Impact Report
Biodesign Swette Center for Environmental Biotechnology

Members of the Torres Lab enjoying some paletas at the “Abriendo Puertas” Block Party organized by the Hispanic Research Center at ASU. From left to right: Zia Ullah, Soham Sanghvi, Dr. Jesús Pérez-García, Atul Ojha, Dr. Christine Lewis, Amelia Bryan, and Dr. Fausto Ortiz-Medina.

Sparky and Bruce Rittmann at the beginning of the Biodesign 20-Year Anniversary celebrations in January 2024.

Research Scientist Yen-Jung (Sean) Lai mentors many graduate students and postdocs, including PhD student Asma Sattar and Visiting PhD student Ting Li.

January - December 2024
Strategic Investment - Annual Impact Report

Using the building blocks of Nature's grand designs, our talented researchers are pushing the frontiers of knowledge and advancing research and discovery to make major impacts on improving the sustainability of our community, nation, and World.

Introduction

We are most grateful for the generous support and confidence that the Swette family has provided. The Swette Strategic Investment Fund supports the Biodesign Swette Center for Environmental Biotechnology (aka, Swette Center or BSCEB) as its researchers develop preliminary results, publish seminal papers, give talks across the world to eager audiences, and have time to seek funding for new projects. We have attracted outstanding researchers whose talents, energy, and inspiration are leading to new science discoveries and new technologies. The Swette's support greatly amplifies our achievements and their impacts.

This Impact Report documents the many activities and achievements within BSCEB for 2024, including researcher activities, awards received, degrees granted, papers published, grants awarded, and service rendered. Beyond summarizing our success in 2024, this impact report illuminates why BSCEB expects to attain even greater impacts in 2025 and beyond.

The Swette Strategic Investment Fund is advancing our ability to create new solutions to improve the sustainability of society.

Executive Summary

The Swette funds are catalyzing our efforts to perform high-impact research and obtain major research funding from multiple sources, both of which enhance the sustainability of our society. For example, BSCEB researchers are leaders in four NSF-supported centers: SouthWest Sustainability Innovation Engine (SWSIE), Science and Technology for Enhancing Sustainable Phosphorus (STEPS), Nano-Enabled Water Technology (NEWT), and the Center for Bioinspired and Bio-mediated Geotechnics (CBBG). Major funding in 2024 also came from the Department of Energy, Department of Defense, the National Science Foundation outside the centers, the State of Arizona, and several industry partners.

Here are three examples of projects that have gained success due to the Swette funding:

First, we are expanding our work with membrane-film reactors to bioremediate waters contaminated with per- and poly-fluorinated alkanoic substances (PFAS). Our hybrid systems integrate nanoparticle catalysis and biodegradation to create a practical means to detoxify the so-called “forever” contaminants. This area now has major research support from the Department of Defense, the NSF, and private industry.

Second, Swette researchers are at the leading edge of the exciting area of valorizing CO_2 and CO through microbial biotransformation that produces valuable organic products. The microbial systems include ones that utilize bacteria that employ photosynthesis, electrochemistry, fermentation, and chain elongation.

Third, we are active in developing novel anaerobic technology to recover renewable energy and nutrients from high-strength organic wastewaters, such as from dairy farms, confined animal feeding operations, food processing, and food waste. Recovering renewable energy and nutrients, protects environmental quality, advances “circular economies,” and makes pollution abatement a “profit center” that encourages industries and municipalities to take positive steps towards better sustainability.

Center Mission

The Biodesign Swette Center for Environmental Biotechnology manages microbial communities that provide services to society. Most of the services make our society more environmentally sustainable, for example, by generating renewable energy, valorizing CO_2, and making polluted water and soil clean. The microbial services make humans healthier – directly and indirectly.

Our researchers apply the most advanced tools of molecular microbial ecology, chemistry, microscopy and mathematical modeling to think like the microorganisms and, in turn, create systems that allow the microorganisms to provide beneficial services ranging from sustainable environmental processes, to nutrient and energy recovery, to making humans healthier.

We are known for our culture of cross-disciplinary and team-based research. This culture begins with our diverse set of researchers, who come from many disciplines within engineering, life sciences, chemistry, and more. The researchers also come from many parts of the United States and abroad. Partnerships are common within the different research groups in the Center, as well as with other groups in ASU, national and international universities, and practitioners.

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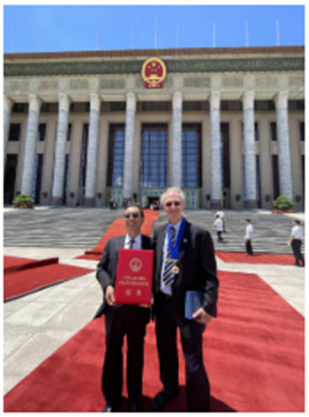
HIGHLIGHTS

Welcome, Kassandra Kellenberger! Summer of 2024 brought our Center a new Research Laboratory Coordinator Sr. to help us with our safety compliance across the board: lab inspections, Institutional Review Board reviews, Institutional Biosafety Committee protocols, and much more. Kassandra, an alumna of ASU, graduated with a Bachelor's of Science in Molecular Biology while working at an ASU lab managing educational lab spaces for 2 years. She has 5 years' experience as a Lab Technician Senior at Estrella Mountain Community College.

Rittmann Wins SciTech Cooperation Award. Dr. Bruce Rittmann won the International Science and Technology Cooperation Award of the People's Republic of China. He was presented the award at the National Science and Technology Awards Conference of the People's Republic of China on June 24, 2024, in Beijing. Pictured with Dr. Rittmann in the bottom right photo is Professor Siqing Xian from Tongji University, who nominated him. Congratulations, Dr. Rittmann!



Cadillo Interviewed about Phoenix Methane Leaks. Dr. Hinsby Cadillo Quiroz provided extensive analysis and feedback about what the City of Phoenix could do to ascertain the extent of methane leaking from underground repositories and treat them.
Meiners, J., Seely, T. (2024, February 16). Phoenix touts climate awareness, but hasn't addressed methane levels at city-owned site. *The Arizona Republic*. LINK

BSCEB Students Travel to Tongji University. Riley Berg and Hannah Collins were two of seven students nationwide selected to represent Arizona State University at the 2024 Environmental Science & Engineering Summer School at Tongji University in Shanghai, China from August 15, 2024 to August 21, 2024.

Participants of the 2024 Tongji University Environmental Science & Engineering Summer School program pose with a sign welcoming new students to the university's College of Environmental Science and Engineering. The Ira A. Fulton Schools of Engineering at

Arizona State University worked with Tongji University in Shanghai, China to create a new global experience to foster collaboration and the exchange of ideas about engineering solutions to common environmental challenges. Photo courtesy of Mackenzie Boyer. For more details, see this Arizona State University Full Circle post.

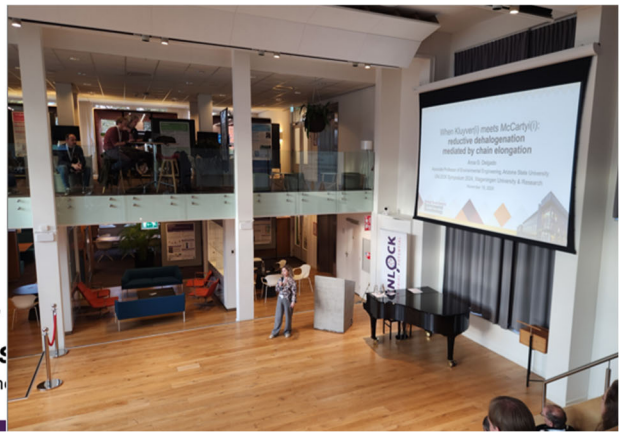
Anca Delgado & César Torres Sabbaticals. Professors Delgado and Torres took sabbatical leaves during Fall 2024 semester. They went to Wageningen University & Research in Wageningen, the Netherlands. Professor Delgado's project was focused on anaerobic biodegradation of plastics and chain elongation. She co-advised an MS student with her collaborator from Wageningen University, Professor David Strik. During her sabbatical, Professor Delgado also visited other European universities/research institutions in the Netherlands, Belgium, and Italy, and connected with many international leaders in environmental biotechnology. Professor Delgado gave the following presentations:

- Department seminars in Wageningen University & Research (Netherlands), Ghent University (Belgium), and UCLouvain (Belgium)
- Invited presentation at DehaloCon IV - Forth International Conference on Anaerobic Biological Dehalogenation & First Symposium on Remediation of Organohalide Contamination in Guangzhou, China
- Keynote presentation at Unlock Symposium, Wageningen University & Research (Netherlands)
- Research thrust presentation in the Engineering Center, CBBG, during the annual center meeting and NSF site visit in Atlanta, GA
- Investigator poster presentation at ASGSR (NASA conference) in San Juan, Puerto Rico

Prof. Torres had two projects at Wageningen University. The first one dealt with electroactivity of Annamox Bacteria , where he worked with researchers at Raboud University (Nijmegen, Netherlands), experts in Annamox growth, to develop an electrochemical reactor design to test these organisms. The second aimed to image pH gradients in electroactive bacteria using MRI techniques. He advised a Ph.D. student and an M.S. student in the group, related to these projects. As part of the sabbatical, leaders at Wageningen University organized a small conference of the International Society for Microbial Electrochemistry and Technologies (ISMET), where 15 professors across Europe visited and presented their latest research. Apart from these, Dr. Torres gave the following visits and presentations:

- VITO in Belgium (10/07) – Deepak Pant and Xochitl Dominguez
- Water Research Institute in Rome (10/25) – Federico Aulenta, Bruna Matturo, Simona Rosetti
- Sapienza University in Rome (10/28) – Marianna Villano
- WETSUS in Netherlands (10/31) – Project presentation with Philipp Kuntke
- Seelanol Plant in Arcelor Mittal (12/11) – Tour of facilities.
- Ghent University in Belgium (12/12) – Center seminar with Korneel Rabaey and Willy Verstraete.

Anca gave a plenary presentation on chain elongation research from our group and on her sabbatical project which involves characterization and isolation of chain-elongating and plastic fermenting microorganisms



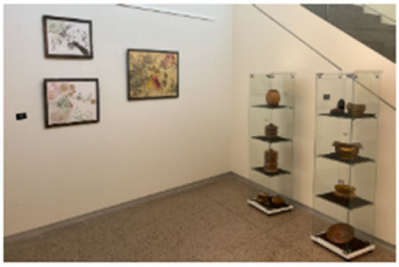
Professor Torres participated in a mini ISMET (International Society for Microbial Electrochemistry and Technologies) meeting with several researchers from European universities meeting, October 14-15.

Biodesign's 20th Anniversary. 2024 marked the 20th anniversary of the Biodesign Institute at Arizona State University. The Swette Center for Environmental Biotechnology was a founding center. BSCEB's Business Manager, Carole Flores, led the internal celebration committee and many of our members participated in activities throughout the year, including a carnival, weekly wellness events (painting, sound healing, yoga, book club, board games, walking), *Artists of Biodesign* exhibition, field day, "20 Years of Launching Innovators; A Biodesign Symposium" featuring BSCE alumnus Brad Lusk, and culminating Arntzen Grand Challenges lecture featuring chemist and Nobel laureate Carolyn Bertozzi at the Desert Botanical Gardens. Photos courtesy of ASU Knowledge Enterprise/Andy DeLisle and Carole Flores.





Panelists
Panelists


STAFFING in 2024

TOTAL MEMBERS = 77

TENURE-TRACK PROFESSORS = 4

Name	Academic Home/Program
Hinsby Cadillo Quiroz	School of Life Sciences (SoLS)
Anca Delgado	Fulton Schools of Engineering (FSE), School of Sustainable Engineering and the Built Environment (SSEBE)
Bruce Rittmann	Fulton Schools of Engineering (FSE), School of Sustainable Engineering and the Built Environment (SSEBE)
César Torres	Fulton Schools of Engineering (FSE), School of Engineering of Matter, Transport, and Energy (SEMTE)

FULL-TIME STAFF = 5

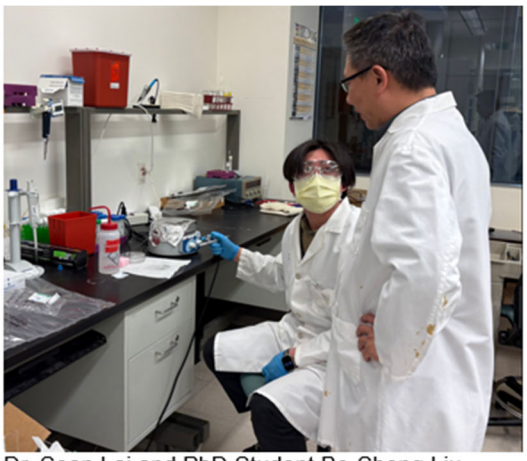
Name	**Title**	**Lab**
Carole Flores	Business Ops Manager	All BSCEB PIs
Kassandra Kellengberger	Research Coordinator Sr.	All BSCEB PIs
Christopher Muse	Research Specialist	All BSCEB PIs
Rachel Simoes	Research Technician	Cadillo
Richard Kupferer	Research Specialist	Rittmann

RESEARCH PROFESSORS and SCIENTISTS = 3

Name	**Lab**
Yen-Jung Lai	Rittmann
Wei Li	Rittmann
Everett Eustance	Rittmann

POSTDOCTORAL ASSOCIATES = 8

Name	**Lab**
Jie Dai	Cadillo
Han Fu	Rittmann
Seungyeob Han	Rittmann
Bongyeon Jung	Rittmann
Chenwei Zheng	Rittmann
Jesus Alberto Perez Garcia	Torres
Christine Lewis	Torres
Juan Fausto Ortiz Medina	Torres



Dr. Sean Lai and PhD Student Bo-Sheng Liu.

Professor Torres and PhD Student Sam Ferrante.

PH.D. STUDENTS = 23

Biological Design, SEMTE = 3	
Name	**Lab**
Dorsa Daeizadeh	Delgado
Briana Paiz	Delgado
Winter Taniguchi	Rittmann
Biology and Society = 1	
Alice Sansonetti	Cadillo
Chemical Engineering, SEMTE = 3	
Amelia Bryan	Torres
Samuel Ferrante	Torres
Zachary Hubbard	Torres
Civil, Sustain., & Env Eng, SSEBE = 15	
Anwar Alsanea	Rittmann
Kartik Bhagat	Rittmann
Avery Brewer	Delgado
Hannah Collins	Rittmann
Katie Currier	Rittmann
Kelsie Herzer	Delgado
Maheen Mahmood	Rittmann
Jesus Marin	Cadillo
Caleb McLaughlin	Delgado
Alba Medina Benitez	Delgado
Elias Mindreau	Rittmann
Alireza Rahimi	Rittmann
Asma Sattar	Rittmann
Maya Suzuki	Rittmann
Genji Yao	Rittmann
Environmental Life Sciences, SOLS = 1	
Victor Hugo Ochoa Henriquez	Cadillo

A fun night out to eat! Pictured from left to right: Sreepriya Sankaran, Mona Rafat, Prapti Shetty, Asma Sattar, and Hannah Collins

MASTERS STUDENTS = 11

Name	**Lab**
Chemical Engineering, SEMTE = 4	
Jeel Jasoliya	Torres
Tejaswi Kanumilli	Torres
Atul Harimohan Ojha	Torres
Soham Sanghvi	Torres
Biology, SOLS = 2	
Camilla Delgado Montez	Cadillo
Lilly Vael	Cadillo
Environmental Engineering, SSEBE = 4	
Prapti Shetty	Rittmann
Anh Quan Truong	Delgado
Riley Berg	Delgado
Jordan Coulam	Torres
Microbiology, SOLS = 1	
Julia Furedy	Cadillo

UNDERGRADUATES = 13

Cadillo Lab = 1
Johanan Unchiasu
Delgado Lab = 4
Ashley Griffin
Helene Budd
Jaden Lynch
Natalie Pargmann
Rittmann Lab = 4
Pranav Arun
Jordyn Begay
Manan Godhani
Arzu Hasanova
Torres Lab = 4
Mohamad Alquran
Ava Ferraro
Megan Langella
Ella Thorsen

Visiting PhD student Muhammad Usman Saleem joined the Swette Center in Dec 2024. Left: Pictured with Prof. Bruce Rittmann. Right: Working in the lab on co-removal of per- and polyfluoroalkyl substances (PFAS) and ciprofloxacin (CIP) through an innovative synergistic platform combining membrane catalyst film reactors (MCfR) and membrane biofilm reactors (MBfR). Usman is pursuing his PhD from the National University of Sciences and Technology (NUST)-Pakistan. This research aims to reduce the release of hazardous chemicals into the environment, advancing scientific understanding and contributing to global efforts in environmental sustainability and public health.

VISITING SCHOLARS = 4

Name	Lab	Affiliation
Nada Ashraf	Rittmann	Ain Shams University, Cairo, Egypt
Ting Li	Rittmann	School of Environmental Science & Engineering, Nankai University, PR-China
Bo-Sheng Liu	Rittmann	National Tsing Hua University, Taiwan
Muhammad Usman Saleem	Rittmann (Yen-Jung Lai, Chenwei Zheng)	National University of Sciences & Technology, Islamabad, Pakistan
Zia Ullah	Torres	National University of Sciences & Technology, Islamabad, Pakistan

OTHERS = 6

Name	Lab (Mentor)	Affiliation
Genevieve Alexander High school student	Delgado	Desert Mountain High School
Ashley Burkart Community College Teacher	Delgado	Estrella Mountain Community College
Kaitlyn Pany High school student	Rittmann (Chenwei Zheng)	BASIS High School, Chandler
Robert Stirling	All BSCEB PIs	Techno-Economist
Olneya Fong High school student	Torres	
Iraj Shroff High school student	Rittmann (Genji Yao)	BASIS High School, Chandler

GRADUATES in 2024

Cadillo Quiroz Graduates

1. Michael Pavia (May 2024). Ph.D. [Microbiology]. Thesis title: Microbial functions and interactions in carbon cycling of Amazon peatlands.
2. Julia Furedy (May 2024). M.S. [Microbiology]. Thesis title: *Culturable diversity of methanotrophic bacteria in tropical peatlands.*
3. Lilly Vael (May 2024). M.S. [Microbiology]. Paper-based: The Carbon Cycling and Climate Microbial Collection for Tropical Peatlands (C3-MicroTroP).

Rittmann Graduates:

1. Alsanea, Anwar (Dec 2024). Ph.D. [Environmental Engineering]. Thesis Title: The Recovery of Elemental Sulfur from High Sulfate Phosphogypsum Water using Membrane Biofilm Reactors.
2. Juliana Levi (Dec 2024). PhD. [Environmental Engineering]. Thesis Title: Advancing the Technology Readiness of Membrane: Catalyst-film Reactors for Nitrate Removal.

Ira A. Fulton Schools of Engineering Graduate Convocation – Fall 2024. Left: Anwar Alsanea; Right: Professor Bruce Rittmann.

Torres Graduates:

1. Jordan Coulam (May 2024). M.S. [Environmental Engineering] Thesis: Assessing the Utility of Various Buffer Concentrations for Alleviating pH Gradients in Geobacter sulfurreducens Biofilms
2. Jeel Jasoliya (May 2024). M.S. [Chemical Engineering]. Hydrogen peroxide as an oxygen source in wastewater treatment.

3. Tejaswi Kanumilli (August 2024). M.S. [Chemical Engineering]. Electrochemical production of hydrogen peroxide through the oxygen reduction reaction.
4. Soham Sanghvi (December 2024). M.S. [Chemical Engineering]. Measuring Growth and Kinetic Parameters of Wastewater Treatment using Hydrogen Peroxide.

AWARDS, HONORS, AND PROMOTIONS IN 2024

Awards

1. Bruce Rittmann received the International Science and Technology Collaboration Award from the Peoples' Republic of China (June 2024)
2. Riley Berg and Hannah Collins were two of seven students nationwide selected to represent Arizona State University at the 2024 Environmental Science & Engineering Summer School at Tongji University in Shanghai, China from August 15, 2024 to August 21, 2024
3. Caleb McLaughlin received an Honorable Mention for his NSF Graduate Research Fellowship Program application (award granted April 2024)
4. Alba Medina received the experiential travel grant (May 2024) from FSE which she used to go to the Battelle conference in Denver.
5. Swette Center was given a Certificate of Excellence for our active participation in the summer 2024 Biodesign Clean Up. This program is done annually during the summer to promote lab cleanliness and organization to contribute to a safer lab environment for everyone. (July 2024)
6. Rittmann lab spaces had a Biosafety inspection with ZERO findings! This means our biosafety standards are being executed safely and appropriately to such a standard that the officials in biosafety within Environmental Health and Safety saw nothing wrong with the performance in our labs. (December 2024)

Events

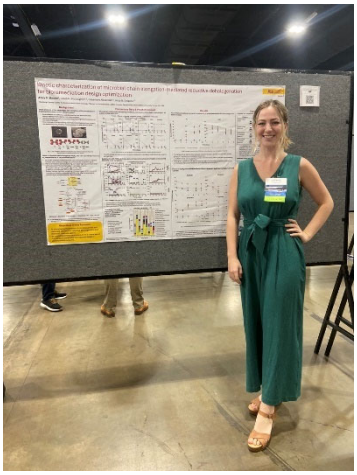
1. Hannah Collins, Caleb McLaughlin, and Maya Suzuki were nominated by Arizona State University to engage in a discussion about water management in Arizona with Estelle Brachlianoff, CEO of Veolia, a $49 billion company at the forefront of climate change and water access solutions on December 23, 2024. The discussion took place on January 23, 2025.
2. Chenwei Zheng served as the Session Co-chair - Biofilms and Pathogen Management in Water Distribution, IWA-WWCE, Toronto, Canada (2024)

Internships

1. Hannah Collins was nominated by the President of Arizona State University's Graduate Student Government to be the Graduate Student Representative on Arizona State University's University Graduate Council (August 8, 2024)
2. Caleb McLaughlin was accepted for the NSF INTERN program in which he interned at Haley & Aldrich Inc (Aug 2024 - Jan 2025).
3. Maya Suzuki was selected as an intern for Regeneration/Resolve to spearhead a project finding candidate abandoned mine sites that could qualify as Good Samaritan projects

under the Good Samaritan Remediation of Abandoned Hardrock Mines Act of 2022 (May 2024 - Jan 2025).

Papers, Posters



1. Avery Brewer was awarded Best Student Poster at the Battelle Chlorinated Conference (June 2024). (Pictured, right)
2. Avery Brewer won third place in the RemFest 4.0 poster competition (November 2024).
3. Hannah Collins won the 1st Place Poster Award at the 18th Biennial Symposium on Managed Aquifer Recharge (BSMAR18) (April 5, 2024)
4. Kelsei Herzer was accepted to present a poster at the DehaloCon IV - Fourth International Conference on Anaerobic Biological Dehalogenation & First Symposium on Remediation of Organohalide Contamination, in Guangzhou, China. (September 26 - 28, 2024)
5. Maya Suzuki was selected to present in EPAZ's Student Poster Session during their Spring 2025 conference (Dec. 2024).
6. Chenwei Zheng won the cover of Environmental Science & Technology Cover Paper, Vol 58/Issue 26, 2024

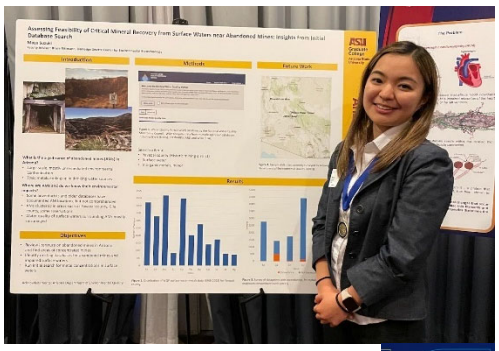
Promotions

1. Anca Delgado was promoted to Associate Professor with tenure in the School of Sustainable Engineering and the Built Environment (SEBE) at ASU. She was also appointed Research Director in SSEBE.

Scholarships & Fellowships

1. Amelia Bryan was awarded the Fulton Fellowship award from Arizona State University (March 11, 2024)
2. Hannah Collins won the Environmental Professionals of Arizona (EPAZ) Scholarship (February 15, 2024)
3. Hannah Collins won the 2024-2025 Phoenix/Scottsdale Groundwater Contamination Scholarship for Environmental Science (June 21, 2024)
4. Hannah Collins was awarded a University Graduate Fellowship from Arizona State University (November 15, 2024)Hannah
5. Anca Delgado was a 2024-25 Fulbright US Scholar Program Finalist.
6. Jaden Lynch was awarded the Bidstrup Undergraduate Research Fellowship (September 2, 2024).
7. Jaden Lynch and Natalie Pargmann were accepted into the Fulton Undergraduate Research Initiative (FURI) and presented research posters at the FURI symposium (May - November 2024).

8. Briana Paiz was awarded a University Graduate Fellowship from Arizona State University (September 13th 2024).
9. Maya Suzuki (pictured to the right) won the ARCS Scholarship (February 27, 2024).
10. Maya Suzuki won the AZ Water Association Scholarship (April 2024).
11. Maya Suzuki won the Brown & Caldwell Minority Scholarship (June 2024).
12. Maya Suzuki was awarded a University Graduate Fellowship from Arizona State University (December 3, 2024).
13. Maya Suzuki won the NSF Graduate Research Fellowship (April 4, 2024).
14. Genji Yao was awarded a University Graduate Fellowship from Arizona State University (November 15, 2024)



PUBLICATIONS in 2024

Total Number of Publications: 53

PI Name: Hinsby Cadillo-Quiroz, Professor
Total Number Published Papers: 6

1. Pavia, M.J., Garber, A. I., Cole, S., Macedo-Tafur, F, Tello-Espinoza,R., **Cadillo-Quiroz, H**. 2024.Functional insights of novel Bathyarchaeia reveal metabolic versatility in their role in peatlands of the Peruvian Amazon. Microbiology spectrum 12(12):e00387-24.
   *g= lead author group's PhD student, *u= Latinx undergraduate, role: PI, senior author, project coordinator, supervisor, data validation, manuscript development

2. Reynolds, M.*g and **Cadillo-Quiroz, H**. 2024. Microbial DNA sample preservation and possible artifacts for field-based research in remote tropical peatlands. Journal of Microbiological Methods. 124: 106997.
   *g= lead author group's PhD student, role: PI, senior author, project coordinator, supervisor, data validation, manuscript development

3. National Academies of Sciences, E., Medicine, 2024. A Research Agenda Toward Atmospheric Methane Removal, The National Academies Press, Washington, DC.
   Cadillo Role: Committee Member, Co-author, Report development

4. Crawford, A.J., Belcher, C.M., New, S., Gallego-Sala, A., Swindles, G.T., Page, S., Blyakharchuk, T.A., **Cadillo-Quiroz, H**., Charman, D.J., Gałka, M., Hughes, P.D.M., Lähteenoja, O., Mauquoy, D., Roland, T.P., Väliranta, M., 2024. Tropical peat composition may provide a negative feedback on fire occurrence and severity. Nature Communications. 15, 7363.
   Role: Consortium collaborator, manuscript development.

5. Graham, E.B., Camargo, A., Wu,R., Neches, R., Nolan, M., Paez-Espino, D., Copeland, A., Kyrpides, N., Jansson, J., McDermott, J., Hofmockel, K., the Soil Virosphere Consortium: Jun, X., Liu, A., Rodrigues, J. , Freedman, Z., Baldrian, P., Štursová, M., DeAngelis, K. , Lee , S., Godoy-Vitorino, F., Yeoh, Y., **Cadillo-Quiroz, H**. et al. 2024. A global atlas of soil viruses reveals unexplored biodiversity and potential biogeochemical impacts. Nature Microbiology 9, 1873-1883.
   Role: Consortium collaborator, manuscript development

6. Pérez-Castillo, A.G., Monge-Muñoz, M., Durán-Quesada, A.M. Giraldo-Sanclemente,, W., Méndez-Esquivel, A.C., Briceño, N., **Cadillo-Quiroz, H**. 2024. Vegetation and Peat Soil Characteristics of a Fire-Impacted Tropical Peatland in Costa Rica. Wetlands 44, 41

PI Name: Anca Delgado, Associate Professor

Total Number Published Papers: 4

1. Miranda, E. M., McLaughlin, C. M., Reep, J. K., Edgar, M., Landrum, C., Severson, C., Grubb, D. G., Hamdan, N., Hansen, S., Santisteban, L., & **Delgado, A. G**. (2024). High Efficacy Two-Stage Metal Treatment Incorporating Basic Oxygen Furnace Slag and Microbiological Sulfate Reduction. ACS ES&T Engineering, 4(2), 433–444. https://doi.org/10.1021/acsestengg.3c00381.

2. Skinner, J. P., Palar, S., Allen, C., Raderstorf, A., Blake, P., Morán Reyes, A., Berg, R. N., Muse, C., Robles, A., Hamdan, N., Chu, M.-Y., & **Delgado, A. G.** (2024). Acetylene Tunes Microbial Growth During Aerobic Cometabolism of Trichloroethene. Environmental Science & Technology, 58(14), 6274–6283. https://doi.org/10.1021/acs.est.3c08068.

3. Skinner JP, **Delgado AG**, Hyman M, Chu M-Y J, 2024. Implementation of in situ aerobic cometabolism for groundwater treatment: State of the knowledge and important factors for field operation. *Science of The Total Environment*, 925, 171667. https://doi.org/10.1016/j.scitotenv.2024.171667

4. Kabir SF, Sundar SV, Robles A, Miranda EM, **Delgado AG**, Fini EH, 2024. Microbially-mediated rubber recycling to facilitate valorization of scrap tires. *Polymers*, 16, 7, 1017. https://doi.org/10.3390/polym16071017

PI Name: Bruce Rittmann, Center Director and Regents' Professor

Total Number Published Papers: 37

1. Alsanea, A., Bounaga, A., Lyamlouli, K., Zeroual, Y., Boulif, R., Zhou, C., & **Rittmann, B**. (2024). Sulfate Leached from Phosphogypsum Is Transformed in a Hydrogen-Based Membrane Biofilm Reactor. ACS ES&T Engineering.

2. Boltz, J. P. and **B. E. Rittmann** (2024). Microbial ecology of nitrate-, selenate-, selenite-, and sulfate-reducing bacteria in a H2-driven bioprocess. FEMS Microb. Ecol. 100: fiae125.

3. Bounaga, A, A. Alsanea, M. Danouche, **B. E. Rittmann,** C. Zhou, R. Boulif, Y. Zeroual, R. el Fermi, R. Benhida, and K. Lyamlouli (2024). Microbial elemental sulfur recovery from phosphogypsum using O2 membrane biofilm reactor: bioreactor parameters optimization, metagenomic analysis, and metabolic prediction for the biofilm activity. Bioresource Technology 400: 130680.

4. Boyer, T. H., E. Briese, L. Crane, J. Bhadha, D. F. Call, E. S. McLamore, **B. E. Rittmann**, S. Tuberty, P. Westerhoff, and O W. Duckworth (2024). Guidance on aqueous matrices for evaluating novel precipitants and adsorbents for phosphorus removal and recovery. Chemosphere 367: 143648.

5. Cui, X. B. Wu, Z. Wang, Y. Liu, T. Ren, S. Xia, Y. Zhou, and **B. E. Rittmann**. Microalgal extracellular polymeric substances (EPS) and their roles in cultivation, biomass harvesting, and bioproducts extraction. Biores. Technol. 406: 131054.

6. Chen, S., B. Liang, X. Zhu, G. Zhu, X. Tan, L. Chen, Y. Zhang, and **B. E. Rittmann** (2024). N-methyl pyrrolidone manufacturing wastewater as the electron donor for denitrification: from bench to pilot scale. Sci. Total Environ. 912: 169517.

7. Diaz-Munoz, C., C. Nieto-Delgado, Z. E. Ilhan, **B. E. Rittmann**, and A. Ontiveros-Valencia (2024). Lead removal by its precipitation with biogenic sulfide in a membrane biofilm reactor. Sci. Total Environ. 967: 177578.

8. Divine, C., C. Bell, M. Heintz, A. Lorenz, P. Vallin, D. Favero, K Gerber, C. Zheng, and **B. E. Rittmann** (2024). New developments and opportunities in 1,4-dioxane biological treatment. Groundwater Monitoring & Remediation 44 (2): 12-26, doi: 10.1111/gwmr.12649.

9. Elser, J. J., J. Baker, T. H. Boyer, K. D. Grieger, T. Liu, R. L. Muenich, **B. E. Rittmann**, and A. Saha (2024). Creating an alternative future for Earth's phosphorus cycle in the Anthropocene via eco-prospecting, eco-mining, and eco-refining. Treatise on Geochemistry: https://doi.org/10.1016/B978-0-323-99762-1.00023.1.

10. Elser, J., D. F. Call, J. A. Deaver, O. W. Duckworth, B. K. Mayer, E. S. McLamore, **B. E. Rittmann**, M. Mahmood, and P. Westerhoff (2024). The phosphorus challenge: biotechnology approached for a sustainable phosphorus system. Curr. Opin. Biotechnol. 90: 103197.

11. Flores, A., R. Rangel-Mendez, C. Nieto-Delgado, F. Alatriste-Mondragón, **B. E. Rittmann**, and A. Ontiveros-Valencia (2024). Biotransformation of microplastics from three-layer masks by nitrifying-denitrifying consortia. J. Hazardous Materials 480: 136161.

12. Gao, J., Q. Ma, **B. E. Rittmann**, and W Zhang (2024). Direct electrosynthesis and separation of ammonia and chlorine from waste solutions via a stacked membrane-free electrolyzer. Nature Communications 15: 8455 (doi.org/10.1038/s41467-024-52830-4).

~~13. Glesener, H., Abdollahzadeh, D., Muse, C., Krajmalnik-Brown, R., Weaver, M.A., and Voth-Gaeddert, L. (2024) X-ray Irradiation Reduces Live Aspergillus flavus Viability but Not Aflatoxin B1 in Naturally Contaminated Maize. Toxins 2020,16,329.~~

14. Chen, Z., Y. Wu, J. Dolfing, S. Zhuang, B. Wang, D. Li, S. Huang, and **B. E. Rittmann** (2024). Complex ammonia oxidation demands visualized resolution. Science Bulletin: Mar 28: S2095-9273.

15. Hajinajaf, N., A. Fallahi, E. Eustance, A. Sarnaik, A. Askari, M. Najali, R. W. Davis, **B. E. Rittmann,** and A. M. Varman (2024). Managing carbon dioxide mass transfer in photobioreactors for enhancing microalgal growth. Algal Res. 80: 103506.

16. Huang, J., M. Lin, Y. Cai, Y.-H. Luo, D. Zhou, and **B. E. Rittmann** (2024). Complete dehalogenation of chloramphenicol by bimetallic alloy Pd-Ai nanoparticles in a H2-based membrane catalyst-film reactor. Chem. Engr. J. 497: 154758.

17. Levi, J., B. Jung, H. Jacobs, C.-S. Lee, K. Hong, M. Long, J. Donoso, S. Garcia-Segura, M. Wong, **B. E. Rittmann**, and P. Westerhoff (2024). Optimized bimetallic

ratios for durable membrane catalyst-film reactors treating nitrate-polluted water. Sci. Total Environ. 943: 173711.

18. Lin, M., C. Qian, C. Pan, J. Guo, Q. Zhao, F. Feng, Y. Zheng, Y. Zhang, J. Song, and **B. E. Rittmann** (2024). Core taxa and metabolic pathways contributing to robust anaerobic biodegradation of chlorophenol at different temperatures. Environ. Res. 241: 117591.

19. Liu, F., Y. Ma, W. Li, J. Cai, H. Zhang, Y. Zhang, and **B. E. Rittmann** (2024). How Rhodococcus ruber accelerated biodegradation of benzophenone-3. H. Hazardous Matl. 482: 136566.

20. Long, M., Y. Chen, T. P. Senftle, W. Elias, K. Heck, C. Zhou, M. S. Wong, and **B. E. Rittmann** (2024). The method of H2-transfer is vital for catalytic hydrodefluorination of perfluorooctanoic acid (PFOA). Environ. Sci. Technol. 58: 1390-1398.

21. Long, M., J. Cheng, and **B. E. Rittmann** (2024). Enhancing water purity: a lead with palladium nanoparticles in biofilm denitrification. Advances in Engineering: https://advanceseng.com/enhancing-water-purity-leap-palladium-nanoparticles-biofilm-denitrification/

22. Long, M., C. Zheng, M. A. Rolda , C. Zhou, and **B. E. Rittmann** (2024). Co-removal of PFOA and nitrate from water by coupling Pd catalysis with enzymatic biotransformation. Environ. Sci. Technol. 58: 11514-11524.

23. Long, M., C. Zhou, W. Elias, H. Jacobs, K. Heck, M. Wong, and **B. E. Rittmann** (2024). Auto-assembled Pd-Rh nanoalloys catalyzed faster and deeper hydrodefluorination of Perfluorooctanoic Acid (PFOA) in environmental conditions. ACS ES&T Engr. 4: 1073-1080.

24. Ma, Y., S. Chen, H. Zhang, F. Liu, X. Peng, M. Li, Y. Zhang, and **B. E. Rittmann** (2024). Soybean-processing wastewater as electron donor for denitrification. Intl. Biodet. Biodegr. 188: 105745.

25. Ren, T., X. Cui, B. Wu, Y. Zhou, and **B. E. Rittmann** (2024). Differentiation and quantification of extracellular polymeric substances from microalgae and bacteria in symbiotic culture. Water Res. 256: 121641.

26. Seagren, E. A., D. J. Hollander, D. A. Stahl, and **B. E. Rittmann** (2024). An integrated evaluation of bioenhanced in situ LNAPL dissolution. J. Contam. Hydrol. 264: 104338.

27. Seenivasagham, V., K. C. Bal Krishna, J. P. Chandy, G. Kastl, L. L. Blackwell, **B. E. Rittmann**, and A. Sathasivan (2024). Heterotrophic bacteria isolated from a chloraminated system accelerate chloramine decay. Chemosphere 359: 142341.

28. Schwarz, A., M. Aybar, J. Suárez, and **B. E. Rittmann** (2024). A steady-state pH-control model for the biological production of elemental sulfur from sulfate in mining-influenced water. Water Res. 250: 121067.

29. Wang, T.-H., Y.-J. S Lai, C.-K. Tsai, H. Fu, R.-A. Doong, P. Westerhoff, and **B. E. Rittmann** (2024). Efficient CO2conversion through a novel dual-fiber reactor system. Environ, Sci. Technol. 58: 13717-13725.

30. Wu, C., J. Zhou, S. Pang, L. Yang, E. Lichfouse, S. Xia, and **B. E. Rittmann** (2024). Reduction and precipitation of chromium (VI) using a palladized membrane biofilm reactor. Water Res. 249: 120878.

31. Xu, Y., Y. Wu, and **B. E. Rittmann** (2024). Describing chemical mitigation processes at the sediment periphytic-biofilm-water interface. Environ. Sci. Technol. 58: 3577-3579.

32. Zhang J., Z.-H. Liu, W. Hayat, J.-L. Wu, Y-T. Ding, Q.-G. Ma, P.-J. Wang, J. Dang, and **B. E. Rittmann** (2024). Deconjugation potentials of natural estrogen conjugates in sewage and wastewater treatment plant: insights from model prediction and on-site investigations. Sci. Total Environ. 926: 172071.

33. Zhang, H., Y. Ma, X. Peng, M. Li, Y. Zhang, and **B. E. Rittmann** (2024). Fate of organic nitrogen in amino acids during alternating denitrification and nitrification. Intl. J. Biodet. Biodegr. 193: 105850.

34. Zheng, C., Y.-J. Lai, Y.-H. Luo, Y. Cai, W. Wu, and **B. E. Rittmann** (2024). A two-stage design enhanced biodegradation of high concentrations of a C16-alkyl quaternary ammonium compound in oxygen-based Membrane Biofilm Reactors. Water Res. 250: 120963.

35. Zhou, J., L. Yang, X. Li, B. Dai, J. He, S. Xia, and **B. E. Rittmann** (2024). Biogenic palladium improved perchlorate reduction during nitrate co-reduction by diverting electron flow in a hydrogenotrophic biofilm. Environ. Sci. Technol. 58: 10644-10651.

36. Zhou, Y. B. Wu, X. Cui, T. Ren, T. Ran, and **B. E. Rittmann** (2024). Mass flow and metabolic pathway of non-aeration greywater treatment in an oxygenic microalgal-bacteria biofilm. Environ. Sc. Technol. 58: 534-544.

37. Zhou, Y., B. Wu, X. Cui, T. Ran, and **B. E. Rittmann** (2024). Mass flow and metabolic pathway of non-aeration greywater treatment in an oxygenic microalgal-bacterial biofilm. Environ. Sci. Technol. 58: 534 – 544.

38. Zhou, Y., X. Cui, B. Wu, Z. Want, Y. Liu, T. Ren, S. Xia, and **B. E. Rittmann** (2024). Microalgal extracellular polymeric substances (EPS) and their roles in cultivation, biomass harvesting, and bioproducts extraction. Biores. Technol. 406: 131054.

PI Name: Yen-Jung Lai, Research Assistant Professor
Total Number Published Papers: 5
1. Wang TH, **Lai YJ***, Tsai CK, Fu H, Doong RA, Westerhoff P*, Rittmann BE. Efficient CO_2 conversion through a novel dual-fiber reactor system. *Environ. Sci. Technol.* 2024, *58* (31), 13717–13725. https://doi.org/10.1021/acs.est.3c10274. 2. Wang J, **Lai YJ**, Wang TH, Zeng C, Westerhoff P, Mu Y. Water Quality Constraints H_2O_2 Production in a Dual-Fiber Photocatalytic Reactor. *Water Res.* 2024, *260*, 121880. https://doi.org/10.1016/j.watres.2024.121880. 3. Godar AG, Chase T, Conway D, Ravichandran D, Woodson I**, Lai YJ**, Song K, Rittmann BE, Wang X, Nielsen DR. 'Dark' CO2 Fixation in Succinate Fermentations Enabled by Direct CO2 Delivery via Hollow Fiber Membrane Carbonation. *Bioprocess Biosyst. Eng.* 2024, *47* (2), 223–233. https://doi.org/10.1007/s00449-023-02957-3. 4. Fu H, Wang TH, Doong RA, **Lai YJ**, Garcia-Segura S, Zhao Z, Westerhoff P. Boosting Hydrogen Production via Water Splitting: An ITO Plus g-C_3N_4 Nanomaterial Enabled Polymer Optical Fiber Design. *ACS Mater. Lett.* 2024, *6* (6), 2267–2275. https://doi.org/10.1021/acsmaterialslett.4c00456. 5. Zheng C, Luo YH*, Lai YJ*, Ilhan ZE, Ontiveros-Valencia A, Krajmalnik-Brown R, Gu H, Rittmann BE. Metatranscriptome and Metabolome Integration: Identifying Biodegradation Pathway of Cetrimonium Bromide (CTAB) *Water Res.* 2024, *250*, 120963. https://doi.org/10.1016/j.watres.2023.120963.

PI Name: Everett Eustance, Research Assistant Professor
Total Number Published Papers: 1
1. Hajinajaf, N., A. Fallahi, **E. Eustance**, A. Sarnaik, A. Askari, M. Najali, R. W. Davis, B. E. Rittmann, and A. M. Varman (2024). Managing carbon dioxide mass transfer in photobioreactors for enhancing microalgal growth. Algal Res. 80: 103506.

INVITED PRESENTATIONS OUTSIDE ASU 2024

Total Number of Presentations: 69

PI Name: Hinsby Cadillo-Quiroz, Named Professor
Total Number of Presentations: 2
1. Cadillo-Quiroz, H. 2024**. "**High Spatial Variability of GHG fluxes is linked to microbial community composition in sub boreal conifer forest". Cadillo-Quiroz, H., Taumer, J., Savage, K.E., Fraver, S., Watts, J., Kahn, D., Dietrich, Z., Ouimette, A., Xu, X., Sihi, D. and Briones, V. American Geophysical Union. Annual Meeting.Washington DC. 2. Cadillo-Quiroz, H. 2024. "Amazon peatlands". Highlight NGS Explorer festival.

PI Name: Anca Delgado, Associate Professor

Total Number Presentations: 17

1. Delgado AG. When Kluyver(i) meets McCartyi(i): reductive dehalogenation mediated by chain elongation. UNLOCK Symposium, Wageningen University & Research, Wageningen, the Netherlands, Nov 2024 (keynote presentation).

2. Delgado AG. Carboxylate chain elongation: microbial ecology and role in organic carbon transformation in anaerobic environments. Université Catholique de Louvain, Louvain-la-Neuve, Belgium, Nov 2024.

3. Delgado AG, Robles A, McLaughlin CM. Harnessing hydrogen during microbial chain elongation for anaerobic bioremediation of chlorinated solvents. ETE Colloquium, Wageningen University & Research, Wageningen, the Netherlands, Nov 2024.

4. Delgado AG, Robles A, McLaughlin CM, Evelyn Miranda M. Carboxylate chain elongation: environmental relevance, applications, and implications for bioremediation and human health. Ghent University, Ghent, Belgium, Oct 2024.

5. Delgado AG, Robles A, McLaughlin CM, Brewer AM. Carboxylate chain elongation: environmental relevance, ecology, and usage in anaerobic dehalogenation. DehaloCon IV - Forth International Conference on Anaerobic Biological Dehalogenation & First Symposium on Remediation of Organohalide Contamination, Guangzhou, China, Sep 2024.

6. Miranda EM, McLaughlin CM, Santisteban L, Delgado AG. Biological passive treatment of metals and sulfate in mining-influenced water. Lunch with Technical Experts Webinar, Arizona Department of Environmental Quality (ADEQ), Aug 2024.
7. Miranda EM, McLaughlin CM, Santisteban L, Delgado AG. High efficacy two-stage metal treatment incorporating basic oxygen furnace slag and microbiological sulfate reduction. 2024 Chlorinated Conference, Denver, CO, Jun 2024.

8. Delgado AG. Harnessing hydrogen during microbial chain elongation for anaerobic bioremediation of chlorinated solvents. GWAG Webinar, Geosyntec Consultants, Phoenix, AZ, April 2024.

9. Delgado AG, Paiz BM, Medina Benitez AJ, Lynch J, Pargmann N, Palmer A, Tfailly M, Rajakaruna SG, Edmonson F. Accelerated bioweathering of Martian regolith through microbial perchlorate reduction. American Society for Gravitational and Space Research, ASGSR 2024, San Juan, PR, Dec 2024.

10. Edmonson F, Palmer A, Delgado AG. Evaluation of microbially remediated Martian regolith simulants – the impact of perchlorate removal on plant growth and development. American Society for Gravitational and Space Research, ASGSR 2024, San Juan, PR, Dec 2024.

11. McLaughlin CM, Delgado AG. Deciphering Microbial Interactions in Reductive Dechlorination Mediated by Chain Elongation and Fermentation. Center for Bio-mediated and Bio-inspired Geotechnics midyear meeting. Atlanta, GA, Apr 2024.

12. Brewer AM, McLaughlin CM, Alexander GM, Delgado AG. Kinetic characterization of microbial chain elongation-mediated reductive dehalogenation for bioremediation design optimization. Battelle Chlorinated Conference 2024, Denver, CO, Jun 2024.

13. McLaughlin CM, Delgado AG, Robles A, Bennett P, Chu MY, Calhoun M. Microbial Chain Elongation Supports Reductive Dechlorination of Chlorinated Ethenes: Outlook from a Study at a Superfund Site. Battelle Chlorinated Conference 2024, Denver, CO, Jun 2024.

14. Medina Benitez AJ, Delgado AG, Paiz B, Pargmann N, Lynch J. Initiating the Biotransformation of Martian Regolith by Dissimilatory Perchlorate-Reducing Microorganisms. Battelle Chlorinated Conference 2024, Denver, CO, Jun 2024.

15. Berg RN, Delgado AG. Investigating Aerobic Cometabolism of 1,1-Dichloroethylene and Trichloroethylene with NOVA5/COMET1 Cultures before and after Carbon Source Depletion. Center for Bio-mediated and Bioinspired Geotechnics Annual Meeting. Atlanta, GA, Oct 2024.

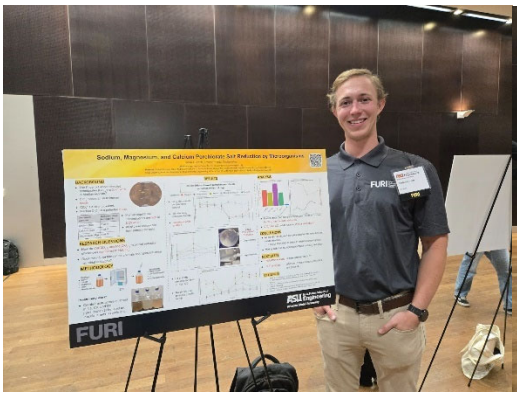
16. Brewer AM, McLaughlin CM, Alexander GM, Delgado AG. Kinetic characterization of microbial chain elongation-mediated reductive dehalogenation for bioremediation design optimization. RemFest 4.0 2024, Scottsdale, AZ, Nov 2024.

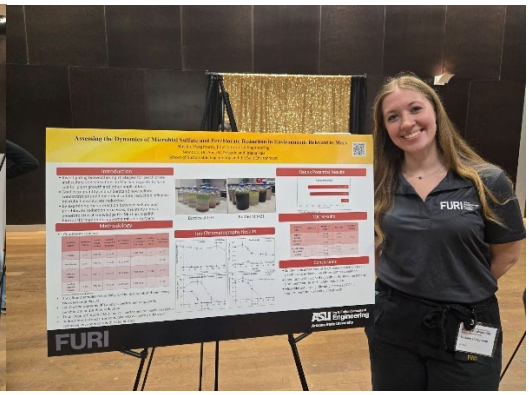
17. Medina Benitez AJ, Delgado AG, Paiz B, Pargmann N, Lynch J. Genetic and Metabolic Profiling of Microbial Cultures for Perchlorate Detoxification in Martian Regolith Simulant. ASGSR – American Society for Gravitational and Space Research 2024, San Juan, Puerto Rico, Dec 2024.

From left to right: Justin Skinner, Avery Brewer, Anca Delgado, Alba Medina Benitez, and Caleb McLaughlin at the Battelle Chlorinated Conference reception held at the Denver Museum of Nature & Science (June 2024).

Professor Anca Delgado and PhD student Kelsie Herzer at the Dehalocon IV 2024 International Conference in Guangzhou, China on September 26, 2024.

PhD student Avery Brewer analyzing samples
for her research…





Jaden Lynch (left) and Natalie Pargmann (right) presented their research posters for their work on the Martian Regolith Bioweatheirng project at the Fulton Undergraduate Research Initiative (FURI) Symposium.

PI Name: Bruce Rittmann, Center Director and Regents' Professor
Total Number Presentations: 40
National or International Invited Lectures - **Bruce Rittmann** 1. March 8 – Moving Wastewater from Treatment to Resource, University of Pittsburgh, Pittsburgh 2. March 19 – The Synergistic Platform for Defluorination and Mineralization of PFAS, Shanghai Normal University, Shanghai, China 3. March 20 – How Graduate Students Succeed in Environmental Engineering in the USA, Shanghai Normal University, Shanghai, China 4. March 21 – The Microorganisms Always Close the Mass Balance, Shanghai University, Shanghai, China 5. March 22 – How Graduate Students Succeed in Environmental Engineering in the USA, Shanghai University, Shanghai, China 6. March 26 – Moving Wastewater from Treatment to Resource, Dalian University of Technology, Dalian, China 7. March 27 – How Graduate Students Succeed in Environmental Engineering in the USA, Dalian University of Technology 8. March 29 – Moving Wastewater from Treatment to Resource – Northeast Normal University, Changchun, China 9. March 30 -- The Synergistic Platform for Defluorination and Mineralization of PFAS, Jilin University, Changchun, China 10. March 31 – How Graduate Students Succeed in Environmental Engineering in the USA, Northeast Normal University, Changchun, China 11. April 2 -- The Synergistic Platform for Defluorination and Mineralization of PFAS, Tongji University, Shanghai, China 12. April 4 – The Microorganisms Always Close the Mass Balance, Zhejiang University, Hangzhou, China 13. June 18 – Moving Wastewater from Treatment to Resource, Feng-Chia University, Taiwan

14. June 19 – The Microorganisms Always Close the Mass Balance. Chung-Hsing University, Taiwan
15. June 20 – Moving Wastewater from Treatment to Resource, National Sun Yat San University, Taiwan.
16. June 21 – How PhD Students Succeed in Environmental Engineering in the USA. National Kaohsiung University of Science and Technology, Taiwan.
17. July 25 – Mechanisms of Real-world PFAS Defluorination in Membrane Catalyst-film Reactors and Membrane Biofilm Reactors, SERDP PFAS Symposium, Long Beach, CA
18. August 6 – The Microorganisms Always Close the Mass Balance. Association of Carbon-neutral Circular Economy, KENTECH, Naju, South Korea (Plenary Lecture)
19. August 6 – Moving Wastewater from Treatment to Resource, Institute for Environmental and Climate Technology, KENTECH, Naju, South Korea
20. August 7 – How PhD Students Succeed in Environmental Engineering, KENTECH, Naju, South Korea
21. August 17 – Environmental Engineering and Science. International Workshop on Environmental Science and Engineering, Tongji University, Shanghai, P. R. China (virtual)
22. August 18 – How to be a Successful PhD Student (and Post Doc) in Environmental Engineering and Science, International Workshop on Environmental Science and Engineering, Tongji University, Shanghai, P. R. China (virtual)
23. October 22 – The Role of AOB in N2O Generation, IWA Biofilms 2024 Conference, Shanghai, China.
24. October 23 -- Making the MBfR Do More by Depositing Catalytic Nanoparticles, IWA Biofilms 2024 Conference, Shanghai, China.
25. October 23 -- Biofilms in Environmental Engineering and Science, IWA Biofilms 2024 Conference, Shanghai, China.
26. October 24 – The Microorganisms Always Close the Mass Balance, Nanjing University, Suzhou Campus, Suzhou, China
27. October 24 – How to be a Successful PhD Student in Environmental Engineering, Nanjing University, Suzhou Campus, Suzhou, China

Local Invited Presentations - Bruce Rittmann

1. January 25 – Climate Change Impacts Panel. Global Futures Laboratory, Walton Center, ASU
2. February 1 -- How Unique PFAS Properties Influence Behavior in Water Treatment Processes, with Paul Westerhoff, AZWater Symposium on PFAS, Phoenix
3. April 12 – Sustainability and Environmental Biotechnology, Biodesign Fusion, Phoenix
4. September 24 – Energy Options. Grand Challenges Course, FSE 150.
5. October 16 – How to be a Successful PhD Student in Environmental Engineering and Biotechnology, Biodesign Swette Center for Environmental Biotechnology.

Locally Invited Presentations - Maya Suzuki

1. February 16 – Assessing Feasibility of Critical Mineral Recovery from Surface Waters near Abandoned Mines: Insights from Initial Database Search. School of Sustainability, Engineering and Built Environment (SSEBE) Graduate Poster Symposium.
2. April 24 – Assessing Feasibility of Critical Mineral Recovery from Surface Waters near Abandoned Mines: Insights from Initial Database Search. ARCS Scholar Night, Phoenix.
3. December 2 – Abandoned Mines Remediation Policy. ARCS Luncheon, Phoenix.

Local Invited Presentations - Hannah Collins

1. April 4, 2024 – Movement and Quantification of *Escherichia coli* at a Managed Aquifer Recharge Site. 18th Biennial Symposium on Managed Aquifer Recharge (BSMAR18), Tucson, Arizona
2. April 25, 2024 – Movement and Quantification of *Escherichia coli* at a Managed Aquifer Recharge Site. AZ Water Association Conference, Phoenix, Arizona
3. July 25, 2024 – Movement and Quantification of *Escherichia coli* at a Managed Aquifer Recharge Site. July Maricopa County Waterborne Disease Task Force meeting, Phoenix, Arizona
4. April 12, 2024 – Movement and Quantification of *Escherichia coli* at a Managed Aquifer Recharge Site. Arizona State University Biodesign Fusion Scientific Retreat, Phoenix, Arizona

PI Name: César Torres, Asst. Center Director and Professor

Total Number Presentations: 6

1. Pérez-García, J.A. Advances in microbial-electrochemical technologies for wastewater treatment: Implications and challenges. Plenary lecture at XXXIX National Congress of Mexican Electrochemical Society and 17th Meeting of the Mexican Section of the Electrochemical Society. Campeche, Campeche, México. October 2024.
2. **Torres CI**. The bioelectrochemical production and biological consumption of hydrogen peroxide at a wastewater treatment plant. Invited Seminar at Ghent University, Ghent, Belgium, December 2024.
3. Torres CI. The bio-electrochemical production and biological consumption of hydrogen peroxide at a wastewater treatment plant. Invited Seminar for Latin-America ISMET, Online, June 2024.
4. **Torres CI.** Conceptual Models to Predict G. sulfurreducens' Electrochemical Response and Recent Advances That Have Altered Them. Invited talk at Bio-electrochemical Society Conference, Alcalá, Spain, May 2024.
5. **Torres CI**. Iron-based precipitations for engineered soil treatments. Invited Seminar for Center for Bio-mediated and Bio-inspired Geotechnics, Arizona State University, Tempe, AZ, February 2024.
6. **Torres CI**. Microbial electro-photosynthesis (MEPS): A platform to deliver electrons for biosynthesis to photosynthetic microorganisms. Invited Talk at Electrochemical Synthesis Workshop, University of Wisconsin, Madison, WI, May 2024.

Dr. Jesús Alberto Pérez García presenting a speech about microbial electrochemical technologies for wastewater treatment in the XXXIX National Conference of the Mexican Electrochemical Society, held in Campeche, Mexico. October 9th, 2024.

Jeel Jasoliya (left) presenting the results of his work at the SEMTE Research Symposium on April 26th, 2024, under the supervision of Dr. César Torres (center right) and Dr. Fausto Ortiz-Medina (far right).

Soham Sanghvi (second from the left) presenting the results of his work at the SEMTE Research Symposium on December 6th, 2024, under the supervision of Dr. César Torres (not pictured) and Dr. Fausto Ortiz-Medina (far right). Alongside him, members of the Torres Lab (from left to right): Sam Ferrante (far left), Atul Ojha, Amelia Bryan, and Zia Ullah.

PI Name: Yen-Jung Lai, Research Assistant Professor
Total Number Presentations: 3
1. Zheng C, Luo Y-H, **Lai YJ,** and Rittmann BE. Identifying Biodegradation Pathways of Cetrimonium Bromide (CTAB) Using Metagenome, Metatranscriptome, and Metabolome Tri-omics Integration. IWA-LET, Essen, Germany, June 24-28, 2024. 2. Zheng C, **Lai YJ,** and Rittmann, BE. Biodegradation of Surfactants in the O_2-based MBfR and the Impacts on the Microbial Community and Antimicrobial-resistance Genes. IWA-WWCE, Toronto, Canada, August 12-15, 2024. 3. Lai, YJ. Membrane Carbonation integrated with Microalgae cultivation to upgrade CH_4 in biogas. Biodesign Swette Center for Environmental Biotechnology, ASU, Feb. 2024

PI Name: Everett Eustance, Research Assistant Professor
Total Number Presentations: 1
1. **Eustance E**, Forrester J, McGowen J. Presentation at International Conference on Algal Biomass, Biofuels & Bioproducts 2024, Clearwater, FL. Balancing Biomass Productivity and Carbon Utilization in Outdoor Raceways. 6-11-2024

TECHNOLOGY TRANSFER OUTPUTS IN 2024

Total number of <u>licensed</u> patents for the center: 2
Total number of <u>submitted</u> patents for the center: 4

Filed	
Authors	Delgado AG, Fini E, Kabir SF
Title	Microbial desulfurization and surface activation of rubber
Number	US patent 12103985, 2024

Filed	
Authors	Mohana Rangan S, Delgado AG, Krajmalnik-Brown R
Title	Methods for simultaneous quantification of anions using ion chromatography and suppressed conductivity
Number	US patent 12085544, 2024

Submitted	April 30, 2024
Authors	Justin Flory, Everett Eustance, Bruce Rittmann, Yen-Jung Lai, Tarun Shesh, Diana Calvo-Martinez
Title	Method and System for Membrane Carbonation
Number	US patent application No. 11,970,683

Submitted	Aug, 2024
Authors	Bruce Rittmann, YenJung Lai

Title	Destroying PFAS via nucleophilic reaction occurring in a novel membrane catalyst-film reactor
Number	US patent application No. 63/685,225

Submitted	March, 2024
Authors	YenJung Lai, Tzu-Heng Wang, Paul Westerhoff, Bruce Rittamnn.
Title	High-efficiency photocatalytic hydrogen peroxide production in a dual optical-fiber plus gas permeable membrane-fiber system
Number	US patent application No. 18/614,054

Submitted	February, 20204
Authors	YenJung Lai, Tzu-Heng Wang, Paul Westerhoff, Bruce Rittmann
Title	High-Efficiency Photocatalytic reduction of carbon dioxide in a Dual Optical-Fiber Photocatalytic System
Number	US patent application No. 63/558,229

SPIN OFF COMPANIES IN 2024

1. Precient Technologies, LLC. -- Bruce Rittmann, Chen Zhou, et al successfully completed an NSF-support Phase I STTR Project Report

2. Metric Water Catalyst – Bruce Rittmann was a co-founder of this spin-off company to commercialize the MCfR/MBfR technology to destroy PFAS in water.

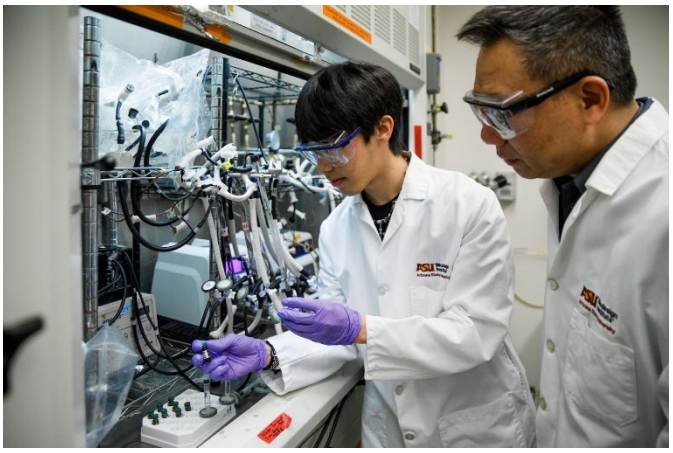
NEW ANALYTICAL CAPABILITIES IN 2024

1. Saleem, Muhammad Usman and Muse, Chris. Developed a new and reliable method using UPLC to measure ciprofloxacin (CIP) at levels as low as 0.2 mg/L. Their approach has shown consistent and reproducible results, making it a promising technique for accurate detection. This advancement not only enhances analytical assays but also paves the way for more efficient research on the co-removal of emerging contaminants such as antibiotics and PFAS compounds.

2. Chris Muse facilitated the Installation of Shimadzu 8060nx LC/MS/MS allowing for low level detection of PFAS compounds.

NEW PURE/MIXED MICROBIAL METABOLISMS

1. Wei, L; Taniguchi, W; Yen-Jung, L, 2024 - *Shewanella oneidensis* MR-1 pure culture in an anaerobic membrane biofilm reactor system for PFAS reduction.



PhD student Winter Taniguchi reviews a reactor set-up with mentor Sean Lai.

UPSCALED BIOPROCESSES IN 2024

1. Bhagat, Kartik. Optimized the ethanol production from anaerobic fermentation.

SPECIALIZED TRAINING IN 2024

1. McLaughlin, Caleb (2024 September). OSHA's Hazardous Waste Operations and Emergency Response training.

OUTSIDE COLLABORATIONS IN 2024

Other ASU Departments:

BSCEB Member	***Collaborator Name, Title***	***ASU Department***
Bruce Rittmann	David Nielson	SEMTE
Bruce Rittmann	Xuan Wang	SOLS
Bruce Rittmann	Paul Westerhoff	SSEBE
YenJung Lai	David Nielson	SEMTE
YenJung Lai	Paul Westerhoff	SSEBE
YenJung Lai	Haiwei Gu	College of Health Solutions
Everett Eustance	Ellie Fini	SSEBE

Everett Eustance	Peter Lammers	SSEBE
Avery Brewer	Emma Frow (Associate professor), Dalton George (Postdoctoral researcher)	SFIS, SBHSE

Outside of ASU:

BSCEB Member	***Collaborator Name, Title***	***Organization, City, Country (outside ASU)***
Bruce Rittmann	Yongming Zhang	Shanghai Normal University, Shanghai, China
Bruce Rittmann	Siqing Xia, Min Long	Tongji University, Shanghai, China
Bruce Rittmann	He-Ping Zhao	Zhejiang University, Hangzhou, China
Bruce Rittmann	Yihao Luo, Yuhang Cai, Dandan Zhou	Northeast Normal University, Changchun, China
Bruce Rittmann	Yonghong Wu	Chinese Academy of Sciences, Wuhan, China
Bruce Rittmann	Joshua Boltz	Woodard & Curran, Portland, ME
Bruce Rittmann	Ahmed Al-Omari, Jose Jimenez	Brown & Caldwell, Alexandria, VA
Bruce Rittmann	Aura Ontiveros-Valencia	IPICyT, San Luis Potosi, Mexico
Bruce Rittmann	Alex Schwarz	University of Concepcion, Concepcion, Chile
Bruce Rittmann	Ayoub Bounaga, Karim LYAMLOULI	UM6P, Ben Guerir, Morocco
Maya Suzuki	Olenka Forde, Charley Mumford	Regeneration/Resolve, SLR Consulting
Maya Suzuki	Natalie Muilenberg	Arizona Department of Environmental Quality
Maya Suzuki	Bryn Thoms	Oregon Department of Environmental Quality
YenJung Lai	Ruey-an Doong, Dean	National TsingHua University, TW
YenJung Lai	Tsu-Chin Chou, Assi Prof	National TsingHua University, TW

YenJung Lai	Hui Hsin Tseng	Taiwan Semiconductor Manufacturing Company Limited, Hsinchu, TW
YenJung Lai	Cheng-Kuo Tsai, Ass Prof	National Yunlin University of Science and Technology Science
Everett Eustance	Alina Corcoran	New Mexico State University
Everett Eustance	Omar Holguin	New Mexico State University
Everett Eustance	Claire Sanders	Los Alamos National Lab
Everett Eustance	Louis Brown	Los Alamos National Lab
Everett Eustance	Lieve Laurens	National Renewable Energy Lab
Everett Eustance	Jason Quinn	Colorado State University
Everett Eustance	Matthew Posewitz	Colorado School of Mines
Everett Eustance	Robin Gerlach	Montana State University
Everett Eustance	Todd Henson	NBO3
Everett Eustance	Jay McCarren	Viridos
Everett Eustance	Ike Levine	The Algae Foundation
Everett Eustance	Graham Peers	Colorado State University
Everett Eustance	Elise Wilbourn	Sandia National Lab
Everett Eustance	Michael Huesemann	Pacific Northwest National Lab
Everett Eustance	James Drouillard	Kansas State University
Anca Delgado	Matthew Scarborough, Assistant Professor	University of Vermont
Anca Delgado	Andrew Palmer	Florida Tech
Anca Delgado	Malak Tfailly	University of Arizona
Anca Delgado	David Strik, Associate Professor	Wageningen University & Research, Wageningen, The Netherlands
Anca Delgado	Jacob Chu ,Engineer, Consultant	Haley & Aldrich
Anca Delgado	Leonard Santisteban, Senior Researcher	Freeport-McMoRan Copper & Gold

Cesar Torres	Annemiek Ter Heijne, Professor	Wageningen University
Cesar Torres	Sanne de Smit, Assistant Professor	Wageningen University
Cesar Torres	Daniel Bond, Professor	University of Minnesota
Cesar Torres	Michelle Young, Senior Technologist	Carollo Engineers
Cesar Torres	Diego Rosso	University of California, Irvine

SERVICE ACTIVITIES IN 2024

*Activities **within Biodesign**:*

BSCEB Member	**Date**	**Location (Center)**	**Activity**
Chris Muse	Jan - Dec 2024	Biodesign Institute	20th Anniversary Biodesign Art Committee
Chris Muse	Jan-April 2024	Biodesign Institute	Mentor Capstone project for Ashley Miranda, Sothea Dien and Ivan Matyushov from Material Science and Engineering
Carole Flores	Jan - Dec 2024	Biodesign Institute	20th Anniversary Internal Celebration Committee Lead
Kassandra Kellenberger	July 2024-Ongoing	Biodesign Institute	Biodesign Safety Committee Member
YenJung Lai	Feb, 2024	Biodesign Institute	ASU Open Door
All members of Swette Center	July 2024	Biodesign Institute	Summer Biodesign Clean-Up Event

*Activities **at ASU**:*

BSCEB Member	Date	Location (Department)	Activity
Bruce Rittmann	2024	SSEBE	Chair, Awards Committee
Caleb McLaughlin, Riley Berg	Nov 2024	Tempe, AZ	Tabling event within the Center for Bio-mediated and Bio-inspired Geotechnics to discuss research at ASU Homecoming
Kassandra Kellenberger	June 2024-Ongoing	Tempe, AZ	Lab Innovation Safety Team member
Juan Fausto Ortiz Medina	2024	Tempe, AZ	Participated in Professional Postdoc Association and ran for a leadership position.
Anca Delgado	2024	SSEBE	Research Director
Cesar Torres	2021-Ongoing	SEMTE	Graduate Chair, Chemical Engineering Program
Cesar Torres	2022-Ongoing	Tempe, AZ	Knowledge Enterprise Advisory Committee

Dr. Fausto Ortiz-Medina presenting his research results at the Arizona Postdoctoral Conference held at University of Arizona, September 20th, 2024.

Inaugural Student and Researcher Peer Support Club meeting on March 14, 2024. Hannah Collins founded the club to provide student-researchers with opportunities to give and receive mental and emotional support. Pictured from left to right: Winter Taniguchi, Prapti Shetty, Hannah Collins, Maya Suzuki, and Kartik Bhagat. Student and Researcher Peer Support Club logo, created by Hannah Collins

Research Specialist Chris Muse featured his glass and wood art in two *Artists of Biodesign* exhibitions in celebration of Biodesign's 20th anniversary. The year-long exhibition was one of many internal activities designed to celebrate our community. Chris also served on the Art committee.

*Activities within the **community and beyond:***

BSEB Member	**Date**	**Location (City, State, Country)**	**Activity**
Chris Muse	March 2024	Tempe, AZ	Creating pottery bowls for the Empty Bowls Take action against hunger through art benefit
Everett Eustance	2024	Houston, TX	Algae Biomass Summit, Vice Chair
Caleb McLaughlin	April 2024	Virtual	Discussed research with a sixth grade science class for the Center for Bio-mediated and Bio-inspired Geotechnics “Engineering Buddies” program
Maya Suzuki	June - Oct 2024	Virtual	Mentored a high school student writing a literature review paper on innovations in stormwater infrastructure and the use of AI
Genji Yao	Sep-Dec 2024	Tempe, AZ	Mentored a high school student to attend science fair with the idea of economical-friendly PFAS degradation
Briana Piaz	May-June 2024	Virtual	Aided in the design and development of the Remote, Iterative, STEM Exchange (RISE) program, aimed at engaging high school students in hands-on, remote STEM learning experiences.
Avery Brewer	2024 - ongoing	Phoenix, AZ	Promoting sustainable agriculture and community-based asset development with Tiger Mountain Foundation via participation in local community farms.
Hannah Collins	March 2024 - ongoing	Tempe, AZ	Founded an unofficial ASU club called the Student and Researcher Peer Support Club, which offers mental and emotional support for fellow peers. Has been providing mentorship for fellow students on classes, program requirements, literature reviews, laboratory work, presentations, funding and job opportunities, school/work/life balance, and more.

ASU Open Door 2024 was managed by Chenwei Zheng, Kartik Bhagat, Genji Yao, Manan Godhani, Asma Sattar, and Prapti Shetti.

Guests created microbial biofilms through a fun game while students explained how microbes transform pollution into useful or harmless chemicals.

Bruce is wearing the 2024 t-shirt contest winner, designed by Sean Lai (right) and his son, Joseph.

EXTERNAL FUNDING

Funding Awards

PI	Title	Sponsor	Sponsor Award #	Start	End	Total Budget
Cadillo, Delgado, Rittmann, Torres	Engineering Research Center for Bio-Mediated and Bio-Inspired Geotechnics (CBBG)	National Science Foundation (NSF)	1449501	08/15	07/25	$34,512,104
Cadillo	Biophysical Processes and Feedback Mechanisms Controlling the Methane Budget of an Amazonian Peatland	University of Minnesota	H007829702	9/1/19	2/29/24	$138,452
Cadillo	Monitoring the changes in methane CH4 emissions and microbes of manipulated cells of the Salt River Landfill an Arid Zone Landfill case study SRL	ASU: Center for Bio-Mediated and Bio-Inspired Geotechnics (CGGB) Consortium	AGR 10/1/2019	8/1/19	7/31/25	$566,860
Cadillo	Hydrologic effects of gold mining in western Amazonia and their implications for mercury and greenhouse gas production	National Geographic Society	PFA-21-PP036	1/1/22	1/31/25	$76,682
Cadillo	Collaborative Research Understanding Collaborative Research Understanding biophysical drivers of the CH4 source sink transition in Northern Forests drive	National Science Foundation (NSF)	2208657	11/1/22	10/31/25	$479,978
Delgado	Enhanced Control of Microbial CBBG Delgado	National Science Foundation (NSF)	1449501	8/1/20	7/31/25	$337,900
Delgado	Collaborative Microbial chain elongation-mediated dehalogenation and carbon transformation	National Science Foundation (NSF)	2221805	9/1/22	8/31/25	$240,039
Delgado	Supplemental - Internship Account - Collaborative Microbial chain elongation-mediated	National Science Foundation (NSF)	2221805	5/21/24	8/31/25	$54,862

	dehalogenation and carbon transformation					
Delgado	EFRI ELiS Bioweathering dynamics and ecophysiology of microbially catalyzed soil genesis of Martian regolith	National Science Foundation (NSF)	2223829	9/1/22	8/31/26	$1,119,625
Delgado	Passive Technologies to Remediate Mining Waste Streams	Arizona Office of the Governor	ISA-ARPA-ASU-102022-40	8/1/24	12/31/26	$66,564
Lai	Enhancing Microbial CO2 Valorization toward Biofuels via a Dual-Fiber System Powered by Visible Light	Arizona Office of the Governor	ISA-ARPA-ASU-102022-40	7/1/23	12/31/26	$265,961
Lai (Rittmann Co-PI)	RAISE CET Enhancing Microbial CO2 Valorization toward Biofuels by a Dual-Fiber System Powered by Visible Light	National Science Foundation (NSF)	2401035	9/1/24	8/31/27	$990,754
Lai	Innovation for Carbon-Water-Energy NEUXE Motivation	Taiwanese Incentive Fund, Global Academic Initiatives	Office of the University Provost , ASU	05/1/24	06/30/25	$16,991
Rittmann (Co-PI)	NSF Nanosystems Engineering Research Center for Off-Grid Nanotechnology Enabled Water Treatment (NEWT)-Yrs 6-10	Rice University (Prime: NSF)	R3F80A	08/20	07/25	$3,318,134
Rittmann (Co-PI)	STEPS Project 2-2 Characterizing Phosphorus After Anaerobic Treatment of High-Strength Organic Waste Streams	North Carolina State University	20020-0165-02	10/1/21	9/30/26	$4,188,100
Rittmann	Maximizing Value from Dairy-cow Wastewater by Intensifying Anaerobic Digestion	Dairy Managemen t Inc.	34270	7/1/21	12/31/24	$243,460
Rittmann	SubContract-DMI-ASU-Woodard Curran	Dairy Managemen t Inc.	34270	7/1/21	12/31/24	$77,442
Rittmann	Improving the performance and efficiency of heterotrophic carbon	National Science Foundation (NSF)	2148629	5/1/22	4/30/26	$588,786

	fixation through strain engineering and membrane-based CO2 delivery					
Rittmann	Bioremediation of 14-Dioxane Using Cometabolic Bioreactors	Arcadis	D22-332R1	8/26/22	10/31/25	$247,913
Rittmann	Enhancing Microbial CO2 Valorization toward Biofuels via a Dual-Fiber System Powered by Visible Light	Arizona Office of the Governor	ISA-ARPA-ASU-102022-40	7/1/23	12/31/26	$265,961
Rittmann	Developing and Testing an Engineered Biological Control for Iron Oxidizing Bacteria in Water Wells	DOI-USBR-LCR: Yuma Area Office	R23AC00315	6/1/23	3/31/26	$265,240
Rittmann	NEWT Non-core Project: In-Situ Resources Production of Hydrogen Gas & Liquid Hydrogen Peroxide from Water Using Functionalized Optical Fibers	H2O Insights (Prime: NASA)	AGR 10/13/23-FP00037240 (80NSSC23PB439)	08/23	03/25	$80,000
Rittmann (Lai Co-PI)	Mechanisms of Real-world PFAS Defluorination in Membrane Catalyst-film Reactors and Membrane Biofilm Reactors	US Department of Defense (DOD)	W912HQ24C0007	12/13/23	12/12/26	$1,029,279
Rittmann	NEWT Non-Core Project An Anaerobic Biofilm Membrane Bioreactor for Food and Beverage Production Wastewater Treatment	Pepsico Inc	2024-15907445	2/5/24	12/15/24	$17,930.00
Rittmann	SubContract Woodard and Curran - NEWT Non-Core Project An Anaerobic Biofilm Membrane Bioreactor for Food and Beverage Production Wastewater Treatment	Pepsico Inc	2024-15907445	2/5/24	12/15/24	$79,587
Rittmann	PFAS ASU Two Year Microbe Study	The Confederated Tribes of the Chehalis Reservation	AGR 3/29/2024	3/1/24	2/28/26	$200,000

Rittmann (Co-PI)	NSF Engines Southwest Sustainability Innovation Engine SWSIE	National Science Foundation	2315479	3/24	2/26	$15 million
Rittmann	Modeling Metal-Reducing Bacteria, Nitrogenous Compounds, Metal Precipitation and Dissolution, Alkalinity and pH, and Counter-Diffusion Biofilms in a Saturated-Rock Fill	Elk Valley Resources	AGR 12/23/2024	11/24	8/26	$997,169
Rittmann (PI) Lai (Co-PI) Muhammad Usman Saleem (Visiting Scholar)	Co-removal of PFAS and ciprofloxacin (CIP) from a synergistic platform of MCfR and MBfR	Higher Eduction Commission (HEC), Pakistan	1-8/HEC/HRD/2024/13147	12/5/24	5/27/25	$3,500
Torres	Electrokinetic SubSurface Transport for Mineral Precipitation and Soil Remediation PR6 ENV ASU	National Science Foundation (NSF)	1449501	8/1/15	7/31/25	$363,658
Torres	Torres - SUPP - Electrokinetic Facilitated Carbonate Precipitation PR43 ENV ASU	National Science Foundation (NSF)	1449501	8/1/15	7/31/25	$157,445
Torres	Cesar Torres - CBBG	National Science Foundation (NSF)	1449501	8/1/15	7/31/25	$71,343
Torres	Electrokinetic Subsurface CBBG Torres	National Science Foundation (NSF)	1449501	8/1/15	7/31/25	$69,142
Torres	Bio-Based Barriers CBBG Torres	National Science Foundation (NSF)	1449501	8/1/15	7/31/25	$309,724
Torres	Microbial electro-photosynthesis MEPS as a bioelectronic platform for organic synthesis	DOD-NAVY: Office of Naval Research (ONR)	N00014-23-1-2104	1/1/23	12/31/25	$346,500
Torres	Mainstream Aerobic Wastewater Treatment Using Process-Produced Hydrogen Peroxide	Carollo Engineers	203725	7/31/23	6/30/26	$763,934