

# 2024 CEMI NEWSLETTER

## What is CEMI?

The "**Center for Environmental Microbial Interactions**" was launched in 2012. Initially led by Dianne Newman, CEMI was created as a place where researchers interested in microbial science from across Caltech could gather and collaborate. CEMI's mission is to enable Caltech researchers to tackle important problems involving microbes in bold and innovative ways.

Victoria Orphan took over as director of CEMI in 2020. Dr. Orphan is the James Irvine professor of Environmental



Science and Geobiology and the Allen V. C. and Lenabelle Davis Leadership Chair. She is passionate about the microbial symbioses and methane cycling in the deep ocean. Her lab studies a wide range of unique environments and the microbes that inhabit them, from chemosynthetic ecosystems on the ocean floor, to seagrass beds in Newport bay.

## SAVE THE DATE! 🎉

The **Annual CEMI Symposium & Gala** will be held on **February 28<sup>th</sup>, 2025**.

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, summer training courses, and facilities training. These grants help you expand your skills and share your research. Submit your application by **December 20<sup>th</sup>, 2024**.

### Don't miss CEMinar!

Join us every second Wednesday of the month from **4-5 PM at 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 8<sup>th</sup>, 2025.

## 2023 Caldwell Fellow: Hannah Way

Hannah received her Bachelor of Science in Microbiology from the University of California Riverside in 2019 and joined the Geobiology option at Caltech in fall of 2020. As a member of the Leadbetter lab, Hannah uses microbiological culturing techniques, microscopic imaging and



genetic analysis to explore the complex metabolism and physiology utilized by a unique family of chemolitho-autotrophic manganese oxidizing microbes. She strongly believes in the importance of sustainability and is also investigating the metal adsorptive capacity of these bio-oxides to better understand their role in groundwater environments and potential for application in simple filtration systems. Additionally, Hannah is passionate about sharing her love of science with others and frequently volunteers with outreach efforts on campus and in the community. She is the current treasurer of Womxn in Geosciences (WinG) as well as the current president of the Caltech Turtle Club. When she isn't in lab, Hannah can often be found at the turtle pond sharing fun facts about all the animals there or reading in one of the many beautiful libraries on campus. When not on campus, Hannah enjoys creating art or spending time with her bearded dragon Calcifer.

# Meet the 1st Year Graduate Student Fellows of CEMI!

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

## Jordan Chastain (GPS)

I became interested in microbiology through its applications to life detection and planetary habitability. I spent three years of my undergraduate degree researching algal-bacterial symbioses in soils, learning a wide variety of microbiology skills along the way and developing my interest in this field. Now, I have started my PhD to investigate how we might detect past or present life on other planets or moons, likely through studying microbes in extreme environments on Earth and developing new detection techniques to use elsewhere in the solar system.



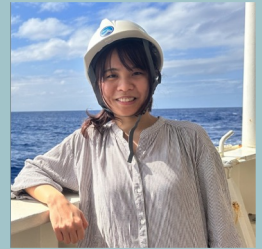
## Kemal Demirer (BBE)

I came to Caltech due to the unique and interdisciplinary ways I could study microbes, and I am grateful to be part of a community that supports that vision. I am broadly interested in studying microbial physiology from diverse perspectives and hope to address environmental and health-related challenges by engineering and implementing microbial solutions.



## Yurina Hashimoto (GPS)

I am fascinated by the co-evolution of microbial energy metabolism and geochemical processes in marine chemosynthetic ecosystems, such as deep-sea hydrothermal vents and methane seeps. For my PhD, I am focusing on unraveling the syntrophic mechanisms within microbial communities involved in anaerobic methane oxidation.



## Diane Kang (CCE)

At Caltech, I hope to continue to push the forefront of our understanding of bacterial resistance mechanisms and devising novel strategies to address antimicrobial resistance. Along this line of work, during my first rotation at Caltech in Professor Bil Clemons' lab, I characterized putative single-gene lysis proteins derived from single-stranded RNA phage found in the environment. I envision that single-gene lysis proteins can provide an alternative to small molecule drugs in combating bacterial infections, adding to the arsenal of antibacterial therapies.



## Esther Okamoto (BBE)

I'm interested in insect-microbe symbiosis, particularly how microbial interactions influence host behavior. My research interests also include microbial ecology, population genomics, and using tools like ArcGIS for mapping and spatial analysis. I'm excited to explore these topics further through my time at CEMI and Caltech.



## Pat Simpson (BBE)

Before starting my PhD at Caltech, I worked as a research technician in Sarkis Mazmanian's lab, where I investigated the microbiome's role in health and disease. There, I gained insight into the crucial crosstalk between the immune system and the microbes that colonize the gut. This experience deepened my interest in harnessing microbial engineering to drive adaptive phenotypes in the host. At Caltech, I aim to engineer a synthetic microbe that addresses a pressing challenge in either medicine or climate change, depending on the lab I join.



# Introducing Our 2024 Pilot Grant Recipients!

*Congratulations to the recipients of this year's pilot grants!* 🎉

PI	Student	Project Title
Arnold	Ariane Mora	Mining microbial genomes to unlock new routes to biodegradation of persistent organic pollutants
Demirer	Catherine Griffin	Examining plant root – microbial biofilm interactions at high magnification
Elowitz	Matt Kratz	Recreating synthetic microbial phase variation to engineer and probe microbial communities
Fischer	Calvin Rusley	Exploring the twilight zone of prokaryotic protein homology using protein language models
Hay	Thomas Adamo-Schmidt	Exploring environmental virulence gene removal using a 'non-transgenic' plasmid curing strategy
Karthikeyan	Sal Ibarra	Synthetic cell-based biosensors for monitoring plant-microbiome communication in soil
Karthikeyan	Zahra Shivji	Deepening understanding of nitrogenase diversity to enable cell-free nitrogen fixation
Manthiram	Clara Seo	A high-throughput workout: directing evolution to train cytochromes for enhanced electron transfer
Mazmanian	Danny Dumitrescu	Deciphering neuroactive microbial metabolites via chemical metabolomics
Ruby	Viridiana Avila-Magana	Symbionts under epigenetic control: impact on the early development of host-microbe association
Murray	Han Zhang	Cell-free synthesis of phage particles for large DNA delivery
Newman	Reinaldo Alcalde	Light sheet fluorescence microscope for rhizosphere imaging
Orphan	Magdalena Mayr	Protein turnover of anaerobic methane-oxidizing communities in carbonate rocks using SIP-metaproteomics
Orphan	Alex Ramirez	A submersible holographic microscope for deep sea, in-situ, environmental microbiology
Pierce	Eric Lei	Conditional guide RNAs for cell-selective readout and regulation within bacteria and microbiomes
Stoltz	Jonathan Farhi	Evaluation of pyrroloiminoquinone alkaloid cytotoxicity in opportunistic pathogens
Wang	Daniel Graves	Basewise correction of synthetic DNA
Wang & Mazmanian	Charles Sanfiorenzo	A new paradigm for streamlined gut microbiome engineering
Wei	Rahuljeet Chadha	Development of a micro-Raman platform for live-cell sorting for integrated multi-omics of gut microbiota

*We hope CEMI's support provides the resources needed to get your projects off the ground. The CEMI steering committee was very excited by these innovative pilot projects, and we look forward to hearing about your progress in the coming year.*

# Looking Back: Reflections from 2023 Pilot Grant Recipients

We caught up with some of our 2023 Pilot Grant recipients to hear how CEMI's support has galvanized their research adventures over the past year! ✨



**Chiara Berruto (Demirer group)** The CEMI pilot grant has helped us collect preliminary data to test our hypothesis that rhizosphere engineering can be accomplished through the manipulation of soil carbon niches. Using the CEMI pilot grant we bought a plate reader which has facilitated our investigation of carbon substrate utilization patterns for multiple plant-growth promoting rhizobacteria (PGPR). This has resulted in the identification of selective carbon sources that when added to soil, enrich for the desired PGPR. These selective carbon sources may act as soil prebiotic molecules that can be applied to support the persistence of biofertilizers. Additionally, we are working towards engineering root exudates of model plant species to include these selective carbon sources. We suspect this may promote tighter plant-microbe associations compared to exogenous application, providing a route towards rhizosphere engineering.

**Josh Chen (Shapiro group)** I'm a postdoc in the Shapiro Lab at Caltech, working closely with the Manthiram Lab. This past year has been a whirlwind, especially just coming out of my PhD and moving into a new field. I work on engineering electrogenic bacteria as biosensors for health applications. It's fascinating that these microorganisms are capable of interacting with the environment using electrons, which are fundamental particles involved with many biophysical phenomena. Through the CEMI grant, I've gathered some exciting preliminary data that's setting up the stage for the future. Using these data, I hope to apply for awards that will enable my independent career. I've even met amazing collaborators at other schools like USC who have become interested in my work. Now, we are expanding the scope of the project to include even more interdisciplinary science with electrical engineers by coupling these bacteria with portable electron paramagnetic resonance imagers. I am incredibly grateful that CEMI has enabled my intellectual freedom at Caltech to pursue my independent ideas. It's great there's a community of like-minded researchers at Caltech working on exciting microbial problems, and I hope to meet more of you soon!



**Yan Zhang (Murray group)** The rising challenge of antibiotic resistance has renewed interest in phage therapy, which uses bacterial viruses (phages) to treat infections precisely while sparing the beneficial microbes. Our project aims to take phage production outside living cells and into "cell-free" expression systems. At the end of this project, we strive to establish cell-free expression as a generalized platform to produce phages against diverse microbes. We successfully expressed *E. coli* bacteriophages MS2 and PhiX174 *in vitro* cell-free reactions supplemented with bacteriophage genomes. The cell-free reaction product effectively infected and lysed the *E. coli* host. Our next steps are to express phage genomes further in evolutionary distance from *E. coli* in an *E. coli*-based cell-free expression system. This enables us to start producing biomedically relevant phages without requiring the biomedically relevant host. We believe the cell-free technology developed through this project aligns closely with the interests and mission of CEMI. The interdisciplinary CEMI community has been the source of inspiration! The CEMInar series and the poster sessions have helped foster many inspiring discussions and potential synergies.

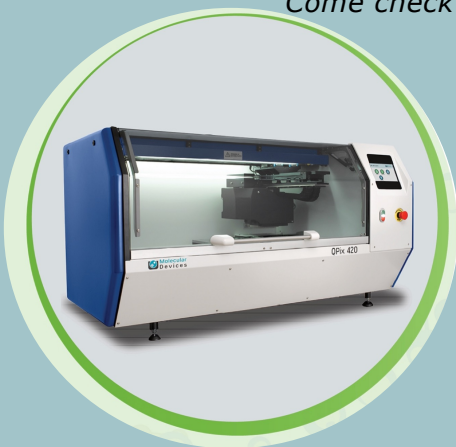


**Natalie Wu-Woods (Ismagilov group)** Our project focuses on investigating the role of microbial contributors to Parkinson's Disease (PD) in a collaboration between Dr. Rustem Ismagilov and Dr. Sarkis Mazmanian. With Dr. Matheus De Castro Fonseca, a postdoc in the Mazmanian lab, we found distinct microbial communities present at various ages in healthy mice. However, in PD mice the microbial aging process appears to be accelerated (with the microbiomes of 5-month PD mice mirroring those of 12-month WT mice). We are now exploring how to modify the microbiome to prevent PD degeneration through microbial replacement therapy and studying which bacterial strains induce symptom remission. It has been a rewarding experience working with Dr. Mazmanian and Dr. Fonseca and I am grateful for CEMI's support in formalizing this collaboration. Anna Romano, a research scientist in the Ismagilov lab, has developed automation infrastructure and protocols for higher-throughput sample handling for subsequent studies. We have also started studying microbial variation along the mouse gut to uncover site-specific microbial effects on disease progression.



## Coming Soon to the RSC: QPix420 Colony Picker!

Come check it out in the Solar Science and Catalysis Center! 🚗



Thanks to the Manthiram lab, the Solar Science and Catalysis Center (SSCC) at the Resnick Sustainability Center (RSC) is now home to a Molecular Devices QPix420 microbial colony picker! This state-of-the-art tool automates colony detection, picking, and fluorescent imaging, making microbial workflows faster and more efficient. The QPix420 will soon (by March 2025!) be available for use by all members of the CEMI community. Stay tuned for details on training sessions and how to access this exciting new resource!

For more information, reach out to Clara (QPix420 point-of-contact, [cseo@caltech.edu](mailto:cseo@caltech.edu)) and Karthish (Director of Solar Science and Catalysis Center, [karthish@caltech.edu](mailto:karthish@caltech.edu)).

## CEMI Spotlight: Rosalind Pan (G3 BBE)

As someone who is passionate about both science and art, I've always been drawn to the ways they intersect. Both are driven by a desire to explore, to notice the details, and to seek a deeper understanding of the world around us. These paintings are a reflection of an attempt to capture the wonder and excitement that comes from looking closer, thinking deeper, and discovering something new. You can find more of my paintings on Instagram at @rosalind\_paints.



"beyond the empty space"



"the dance of matter"



"not all the stars are silent"

Got questions, comments or suggestions? Contact Clara Seo ([cseo@caltech.edu](mailto:cseo@caltech.edu)), Doran Sekaran ([dsekaran@caltech.edu](mailto:dsekaran@caltech.edu)), or Olive Cheng ([olive.cheng@caltech.edu](mailto:olive.cheng@caltech.edu)).

For questions about grants or events, contact Kristy Nguyen ([kristyn@caltech.edu](mailto:kristyn@caltech.edu)).

Explore more about CEMI at <https://microbiology.caltech.edu!>

