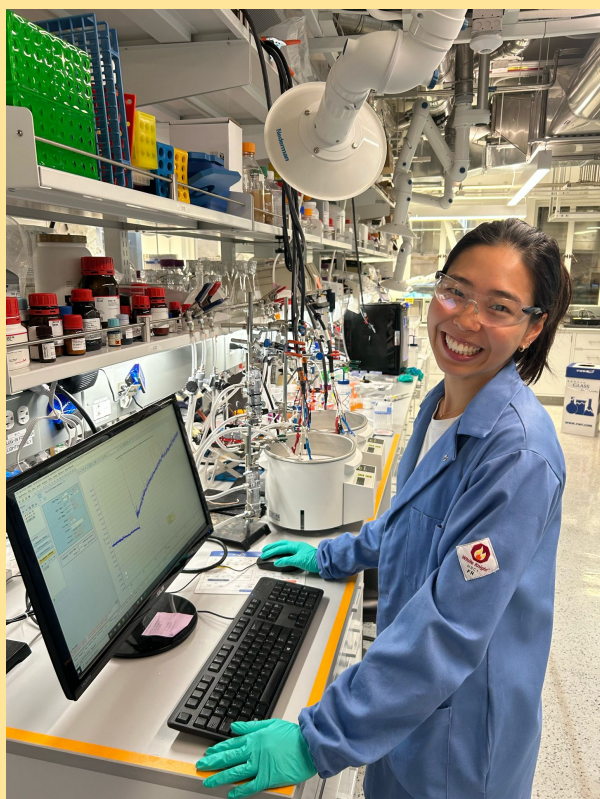
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Calvin Rusley (Fischer Lab) With support from the CEMI pilot grant, we designed, tested, and distributed a modular python package we've named PEAPOD (Protein Embedding Aligner Plus Output Display). PEAPOD is designed to accommodate per-residue protein embeddings from any Protein Language Model (PLM) to align pairs of sequences using a broad and extensible set of algorithms, including novel implementations of principles from legacy alignment tools. Because PLM embeddings incorporate contextual information, PEAPOD alignments perform comparably to structure-based alignment methods, without the need for costly structure prediction. We've leveraged these advancements to study the evolution of chlorophyll-based phototrophy, and found that PEAPOD is capable of identifying theoretical homodimeric ancestors of Photosystem II.



Clara Seo (Manthiram Lab) Bioelectrochemical technologies merge microbial metabolism with electrochemical systems to sustainably generate energy and produce valuable chemicals. However, sluggish rates of extracellular electron transfer remain a major bottleneck, limiting the current densities these systems can achieve. Our project is tackling this challenge using a directed-evolution strategy to enhance biological electron-transfer performance. With support from the CEMI pilot grant, we have been able to conceptualize, prototype, and iterate a high-throughput bioelectrochemical platform. This platform will not only accelerate mutant screening for our current work, but also open doors to a wide range of future bioelectrochemical research directions. I am grateful to CEMI for enabling this highly interdisciplinary pursuit—bringing together microbial metabolism, electrochemistry, and high-throughput engineering. Through monthly CEMInars and annual poster sessions, I've had the chance to meet wonderful peers outside my lab and PhD program. It's been intellectually energizing to learn about projects far beyond my own field and to gain an even greater appreciation for the microbial world. Being part of the CEMI community has been a highlight of my PhD experience, and I look forward to crossing paths with more of you soon!



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Highlights of CEMI-Affiliated Activities This Year

We look back on this year's CEMI activities through photos and look ahead with renewed motivation for the year to come!

American Society of Microbiology 2025

ASM Microbe 2025 was held at the Los Angeles Convention Center from June 19 to 23, and many members of the CEMI community actively presented their ongoing research. CEMI travel grants supported students and postdoctoral researchers, enabling them to engage with experts from around the world and expand their professional networks. We look forward to ASM Microbe 2026, taking place June 4–7, 2026, in Washington, D.C.—please save the date!



5 out of 10 participants from Orphan Lab were funded by CEMI travel grant

Orphan lab hallway art

The Orphan Lab now features new hallway art inspired by methane seeps and anaerobic methane oxidizing archaea, created by Lily Simonson, who participated as the onboard artist during an Orphan Lab Alvin cruise to methane seeps in Costa Rica. Come visit the South Mudd subbasement —no sunlight, deep-sea vibes guaranteed! (Artist website: <https://lilysimonson.com/>)



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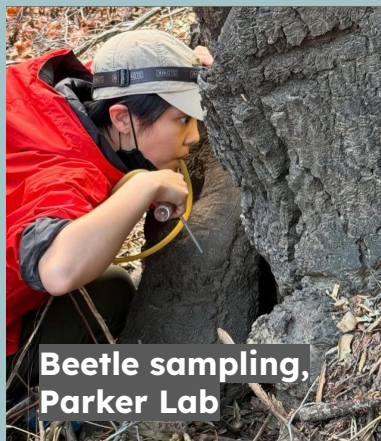


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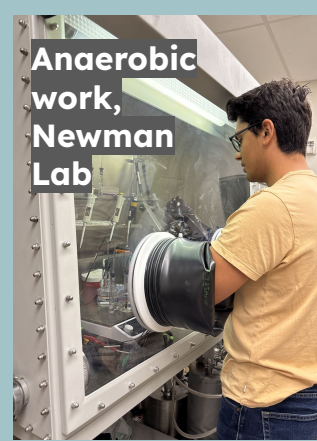
Photo gallery



Beetle sampling,
Parker Lab



Watson Lecture, Karthikeyan Lab



Anaerobic
work,
Newman
Lab

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