

making an impact

Semi-annual Impact Report

Swette Strategic Investment Fund

January 2018 – June 2018

Prepared by Bruce E. Rittmann
Director and Regents' Professor



Swette Center for Environmental Biotechnology



By using the building blocks of Nature's grand designs, our talented researchers have pushed the frontiers of knowledge and advanced research and discovery to make a **major impact** on our community, nation and the world.

2018 was a year of strong momentum for the Biodesign Swette Center for Environmental Biotechnology. This report highlights key advances that are paving the way for greater discoveries in future.

We are most grateful for the generous support and confidence that the Swette family has provided. Without that help, these achievements would not have occurred.

The Swette Strategic Investment Fund has advanced our ability to create new solutions

The Swette Strategic Investment Fund has supported the Biodesign Swette Center for Environmental Biotechnology (Swette Center) as its researchers develop preliminary results, publish seminal papers, give talks across the world to enthusiastic audiences, and have time to seek funding for new projects. We have been fortunate in our ability to attract outstanding researchers and integrate them effectively into our team and our work. Their talents and inspiration is an ongoing source of ideas for traveling new paths and making new discoveries.

The Swette funds have been the fuel that has enabled us not only to attract the best and the brightest, but to take giant leaps in our search for solutions that will help the world create a more sustainable environment. Here are a few examples of projects that have gained traction due to the Swette funds:

- Swette investments were made towards exploring and understanding the human intestinal microbiome. This resulted in a grant from the National Institutes of Health for nearly \$4 million, plus a \$1.3-million grant from the Department of Defense.
- We also invested in our microbial photobioenergy team. This led to a \$1-million grant from the Department of Energy. We continue to invest in the microbial photobioenergy area, because we have promising ideas for how to significantly enhance the productivity of photobioenergy systems.
- The Swette investment also allowed us to play a leadership role in a new initiative at ASU organized by President Michael M. Crow and George Poste. Called DECISIVE (Designed Collaborations for Integrated Scale in Visionary Exploration), the project seeks to stimulate new cross-university collaborations that have the potential to meet some of the world's most pressing challenges.

OUR MISSION

The mission of the Biodesign Swette Center for Environmental Biotechnology is to manage microbial communities that provide services to society. Many of the services make our society more environmentally sustainable, for example, generating renewable resources and making polluted water and soil clean.

The microbial services also make humans healthier – directly and indirectly.

The Swette Center is noted for its culture of cross-disciplinary and team-based research. This culture begins with our researchers who come from diverse disciplines within engineering, life sciences, chemistry, and more.

The Center embraces systems thinking, sustainable engineering, and disruptive innovation. Partnerships are common within the different research groups in the Swette Center, other groups in ASU, national and international universities, and practitioners.

How do we measure success?

The Swette Center is a major international player in the search for new ways to create a more sustainable human society. Our research, technologies, and people are the driving forces for improving environmental quality, creating truly renewable resources, and helping humans be healthier. How do we know that we are having a positive impact?

On the ground, our work is leading to technological advances that are helping society move towards better sustainability. For example, Swette Center research has established that fecal transplants can help those in the autism spectrum interact better with their families and colleagues— preliminary findings that are clearly of interest to a world and a nation where one in 68 children has an autism spectrum disorder. The U.S. alone saw a 30 percent increase from 2012 to 2014, as reported by the Centers for Disease Control and Prevention.

We were also able to demonstrate that our membrane biofilm reactor can convert toxic metals in mining wastewaters into highly valuable nanoparticles. We started a spin-off company to commercialize this exciting advance. And, we are scaling up microbial electrochemical cells to provide energy-neutral wastewater treatment for groups of 50 to 500 people in remote areas.

Our work is adding to an important body of knowledge in the field of environmental biotechnology. Some of the impacts occur primarily within the academia and are readily tabulated. For example, we **published 29 papers**, received **two additional research grants** in the past six months bringing our total to **26 ongoing research programs**, and **garnered 16 awards** over the past six months. We are proud of our long list of alumni who are leading the field and inspiring the next generation of environmental scientists.

More difficult to quantify, but certainly creating impact, are our outreach events that include teaching biology in prisons, involving undergraduates and high-schoolers in our research, and being a magnet for international visiting scientists and research collaborators.

OUR PEOPLE

Building strong leadership



Promotions. The Center’s leadership is provided by six tenure-track faculty and one research professor. In May, **Hinsby Cadillo-Quiroz** was promoted to Associate Professor (with tenure) in the School of Life Sciences, and **Rosa Krajmalnik-Brown** was promoted to Full Professor in the School of Sustainable Engineering and the Built Environment. We celebrated with a Center brunch (**Figure 1**), since success for one represents success for all. We talked about the process of faculty promotion so that our graduate students know what to expect in their academic futures.

Figure 1. Faculty (and family) attend promotion brunch. Pictured left to right: back Treavor Boyer, Cesar Torres, Bruce Rittmann, Rosa Krajmalnik-Brown, Yosi Wolchansky; front row Anca Delgado, Ann Hammond Cadillo, Hinsby Cadillo-Quiroz, Rina Wolchansky

Stockholm Water Prize, Bruce Rittmann. Professor **Bruce Rittmann** is a co-winner of the prestigious 2018 Stockholm Water Prize (**Figure 2**). “Together, Professors Rittmann and van Loosdrecht are leading, illuminating, and demonstrating the path forward in one of the most challenging human enterprises on this planet — that of providing clean and safe water for humans, industry, and ecosystems,” said Torgny Holmgren, executive director of the Stockholm International Water Institute, in an [article](#) published in the April 2018 edition of *The Stockholm Waterfront*.



Figure 2 Professors Bruce Rittmann and Mark van Loosdrecht (Delft University of Technology) share the 2018 Stockholm Water Prize.

CBBG Thrust Leader, Rosa Krajmalnik-Brown. Professor Rosa Krajmalnik-Brown continues to serve as a thrust leader for Environmental Protection and Ecological Restoration (Thrust 2) for the [Center for Bio-mediated and Bio-inspired Geotechnics](#) (Figure 3). As a CBBG researcher, she leads a microbial metabolic exploration team that seeks to isolate microbes and develop enrichment cultures that metabolize hexavalent chromium, trichlorethane, perchlorate and other environmental pollutants for bioremediation purposes. Many of our Center members participate in CBBG research and travelled to Atlanta, GA for the Midyear Meeting for the Center for Bio-mediated, Bio-inspired Geotechnics, including Bruce Rittmann, Rosa Krajmalnik-Brown, Anca Delgado, Cesar Torres, Megan Altizer, Caitlyn Hall, and Srivatsan Mohana Rangan.



Figure 3. Dr. Krajmalnik-Brown leads the Environmental Protection thrust of the Center for Bio-mediated and Bio-inspired Geotechnics.

Developing career paths



Daewook Kang

Daewook Kang was promoted from Assistant to Associate Research Scientist in May of 2018. He has participated in collaborations with the Translational Research Institute and Department of Defense on projects characterizing microbiomes associated with bioenergetics and autism.

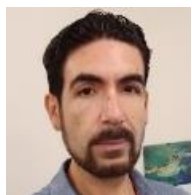


Juan Maldonado Ortiz

Assistant Research Scientist **Juan Maldonado Ortiz** merged the Swette Center Microbiome Analysis with the College of Liberal Arts & Sciences Genomics Facility at the Biodesign Institute, to consolidate Next Generation Sequencing and bioinformatics resources and expertise to serve ASU and beyond in the discovery and characterization of microbiomes unique to their research.

Attracting the right people

The total number of people working in the Swette Center ranged from 90 to 105 people over the year. This includes graduate students, post-doctoral associates, undergraduate interns, high school interns, visiting scholars, and staff. Here are a few of our impressive newcomers.



Carlos Leyva

Carlos Leyva is an Electrical Engineer who graduated from ASU who started working for [Future H₂O](#) and Dr. Treavor Boyer, last year. He is working to build a cyber-physical system of water quality sensors to monitor the quality of the new Biodesign C building's drinking water as it goes from low occupancy to full.



Joshua Boltz

Dr. Joshua Boltz, a noted biofilm-process modeler and environmental-engineering practitioner, joined us in April. Considered an expert on the development and application of process models (particularly those describing biofilm reactors), his experience with [biofilm and biofilm reactor] research, model development and application, experimental and laboratory system design, and full-scale biofilm-reactor design and operations is extensive. Josh will begin at a Visiting Scientist, but we soon will make him a Research Engineer. He has deep expertise and interest in modeling biofilms processes used in aerobic wastewater treatment, and he also is taking a lead at modeling around selenate reduction and anaerobic wastewater treatment.



Chris Connot



Jigar Patel



Yesenia Moreno

New to the Krajmalnik-Brown Lab are Research Technicians **Chris Connot**, **Yesenia Moreno Caro**, and **Jigar Patel**. Mr. Connot will be assisting with molecular biology, chemical analysis, bioreactor culture and sampling, and bioinformatics pertaining to Dr. Krajmalnik-Brown's NIH project *Integrating Quantitative Energetics Determines the Microbiomes Contribution to Energy Balance*. Ms. Moreno Caro and Mr. Patel will be assisting with a project sponsored by Finch Therapeutics, *Enhanced Statistical Analysis of Phase 1 FMT Trial*, for which they will be conducting microbiome analyses for successful FMT trials for individuals with Autism Spectrum Disorder. Under the guidance of Research Scientist Daewook Kang, they will all be culturing microbes associated with the human gut as well as performing molecular biology needed to quantify their diversity in bioreactors and fecal samples and performing analytical chemistry to characterize their products.



Figure 4. University of Costa Rica collaborators Dr. Ana Gabriela Perez from the Greenhouse Gas and Carbon Capture Laboratory, Dr. Ana Mara Duran in the Geophysics Research Center, and Dr. Andrea Vincent from the Biology School.

Initiating world-wide collaborations

Costa Rica Collaboration, Hinsby Cadillo-Quiroz. Dr. Hinsby Cadillo-Quiroz recently visited the University of Costa Rica to develop a new collaboration with Dr. Ana Gabriela Perez from the Greenhouse Gas and Carbon Capture Laboratory, Dr. Ana Mara Duran in the Geophysics Research Center, and Dr. Andrea Vincent from the Biology School (**Figure 4**). Two pre-proposals were developed and submitted for joint research focusing on



Hinsby Cadillo-Quiroz

“Assessment of rural livelihood impacts on ecosystem services in a Costa Rica peatland complex and its connections to climate and policy making for conservation” plus the “Seasonal variations of carbon dioxide and methane emissions in a tropical river bog”. Peatlands in Costa Rica have been understudied, some are under anthropogenic pressure by agriculture and fire and others are under climatic change regime. This collaboration aims to provide first records and solutions on how to manage these fragile ecosystems.

AEESP Chair, Treavor Boyer. Professor Treavor Boyer was selected as the Chair of the organizing committee to host the AEESP Research and Education Conference in May of 2019 at ASU. The AEESP conferences, the premier event for American professors of environmental engineering and science, are held every two years. ASU will host the first AEESP Conference in the Southwest.



Treavor Boyer



Association of Environmental Engineering & Science Professors

1963-2013: Celebrating 50 Years of Advancing Environmental Engineering & Science



Bruce Rittmann

U6MP, Bruce Rittmann. The University of Mohamed 6 Polytechnic is a new university in Morocco. Mohamed 6 is the king of Morocco. UM6P came to ASU a couple years ago with a request to help them get started, and Dr. Rittmann is leading that charge. We are slated to begin a new project on recovering sulfur and rare-earth metals from the wastewater that comes from mining phosphate rock. Morocco controls around 70% of the world’s phosphate reserves; so, phosphate is big business in Morocco. We will adapt our membrane biofilm reactor for this purpose. Dr. Rittmann will visit Morocco in July of 2018, and the new project should begin in September.



Figure 5 UM6P campus



Figure 6 Phosphate mining in Morocco



Isa Peraza

Mayan Culture and Environmental Engineering. As part of a Climate Change course he took this Spring, **Isa Peraza** (PhD student in Environmental Engineering) wrote a research paper titled: The different theories to explain the great Maya collapse influenced by climatic events. Isa is from the Yucatan, is a Mayan scholar, and teaches about the Mayan language. Isa Peraza collaborated to create a curriculum for a summer class in fundamental of scientific research in the natural sciences a class planned to high School students that are a subsection of the Yucatan State University



Neng long Chan

United Nations Internship. Neng long Chan (PhD student in Life Sciences) won a 2018 May Joint FAO/IAEA Programme internship in Soil and Water Management & Crop Nutrition Section. His internship is at the United Nations Food and Agriculture Organization/International Atomic Energy Agency, Vienna, Austria.

Exploring commercialization

NSF National I-Corps Program. The NSF’s I-Corps program provides entrepreneurship training for scientists and engineers to help transition their technologies to the marketplace, with a strong focus on customer discovery. We had three teams from the Swette Center participate: **Dr. Anca Delgado and Megan Altizer** working on a novel reactor for growing dechlorinating bacteria, **Dr. César Torres and Dr. Georgios Papacharalampos** working on applications of microbial electrochemical cells (MECs) in wastewater, and **Dr. Leon van Paassen and Caitlyn Hall** working on a bioinspired technology to repair dam infrastructure (**Figure 5**). Dr. van Paassen and Cailyn Hall advanced to the national level and just completed the program.



Figure 5. VanPaassen and Hall visit Indianapolis, Indiana for three days of interviews with industry professionals.



Matt Scholz

Sustainable Phosphorus Alliance. The Swette Center continues to host the Sustainable Phosphorus Alliance, (SPA) an organization that functions as an industry nonprofit that promotes the sustainable use, recovery, and recycling of phosphorus in the food system. **Matt Scholz** is the Director of SPA.

Leveraging that support, the Alliance hosted its second annual Phosphorus Forum event on the Tempe campus on February 26th, attracting some 60 participants, mostly from industries across the US and Canada (**Figure 6**). The event brought these participants from across the phosphorus value chain together for knowledge sharing and networking. Video footage of the day’s events is available at <https://youtu.be/8A9NFkSwji8>.



Figure 8. 2nd Annual Phosphorus Forum, Tempe, AZ

Modeling our mission



Daniella Saetta

Biodesign Water Quality, Boyer Lab. Engineer **Carlos Leyva**, PhD student **Daniella Saetta**, Masters student **Rebecca Dietz**, and **Professor Treavor Boyer** are leading The Biodesign C Water Quality Project, which is funded by the ASU Future H2O initiative. The goal of the project is to create a tool for building occupants based on the water quality in a newly constructed green building with a focus on human health. The tool will be able to inform users on the real-time water quality within the building.



Carlos Leyva

Water samples are taken twice a week and on-line monitors are placed in the building for continuous water quality analysis (Figure 7). Predictive models will be made with the water quality data to actuate valves used to move aged water out of the system. Green building design has long used “smart” energy systems to reduce their use of energy, while providing a satisfying work environment. This “smart” water system fills the void of technologies available for water quality monitoring in green buildings of the future.



Figure 6. Biodesign C online instrument



Green Events.
Led by PhD student **Burcu Yavuz**, our Center is leading by example by

Burcu Yavuz giving our monthly birthday and other celebrations a sustainability makeover. Since we are dedicating our lives to sustainable principles, we seek to convince the world that “the concept of waste or waste products is obsolete (Rittmann, 2018)”. For example, we celebrated Dr. Hinsby and Dr. Rosy's promotions without generating waste. We requested recyclable materials (aluminum and plastic) from our catering vendor. We provided compostable plates and a bag for organic waste. As we ate, sorted, cleaned, and tallied our numbers, it became clear how good this felt and how easy it can be if we all chip in.



Left to right: *top row* Sayalee Joshi weighs waste and calculates distributions, nearly 75% of all aluminum ever produced is still in use so recycle it, was this actual trash even necessary; *middle row* single-use plastics are very dangerous in the ocean, Steven Hart and Isa Peraza weighed our compostable waste; *bottom row* Shefali Rao and others helped clean recyclable and reusable items, some of the Center members who attended the party celebrate zero waste!

The final numbers and the pictures are inspiring. We generated about 7.2 kg of waste. Of that waste, 42% was **organic compostable material** (that is the number the literature always comes up with!), 51% was **recyclable**, and 7% was **reusable**. The only waste that absolutely had to go to **landfill** was mainly single use plastic and some plastic lined cups that weighed in at about 0.7% of the total mass we generated. Even that is avoidable in the future. In summary, had we thrown things into the trash we would have missed an opportunity to reduce our waste by two orders of magnitude, and it wasn't even hard to do the opposite.

As leaders, we should consider ways in which we can build on these small successes to make our world more beautiful. It is wonderful to live by our principles and it is even more wonderful to apply the things we learn to our work. We are thankful for the gracious participation of everyone in our Center. We've learned that we need to ask caterers to avoid single-use containers (e.g. syrup, butter, and creamer) and we're hoping that these principles can be adopted by the Biodesign Institute as a whole.

| | Category | Mass (kg) | Percent | Category Percent |
|--------------------------|------------|--------------|---------------|------------------|
| Compost | Compost | 3.010 | 41.7% | 41.7% |
| Syrup Cups | Landfill | 0.018 | 0.2% | |
| Butter Cups | Landfill | 0.003 | 0.0% | |
| Coffee Creamer cups | Landfill | 0.011 | 0.2% | |
| Stir sticks | Landfill | 0.001 | 0.0% | 0.5% |
| aluminum | Recyclable | 2.180 | 30.2% | |
| Sterno Aluminum/Tin | Recyclable | 0.174 | 2.4% | |
| Plastic Containers | Recyclable | 0.413 | 5.7% | |
| Plastic Cups | Recyclable | 0.190 | 2.6% | |
| Plastic Jugs | Recyclable | 0.370 | 5.1% | |
| Plastic Caps | Recyclable | 0.010 | 0.1% | |
| Soft plastic | Recyclable | 0.060 | 0.8% | |
| Cardboard | Recyclable | 0.285 | 3.9% | 51.0% |
| Provided plastic utensil | Reusable | 0.236 | 3.3% | |
| Plastic Cutlery | Reusable | 0.265 | 3.7% | 6.9% |
| Total | | 7.226 | 100.0% | 100.0% |

The following section documents the Center's achievements in these categories:

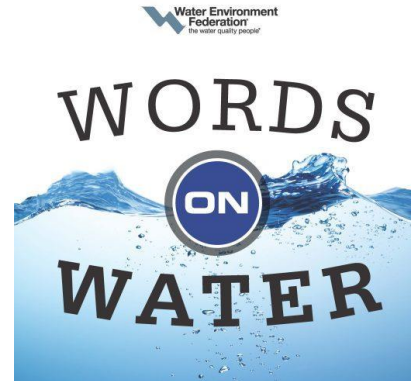
- Research Activities and Outputs
- Mentoring Activities
- Special Activities and Impacts
- Awards and Accolades
- Alumni Success



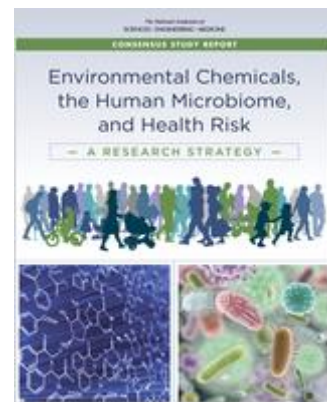
Research activities and outputs, January – June 2018

29 publications and media, 5 high-profile examples

- [In a May 28, 2018 podcast](#), Dr. Bruce Rittmann shared stories about using microbial communities to transform pollutants into resources, applying mathematical modeling to optimize treatment processes, and about how working at a wastewater plant influenced his career.
- [Microbiota Transfer Therapy alters gut ecosystem and improves gastrointestinal and autism symptoms: an open-label study](#), by Rosa Krajmalnik-Brown and Dae-Wook Kang et al and published in *Microbiome*, was selected to appear as a must-read article as part of the 2018 Springer Nature [Change the World](#) initiative.
- Boyer Lab Video. ASU students **Claire Cleveland**, **Jenna Miller**, **Garr Punnett**, and **Grace Clark** filmed and edited a sustainability documentary titled [Peecycling: The #1 Solution](#), in which members of the Boyer Lab describe various strands of research that involve pharmaceutical removal and resource recovery from an abundant resource: urine. Transforming nutrient use from a destructive linear flow into a sustainable cycle, or “peecycle,” can result in a sustainable source of fertilizers to replace chemical fertilizers and prevent eutrophication of lakes and other water bodies. The video also highlights the importance of outreach and education to change the public’s perspective about harvesting resources from urine.



- **Dr. Rosa Krajmalnik-Brown** was on the committee of the National Academies of Sciences, Engineering, and Medicine that released *Advancing Understanding of the Implications of Environmental-Chemical Interactions with the Human Microbiome. Environmental Chemicals, the Human Microbiome, and Health Risk: A Research Strategy*. Washington (DC): National Academies Press (US); 2017 Dec 29. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK481560/> doi: 10.17226/24960.



- Korean PBS interviewed **Drs. Rosa Krajmalnik-Brown, Dr. Daewook Kang,** and **Dr. James Adams** to discuss promising fecal microbial transplant research results featured in a three-part YouTube series. [Joe Kullman](#) authored an article in FSE Full Circle featuring the collaborative project that explores microbiome treatments for people with autism. Read the full article [here](#).



48 presentations at conferences, universities, and other research laboratories, and six examples

- **Hart, S.,** Young, M., Ki, D., Brown, S., Wilson, C., Parameswaran, P., Torres, C.I. "Improved Characterization of Anaerobic Digestion Kinetics of Mixed Sludges With and Without Thermally Pretreated WAS" for the WEF Residuals and Biosolids, Phoenix, AZ, 2018.
- **Ki, D.,** Kupferer, R., Torres, C.I. "Primary sludge to valuable chemicals, hydrogen peroxide (H₂O₂), in microbial electrochemical cells: H₂O₂ production and in-situ sludge treatment" for the WEF Residuals and Biosolids, Phoenix, AZ, 2018 (Podium Presentation).
- **Mohana Rangan, S.,** A. Mouti, A.G. Delgado, R. Krajmalnik-Brown, G.V. Lowry, L. LaPat-Polasko, and H. Brenton. Trade-Offs in Utilizing Zero-Valent Iron for Synergistic Biotic and Abiotic Reduction of Trichloroethene and Perchlorate. Srivatsan Mohana Rangan (Arizona State University/USA). Battelle 2018. Eleventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Spring California. April 2018.
- **Peraza, I.** Presented a talk titled: Mathematical modeling of electroactive biofilms at the first meeting of CONACYT fellowships in United States in Washington DC from 15 to 17 of March.
- **Rittmann, B.E.** Invited lecture, "Including Biofilm Detachment in Models. NSF-sponsored workshop on Mechanical Properties of Biofilms," University of Notre Dame, South Bend, IN. April 23, 2018.
- **Rittmann, B.E.** Invited lecture, "Roux-en-Y Gastric Bypass Surgery Shifts Gut Microbial Communities and Associated Metabolites," Soochow University, Suzhou, PRC. June 8, 2018.

1 patent application pending.

26 externally funded research projects

from **18** U.S. federal agencies (National Science Foundation, National Institutes of Health, Department of Energy, Department of Defense, and NASA)

Other funders included foundations, industries, and foreign agencies.

Mentoring activities

- **7** degrees earned: **2** PhDs, **1** Masters, and **4** Bachelors
- **41** graduate students, **4** post-doctoral associates, and **3** research scientists
- **28** undergraduates, including **1** Swette Undergraduate Sustainability Intern and **3** Fulton Undergraduate Research Initiative Scholars
- **5** visiting scholars
- **3** high school student and **1** teacher
- **3** volunteer researchers

Special activities – highlights (see appendix for comprehensive list)

- Faculty member Rosa Krajmalnik-Brown was invited to participate in the National Academies of Science, Engineering, and Medicine Committee on Advancing Understanding of the Implications of Environmental-Chemical Interactions with the Human Microbiomes
- Ph.D. Student Neng long Chan was selected as a Collaborator to create a curriculum for a summer class in fundamental of scientific research in the natural sciences a class planned to high School students that are a subsection of the Yucatan State University
- Ph.D. Student Isaias Peraza co-designed a curriculum for a summer class in the fundamentals of scientific research in the natural sciences for high school students that are a subsection of the Yucatan State University
- Director Bruce Rittmann participated in the Fellows Steering Committee for the Association of Environmental Engineering and Science Professors

Awards and accolades – highlights (see appendix for comprehensive list)

16 awards to **12** individuals, including:

- **5** Dean’s Fellowships from the Fulton Schools of Engineering
- **2** best-paper winners
- **3** travel grants
- **1** Stockholm Water Prize!

Alumni success

A measure of our alumni success is the number of PhD and post-doc alumni who are now tenured or tenure-track professors at major universities around the world. These include:

- **Sofia Esquivel Elizondo** secured a postdoctoral research fellowship at the Max Planck Institute for Developmental Biology in Tübingen, Germany.

- **Zehra (Esra) Ilhan** secured a postdoctoral research fellowship at the University of Arizona in Phoenix, Arizona.
- **Levi Straka** secured a postdoctoral research fellowship at the University of Washington in the Civil and Environmental Engineering Department.
- **Aura Ontiveros Valencia** completed a postdoctoral research fellowship at the ITESM Campus and ITESM, a postdoctoral research fellowship at the University of Notre Dame, and has been appointed as an Assistant Research Professor at the Tecnológico de Monterrey in Puebla de Zaragoza, Mexico.
- **Avni Solanki** will begin a lecturer position at Washington University in St. Louis in the Department of Energy, Environmental, and Chemical Engineering in Fall of 2018.
- **Prathap Parameswaran**, now Assistant Professor in Civil Engineering at Kansas State University, is one of five recipients of the first award issued by the Kansas NSF EPSCoR, which supports early career research related to Microbiomes of Aquatic, Plant and Soil Systems. **Dr. Parameswaran's** project, Smart adaptation of enriched microbiomes in Recovered Nutrient Products (bio-fertilizers) from anaerobic wastewater treatment to the native soil, is profiled by [this article](#).

The Biodesign Institute is a place unlike any other. We assemble scientifically diverse teams to galvanize great ideas into real-world global solutions in state-of-the-art research laboratories at Arizona State University (one of the nation's largest public research universities) located in Tempe, Arizona. Whether it's seeking a cure for Ebola, removing toxic chemicals from air and water, or developing a diagnostic tool to assess widespread radiation exposure, the scientists at the Biodesign Institute take their cues from people and nature.

OUR APPROACH

We see things differently at Biodesign. Research begins with the identification of a real-world threat or opportunity and engages the best minds and resources.

- **We illuminate threats** ... we identify and understand threats to our health, personal security and our planet
- **We mobilize teams** ... our dynamic teams are interdisciplinary – involving biologists, chemists, engineers, statisticians, physicists, mathematicians, etc. – who look to nature for inspiration to solve today's grand challenges
- **We shepherd solutions** ... we are committed to getting our research outcomes into the hands of those who need it most – through discoveries shared in publications, open science, products or spin-

OUR INSPIRATION

The ASU Biodesign Institute was not created in the image of a traditional research institute, with a rigid focus on a single field of study, but instead focuses on biological and nature-inspired solutions of public value. ASU is broadly inclusive in approach, advancing education for everyone.

THE BIODESIGN MODEL

Launched in 2003, the Biodesign Institute is organized into 16 research centers lead by world-renowned scientific leaders and staffed by distinguished faculty, technicians and students from all over the world – all of whom are dedicated to providing real world solutions to today's global challenges.

OUR LEADERSHP



*Joshua LaBaer, MD, PhD
Executive Director,
Biodesign Institute at ASU
Director, Biodesign Virginia
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Personalized Diagnostics,
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APPENDIX

Appendix

For more information, visit the Center website: <http://www.environmentalbiotechnology.org/>

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New babies!



Above: proud parents of Baby Silvia: Cesar Torres & Anca Delgado



**Baby Ian Dojun Ki
(Papa Dongwon Ki - BSCEB Postdoc)**

**Baby Bella, her pup and her lab cousin Baby Silvia
(Momma Diana Calvo Martinez BSCEB PhD student)**

Research activities and outputs

Funded research

Faculty in the Swette Center have achieved success in leveraging the Swette Strategic Investment to obtain new research projects, including a number of large awards. The table below lists major new projects.

| Sponsor | Principal Investigator | Title and Award Amount |
|---|---|---|
| Aquarius Technologies, LLC (7/15/18-1/14/19) | PI Bruce Rittmann and Joshua Boltz | <i>A model of selected microfauna and meiofauna predation in a biofilm reactor, \$20,002</i> |
| Finch Therapeutics/Crestovo (3/1/18-9/30/18) | PI Krajmalnik-Brown | <i>Microbiome analyses for successful FMT trials for individuals with ASD, \$90,013</i> |
| DOD-ARMY-USAMRAA W81XWH- 16-1-0492 (9/1/16-8/31/20) | PI Adams co-PI Krajmalnik-Brown | <i>Treating gastrointestinal and autism symptoms in adults with autism using Microbiota Transfer Therapy (MTT), \$ 1,293,794</i> |
| ASU Foundation, 30007312 | PI Adams, co-PI Krajmalnik-Brown | <i>Long-term Follow-up on Beneficial Bacteria Treatment Study, \$28,008</i> |
| NSF-ENG-CBET, CAREER 1713704 (7/15/2016 - 12/31/2018) | PI Boyer | <i>Sustainable Urine Processes through integration of Education and Research, \$156,627</i> |
| NASA-GODDARD SPACE FLIGHT CTR NNX15AD53G (12/31/14-12/30/19) | co-PI Cadillo-Quiroz | <i>Exoplanetary Ecosystems: Exploring Life's Detectability on Chemically Diverse Exoplanets, \$6,097,436</i> |
| NSF-GEO-OCE 1658527 (3/15/17-2/29/20) | co-PI Cadillo-Quiroz | <i>Aggregation of Marine Picoplankton, \$687,521.00</i> |
| NSF-BIO-DEB 1355066 (5/1/14-4/30/19) | PI Cadillo-Quiroz | <i>Collaborative Research: Forest productivity and hydrological patterns regulate methane fluxes from peatlands in the Amazon basin, \$626,999.00</i> |
| NSF-BIO-DEB 1637590 (12/1/16-11/30/18) | co-PI Cadillo-Quiroz | <i>LTER CAP IV: Design with Nature, \$4,508,000</i> |
| CHEVRON ENERY & TECH. CORP CW1022841/14072019 (1/27/14-6/30/18) | PI Johnson co-PIs Delgado, Krajmalnik-Brown, Rittmann | <i>In-Situ Remediation of Heavy Hydrocarbons in Impacted Vadose Zone Soils: Strategy and Management Approach for Innovation, Chevron Energy and Technology Company, \$2,075,233</i> |
| National Science Foundation, NSF-ENG-EEC 1449501 (08/01/17–07/31/18) | PI Kavazanjian, Co-PIs Krajmalnik-Brown, Torres, Rittmann, Boyer, Cadillo-Quiroz | <i>Center for Bio-mediated and Bio-inspired Geotechnics, \$18-million</i> |
| National Institutes of Health, HHS-NIH 1R01DK105829-01A1 (9/1/16-6/30/21) | PI Krajmalnik-Brown, co-PIs Rittmann, Marcus | <i>Integrating Quantitative Energetics Determines the Microbiomes Contribution to Energy Balance, \$3,936,800</i> |
| Mayo Clinic Arizona ARI-225822 (3/1/17-8/31/18) | co-PI Krajmalnik-Brown | <i>Obesity in Menopause: The role of estrogen therapy on the gut microbiome and host, \$50,000</i> |

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| Department of Energy, DOE DE-EE0007562 (10/1/16-9/30/18) | PI Lammers, co-PI Krajmalnik-Brown | <i>A novel platform for algal biomass production using cellulosic mixotrophy, \$1,689,791</i> |
| Department of Energy, DOE-EERE DE-EE0007093 (10/1/15-9/30/18) | PI Rittmann, | <i>Atmospheric CO2 Capture and Membrane Delivery, \$1 million</i> |
| National Science Foundation, NSF-ENG 1509933 (7/1/15-6/30/19) | PI Rittmann | <i>Targeted saturated fatty acids synthesis by microbial biohydrogenation and its superior extraction from microalgae biomass through fermentation, \$309,443</i> |
| Sponsor | Principal Investigator | Title and Award Amount |
| National Science Foundation, NSF-ENG 1702445 (7/1/17-6/30/20) | PI Rittmann | <i>Enhancing Biodegradation of Quaternary Ammonium Compounds (QAC), \$329,738</i> |
| Lightworks – FY18 | PI Rittmann | <i>Growth conditions affecting biomass competition for calcifying <i>Emiliana huxleyi</i> in a direct membrane-carbonation photobioreactor, \$13,046</i> |
| GIOS – FY18 | PI Rittmann Co-PIs Krajmalnik-Brown, Torres, Marcus, Boyer, Cadillo-Quiroz | <i>Swette Undergraduate Scholar Fund</i> |
| Department of Defense, DOD-SERDP W912HQ-17-C-0013 (04/01/17-04/05/19) | PI Rittmann co-PI Krajmalnik-Brown | <i>Synergistic Reductive Dechlorination of 111-Trichloroethane and Trichloroethene, \$200,000</i> |
| National Science Foundation, NSF-ENG 1603656 (7/1/16-6/30/19) | PI Rittmann, co-PI Torres | <i>SusChEM: Engineering the Hollow-Fiber Membrane Biofilm Reactor to Convert Syngas to Valuable Products, \$209,022</i> |
| Department of Defense, DOD-NAVY-ONR N00014-15-1-2702 (9/1/15-10/31/18) | PI Torres co-PI Krajmalnik-Brown | <i>Combining Electrochemical -Omics and Microscopic Approaches to Characterize Transport Limitations in Anode-Respiring Bacteria Biofilms, \$448,955</i> |
| Department of Defense, DOD-NAVY-ONR N00014-15-1-2571 (05/01/15-04/30/18) | PI Torres | <i>Development of Substrate-loaded Microbial Fuel Cells for Powering Remote Sensors, \$399,775</i> |
| NSF-EHR-DGE 1144616 (07/01/12-06/30/18) | PI Vermaas co-PI Torres | <i>IGERT: Solar Utilization Network (SUN), \$3,006,642</i> |
| NSF-BIO-DBI 1531991 (09/01/15-08/31/18) | PI Spence Co-PI Torres | <i>MRI: Acquisition of Cryo-EM for Southwest Regional Center, \$2,825,509</i> |
| Center for Applied Structural Discovery Start-Up – FY18 | PI Fromme co-PI Torres | Microbial Electro-Photosynthesis (MEPS) |

Patents issued, licensed, or applications pending

(Current Swette Center members in boldface)

Rittmann, B., Klaus, L., Justin, F., **Megha, P.**, & Allen, W. (2018). Systems and methods of atmospheric carbon dioxide enrichment and delivery to photobioreactors via membrane carbonation. U.S. Patent No. 15/564,862. Washington, DC: U.S. Patent and Trademark Office (application pending).

Papers published or accepted in the first half of 2018

(Current Swette Center members in boldface)

1. Alemán-Nava, G. S., Gatti, I. A., Parra-Saldivar, R., Dallemand, J., **Rittmann, B. E.**, & Iqbal, H. M. (2018). Biotechnological revalorization of Tequila waste and by-product streams for cleaner production – A review from bio-refinery perspective. *Journal of Cleaner Production*, 172, 3713-3720. [doi:10.1016/j.jclepro.2017.07.134](https://doi.org/10.1016/j.jclepro.2017.07.134).
2. Alrashed, W., Lee, J., Park, J., **Rittmann, B.E.**, Tang, Y., Neufeld, J.D., Lee, H.S. (2018). Hypoxic methane oxidation coupled to denitrification in a membrane biofilm. *Chemical Engineering Journal*, 348, 745-753. <https://doi.org/10.1016/j.biortech.2013.03.115>.
3. Burke, R. D., Dancz, C. L., Ketchman, K. J., Bilec, M. M., **Boyer, T. H.**, Davidson, C., . . . Parrish, K. (2018). Faculty Perspectives on Sustainability Integration in Undergraduate Civil and Environmental Engineering Curriculum. *Journal of Professional Issues in Engineering Education and Practice*, 144(3), 04018004. [doi:10.1061/\(asce\)ei.1943-5541.0000373](https://doi.org/10.1061/(asce)ei.1943-5541.0000373).
4. Chen, T., **Yavuz, B. M.**, **Delgado, A. G.**, **Montoya, G.**, Winkle, D. V., Zuo, Y., . . . **Rittmann, B. E.** (2018). Impacts of moisture content during ozonation of soils containing residual petroleum. *Journal of Hazardous Materials*, 344, 1101-1108. [doi:10.1016/j.jhazmat.2017.11.060](https://doi.org/10.1016/j.jhazmat.2017.11.060)
5. **Chen, T.**, **Yavuz, B. M.**, **Delgado, A. G.**, **Montoya, G.**, **Winkle, D. V.**, Zuo, Y., . . . **Rittmann, B. E.** (2018). Impacts of moisture content during ozonation of soils containing residual petroleum. *Journal of Hazardous Materials*, 344, 1101-1108. [doi:10.1016/j.jhazmat.2017.11.060](https://doi.org/10.1016/j.jhazmat.2017.11.060).
6. **Esquivel-Elizondo, S.**, **Maldonado, J.**, & **Krajmalnik-Brown, R.** (2018). Anaerobic carbon monoxide metabolism by *Pleomorphomonas carboxyditropha* sp. nov., a new mesophilic hydrogenogenic carboxydrotroph. *FEMS Microbiology Ecology*, 94(6). [doi:10.1093/femsec/fiy056](https://doi.org/10.1093/femsec/fiy056).
7. **Ginkel, S. W.**, **Miceli, J.**, Kim, B., Yang, Z., **Young, M.**, **Marcus, A.**, & **Rittmann, B. E.** (2018). Determining the Mechanism for Low Sludge Yields in the Cannibal Solids Reduction System. *Water Environment Research*, 90(1), 42-47. [doi:10.2175/106143017x14839994523947](https://doi.org/10.2175/106143017x14839994523947).
8. **Ginkel, S. W.**, **Miceli, J.**, Kim, B., Yang, Z., **Young, M.**, **Marcus, A.**, & **Rittmann, B. E.** (2018). Determining the Mechanism for Low Sludge Yields in the Cannibal Solids Reduction System. *Water Environment Research*, 90(1), 42-47. [doi:10.2175/106143017x14839994523947](https://doi.org/10.2175/106143017x14839994523947).
9. **Hobbs, S. R.**, **Landis, A. E.**, **Rittmann, B. E.**, **Young, M. N.**, & **Parameswaran, P.** (2018). Enhancing anaerobic digestion of food waste through biochemical methane potential assays at different substrate: Inoculum ratios. *Waste Management*, 71, 612-617. [doi:10.1016/j.wasman.2017.06.029](https://doi.org/10.1016/j.wasman.2017.06.029).
10. Kushwaha, S., **Marcus, A. K.**, & **Rittmann, B. E.** (2018). PH-dependent speciation and hydrogen (H₂) control U(VI) respiration by *Desulfovibrio vulgaris*. *Biotechnology and Bioengineering*, 115(6), 1465-1474. [doi:10.1002/bit.26579](https://doi.org/10.1002/bit.26579).
11. Lai, C., Lv, P., Dong, Q., Yeo, S. L., **Rittmann, B. E.**, & Zhao, H. (2018). Bromate and Nitrate Bioreduction Coupled with Poly-β-hydroxybutyrate Production in a Methane-Based Membrane Biofilm Reactor. *Environmental Science & Technology*, 52(12), 7024-7031. [doi:10.1021/acs.est.8b00152](https://doi.org/10.1021/acs.est.8b00152).
12. Lanzarini-Lopes, M., **Delgado, A. G.**, Guo, Y., Dahlen, P., & Westerhoff, P. (2018). Optical fiber-mediated photosynthesis for enhanced subsurface oxygen delivery. *Chemosphere*, 195, 742-748. [doi:10.1016/j.chemosphere.2017.12.089](https://doi.org/10.1016/j.chemosphere.2017.12.089).
13. Li, A., **Zhou, C.**, Liu, Z., Xu, X., Zhou, Y., Zhou, D., . . . **Rittmann, B. E.** (2018). Cover Image, Volume 115, Number 7, July 2018. *Biotechnology and Bioengineering*, 115(7), I-I. [doi:10.1002/bit.26421](https://doi.org/10.1002/bit.26421).
14. Li, A., **Zhou, C.**, Liu, Z., Xu, X., Zhou, Y., Zhou, D., . . . **Rittmann, B. E.** (2018). Direct solid-state evidence of H₂-induced partial U(VI) reduction concomitant with adsorption by extracellular polymeric substances (EPS). *Biotechnology and Bioengineering*, 115(7), 1685-1693. [doi:10.1002/bit.26592](https://doi.org/10.1002/bit.26592).

15. Liu, Z., **Zhou, C.**, **Ontiveros-Valencia, A.**, Luo, Y., **Long, M.**, Xu, H., & **Rittmann, B. E.** (2018). Accurate O₂ delivery enabled benzene biodegradation through aerobic activation followed by denitrification-coupled mineralization. *Biotechnology and Bioengineering*. doi:10.1002/bit.26712.
16. **Lusk, B. G.**, **Peraza, I.**, Albal, G., **Marcus, A. K.**, **Popat, S. C.**, & **Torres, C. I.** (2018). PH Dependency in Anode Biofilms of *Thermincola ferriacetica* Suggests a Proton-Dependent Electrochemical Response. *Journal of the American Chemical Society*, 140(16), 5527-5534. doi:10.1021/jacs.8b01734.
17. Medina, B. B., **Boyer, T.**, & Indarawis, K. (2018). Evaluating Options for Regenerant Brine Reuse in Magnetic Ion Exchange Systems. *Journal - American Water Works Association*, 110(5). doi:10.1002/awwa.1046.
18. **Nguyen, B. T.**, & **Rittmann, B. E.** (2018). Low-cost optical sensor to automatically monitor and control biomass concentration in microalgal cultivation. *Algal Research*, 32, 101-106. doi:10.1016/j.algal.2018.03.013.
19. **Ray, H.**, **Saetta, D.**, & **Boyer, T. H.** (2018). Characterization of urea hydrolysis in fresh human urine and inhibition by chemical addition. *Environmental Science: Water Research & Technology*, 4(1), 87-98. doi:10.1039/c7ew00271h.
20. **Rittmann, B. E.**, **Boltz, J. P.**, Brockmann, D., Daigger, G. T., Morgenroth, E., Sørensen, K. H., . . . Vanrolleghem, P. A. (2018). A framework for good biofilm reactor modeling practice (GBRMP). *Water Science and Technology*, 77(5), 1149-1164. doi:10.2166/wst.2018.021.
21. Song, J., Chen, L., Chen, H., Sheng, F., Xing, D., Li, L., . . . **Rittmann, B.** (2018). Characterization and high-throughput sequencing of a trichlorophenol-dechlorinating microbial community acclimated from sewage sludge. *Journal of Cleaner Production*, 197, 306-313. doi:10.1016/j.jclepro.2018.06.061.
22. **Straka, L.**, & **Rittmann, B. E.** (2018). Dynamic response of *Synechocystis* sp. PCC 6803 to changes in light intensity. *Algal Research*, 32, 210-220. doi:10.1016/j.algal.2018.04.004.
23. **Straka, L.**, & **Rittmann, B. E.** (2018). Light-dependent kinetic model for microalgae experiencing photoacclimation, photodamage, and photodamage repair. *Algal Research*, 31, 232-238. doi:10.1016/j.algal.2018.02.022.
24. **Tejedor-Sanz, S.**, Fernández-Labrador, P., **Hart, S.**, **Torres, C. I.**, & Esteve-Núñez, A. (2018). *Geobacter* Dominates the Inner Layers of a Stratified Biofilm on a Fluidized Anode During Brewery Wastewater Treatment. *Frontiers in Microbiology*, 9. doi:10.3389/fmicb.2018.00378.
25. Xiong, H., Dong, S., Zhang, J., Zhou, D., & **Rittmann, B. E.** (2018). Roles of an easily biodegradable co-substrate in enhancing tetracycline treatment in an intimately coupled photocatalytic-biological reactor. *Water Research*, 136, 75-83. doi:10.1016/j.watres.2018.02.061.
26. Yang, C., Tang, Y., Xu, H., Yan, N., Li, N., Zhang, Y., & **Rittmann, B. E.** (2018). Competition for electrons between mono-oxygenations of pyridine and 2-hydroxypyridine. *Biodegradation*. doi:10.1007/s10532-018-9834-0.
27. Zhou, D., Dong, S., **Ki, D.**, & **Rittmann, B. E.** (2018). Photocatalytic-induced electron transfer via anode-respiring bacteria (ARB) at an anode that intimately couples ARB and a TiO₂ photocatalyst. *Chemical Engineering Journal*, 338, 745-751. doi:10.1016/j.cej.2018.01.094.
28. Zhou, Y., **Eustance, E.**, **Straka, L.**, **Lai, Y. S.**, Xia, S., & **Rittmann, B. E.** (2018). Quantification of heterotrophic bacteria during the growth of *Synechocystis* sp. PCC 6803 using fluorescence activated cell sorting and microscopy. *Algal Research*, 30, 94-100. doi:10.1016/j.algal.2018.01.006
29. Zou, S., Zhang, B., Yan, N., Zhang, C., Xu, H., Zhang, Y., & **Rittmann, B. E.** (2018). Competition for molecular oxygen and electron donor between phenol and quinoline during their simultaneous biodegradation. *Process Biochemistry*, 70, 136-143. doi:10.1016/j.procbio.2018.04.015.

Proceedings and presentations

(Swette Center presenter in bold)

1. **Altizer M**, Delgado AG, Krajmalnik-Brown R, Torres CI, Wang J, Cox E. The influence of electrokinetic bioremediation on subsurface microbial communities in perchloroethylene contaminated soil. Battelle Eleventh International Conference on Remediation of Chlorinated
2. **Altizer M.L.**, A.G. Delgado, R. Krajmalnik-Brown, C. Torres, J. Wang, and E. Cox. The Influence of Electrokinetic Bioremediation on Subsurface Microbial Communities in Perchloroethylene Contaminated Soil. Megan Leigh Altizer (Enovo USA/USA). Battelle 2018. Eleventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Spring California. April 2018.
3. **Barbosa T**, Mulchandani A, Rittmann BE. Modeling microalgae *Scenedesmus* sp. to maximize lipid production. 8th International Conference on Algal Biomass, Biofuels and Bioproducts, June 11 - 13, 2018, Seattle, WA.
4. **Boyer, T.H.**, 2018. Pilot-Scale Evaluation of Bicarbonate-Form Anion Exchange for Small Systems. Presented at *255th American Chemical Society National Meeting & Exposition*, New Orleans, Louisiana, 18–22 March 2018.
5. **Calvo-Martinez, D.**, Ontiveros-Valencia, A., Maldonado-Ortiz, J., Torres, C.I., Krajmalnik-Brown, R., Rittmann, B.E., "Acetate production by anaerobic, autotrophic bacteria in an H₂-based Membrane Biofilm Reactor". 254th American Chemical Society National Meeting and Exposition. August 20-24, 2017. Washington. D.C.
6. **Chen, T.**, Yavuz, B.M., Rittmann, B.E. (01.29.2018). Heavy Petroleum Hydrocarbons Remediation using Ozonation and Bioremediation—Progress Report. **Presenter** at the semiannual Chevron soil remediation project meetings, Houston, TX
7. Hall C., G. Hernandez, K. Darby, L. van Paassen, **E. Kavazanjian**, J. DeJong, and D. Wilson. *Centrifuge Model Testing of Liquefaction Mitigation via Denitrification-Induced Desaturation*. Geotechnical Earthquake Engineering and Soil Dynamics V (GEESD V), Austin, TX, June, 2018.
8. **Hall C.A.**, L. van Paassen, E. Kavazanjian, and B. Rittmann. Microbially Induced Desaturation and Precipitation (MIDP) via Denitrification During Centrifugal Loading. Interpore, New Orleans, LA. May, 2018
9. Hall C.A., **Y. Smit.**, and M. Altizer. Journal for the Unpublishable: “Bad” Data and Non-Discovery². European Geoscience Union Assembly, Vienna, Austria. March, 2018.
10. **Hall C.**, Leon van Paassen, Edward Kavazanjian, Jason DeJong, Dan Wilson. *Evaluation of Biogenic Gas Formation by Denitrification in Centrifuge²* 7th International Conference on Unsaturated Soils (UNSAT 2018). Hong Kong, China, August 2018.
11. **Hall C.**, Leon van Paassen, Edward Kavazanjian, Jason DeJong, Dan Wilson. *Evaluation of Biogenic Gas Formation by Denitrification in Centrifuge²* 7th International Conference on Unsaturated Soils (UNSAT 2018). Hong Kong, China, August 2018.
12. **Hart, S.**, Young, M., Ki, D., Brown, S., Wilson, C., Parameswaran, P., Torres, C.I. “Improved Characterization of Anaerobic Digestion Kinetics of Mixed Sludges With and Without Thermally Pretreated WAS” for the WEF Residuals and Biosolids, Phoenix, AZ, 2018.
13. Kavazanjian E., Sean O’Donnell, Bruce Rittmann, Nasser Hamdan, **Caitlyn Hall**, and Leon van Paassen. *Mitigation of Liquefaction Beneath Existing Facilities Using Denitrification*. 11th U.S. National Conference on Earthquake Engineering. Los Angeles, CA, June 2018.

14. **Ki, D.**, Kupferer, R., Torres, C.I. "Primary sludge to valuable chemicals, hydrogen peroxide (H₂O₂), in microbial electrochemical cells: H₂O₂ production and in-situ sludge treatment" for the WEF Residuals and Biosolids, Phoenix, AZ, 2018 (Podium Presentation).
15. **Liu Y**, Lai YS, Barbosa T, Chandra R, Parameswaran P, Bruce E. Rittmann (2018). Electro-selective fermentation enhances lipid extraction and biohydrogenation of *Scenedesmus acutus* biomass. 8th International Conference on Algal Biomass, Biofuels and Bioproducts, June 11 - 13, 2018, Seattle, WA.
16. **Mohana Rangan S**, Mouti A, Delgado AG, Krajmalnik-Brown R, Lowry GV, LaPat-Polasko L, Brenton H. Trade-offs in utilizing zero-valent iron for synergistic biotic and abiotic reduction of trichloroethene and perchlorate. Battelle Eleventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Springs, CA, April 2018. (Poster presentation) .
17. **Mohana Rangan, S.**, A. Mouti, A.G. Delgado, R. Krajmalnik-Brown, G.V. Lowry, L. LaPat-Polasko, and H. Brenton. Trade-Offs in Utilizing Zero-Valent Iron for Synergistic Biotic and Abiotic Reduction of Trichloroethene and Perchlorate. Srivatsan Mohana Rangan (Arizona State University/USA). Battelle 2018. Eleventh International Conference on Remediation of Chlorinated and Recalcitrant Compounds. Palm Spring California. April 2018.
18. O'Donnell, S., **Hall, C.**, Kavazanjian, E. and Rittmann B.E. *A Biogeochemical Model for Soil Improvement by Denitrification*.
19. **Peraza,I.** Presented a talk titled: Mathematical modeling of electroactive biofilms at the first meeting of CONACYT fellowships in United States in Washington DC from 15 to 17 of March.
20. **Peraza,I.** Taught the workshop: *Mathematical Modeling in Environmental Engineering with MATLAB* to Environmental Engineering Graduate Students at the Engineering department at the Yucatan State University
21. **Peraza,I.** Gave a talk at the Technological Institute of Merida, Yucatan, Mexico for Environmental and Chemical engineering bachelor Student about his personal journey as a scientist
22. **Peraza,I.** Gave a talk at the Technological Institute of Merida, Yucatan, Mexico for Environmental and Chemical engineering bachelor Student about his personal journey as a scientist.
23. **Ray, H.**, Boyer, T.H., Perreault, F. Urea Recovery from Source Separated Urine by Forward Osmosis and Membrane Distillation. Talk presented at AZ Water 91st Annual Conference: Phoenix, AZ, May 4, 2018.
24. **Ray, H.**, Boyer, T.H., Perreault, F. Urea Recovery from Source Separated Urine by Forward Osmosis and Membrane Distillation. Poster presented at: ASU SSEBE Graduate Poster Competition: Tempe, Arizona, 16 February 2018.
25. **Ray, H.**, Boyer, T.H., Urea Recovery from Source Separated Urine by Membrane Processes. Poster presented at: AZ Water Research Committee Annual Workshop: Tempe, Arizona, 9 January 2018.
26. **Reynolds, M.C**, Krajmalnik-Brown, R., & Cadillo-Quiroz, H. "Intra-microbial community variation exists within a single municipal solid waste landfill." American Society of Microbiology (ASM), Arizona/Southern Nevada Branch Meeting 2018. Poster
27. **Robles, Aide.** "Reductive Dechlorination of Trichloroethene(TCE) Sustained by Microbial Chain Elongation" at ASU FURI Symposium.

28. **Rittmann, B.E.** Invited lecture, "Including Biofilm Detachment in Models. NSF-sponsored workshop on Mechanical Properties of Biofilms," University of Notre Dame, South Bend, IN. April 23, 2018.
29. **Rittmann, B.E.** Invited lecture, "Microbial Products in Environmental Biotechnologies," Tongji University, Shanghai, PRC. May 22, 2018.
30. **Rittmann, B.E.** Invited lecture, "Biofilm Processes," Shanghai Normal University, Shanghai, PRC. May 23, 2018.
31. **Rittmann, B.E.** Invited lecture, "Activated Sludge," Tongji University, Shanghai, PRC. May 24, 2018.
32. **Rittmann, B.E.** Invited lecture, "Biofilm Processes in Drinking Water Treatment," Hohai University, Nanjing, PRC. May 31, 2018.
33. **Rittmann, B.E.** Invited lecture, "Microbial Photobioenergy – Making CO₂ a Resource, Not a Liability," Dalian University of Technology, Dalian, PRC. June 1, 2018.
34. **Rittmann, B.E.** Invited lecture, "The Hydrogen-based Membrane Biofilm Reactor (MBfR) for Reducing Oxidized Contaminants," Dalian University of Technology, Dalian, PRC. June 2, 2018.
35. **Rittmann, B.E.,** Krajmalnik-Brown, R., Kang, D., Ilhan, Z.E., Marcus, A.K., DiBaise, J., Isern, N.G., Invited lecture, "Roux-en-Y Gastric Bypass Surgery Shifts Gut Microbial Communities and Associated Metabolites," Sichuan University, Chengdu, PRC. June 5, 2018.
36. **Rittmann, B.E.** Invited lecture, "Being Productive," Druid Technologies, Chengdu, PRC. June 6, 2018.
37. **Rittmann, B.E.** Invited lecture, "The Hydrogen-based Membrane Biofilm Reactor for Reducing Oxidized Contaminants," Suzhou University of Science & Technology, Suzhou, PRC. June 7, 2018.
38. **Rittmann, B.E.,** Krajmalnik-Brown, R., Kang, D., Ilhan, Z.E., Marcus, A.K., DiBaise, J., Isern, N.G., Invited lecture, "Roux-en-Y Gastric Bypass Surgery Shifts Gut Microbial Communities and Associated Metabolites," Soochow University, Suzhou, PRC. June 8, 2018.
39. **Rittmann, B.E.** Invited lecture, "The Hydrogen-based Membrane Biofilm Reactor for Reducing Oxidized Contaminants," Hong Kong University, Hong Kong. June 27, 2018.
40. **Rittmann, B.E.** Invited lecture, "Microbial Products in Environmental Biotechnologies," Hong Kong University of Science & Technology, Hong Kong. June 28, 2018.
41. **Rittmann, B.E.** Invited lecture, "The Big Picture of Energy Options," WiseGuise, Scottsdale, AZ. Feb 16, 2018.
42. **Rittmann, B.E.** Invited lecture, "Environmental Biotechnology, Partnering with Microorganisms," Engineers Week Event on Engineering in Practice, ASU. Feb 19, 2018.
43. **Rittmann, B.E.** Invited lecture, "Partnering with Microorganisms to Turn Pollution into Value," Biodesign Open Door, ASU. Feb 24, 2018.
44. **Rittmann, B.E.** Invited lecture, "The Microorganisms Always Close the Mass Balance," Center for Bio-inspired and Bio-mediated Geotechnics Webinar, ASU. Mar 2, 2018.
45. **Wilson, C.,** Hart, S., Brown, S., Young, M., Ki, D., Torres, C.I. "Microbial Electrochemical Cells as An Alternative to Biochemical Methane Potential Tests for Analyzing Batch Anaerobic Digestion Kinetics" for the WEF Residuals and Biosolids, Phoenix, AZ, 2018.
46. **Zeng, C.** "Enhancing the Biodegradation of Heavy-Hydrocarbons in Soil" HHSRG year-end Meeting, 2018. Houston, TX.
47. **Zhou, C.** and Bruce E. Rittmann. "Biorecovery of Precious Metal from Waste Streams: Biofilm Enhanced Nanoparticle Synthesis and Beyond" for the 2018 IWA LET conference in Nanjing, China (poster)

Mentoring activities

Degrees conferred

Ph.D.

1. Avni Solanki, Treavor Boyer advisor, Ph.D. in Environmental Engineering from University of Florida, Dissertation: *Investigation of Pharmaceutical Removal in Source Separated Urine Using Biochar*, May 2018
2. Tengfei Chen, Bruce Rittmann advisor, Ph.D. in Civil, Environmental and Sustainable Engineering from the School of Sustainable Engineering and the Built Environment, Dissertation: *Applying Ozone to Enhance Bioremediation of Petroleum-contaminated Soils*, June 2018.

Masters

1. Sayalee Joshi, Anca Delgado advisor, MS in Chemical Engineering from the School for Engineering of Matter, Transport and Energy, Thesis: *Microbial Metabolic Chain Elongation*, May 2018

Undergraduate

1. Omar Arafa, BS Chemical Engineering, *Mass Transfer Kinetics of Novel Asymmetric Hollow-fiber Membranes* (Barrett the Honors College), May 2018
2. Patricia Ibaló, BS Molecular Biosciences and Biotechnology, May 2018
3. Lidia Peon, BS Biological Sciences, May 2018
4. Ben Wik, BS Chemical Engineering, Sustainability Minor, *Exploring the consequences of permeate recycling in a photobioreactor using multi-component, community-level modelling* (Barrett the Honors College), May 2018

Mentoring relationships

Ph.D.

Megan Altizer (Krajmalnik-Brown, Torres)
Steffen Buessecker (Cadillo Quiroz)
Diana Calvo Martinez (Rittmann)
Neng long Chan (Rittmann)
Tengfei Chen (Rittmann)
Taylor Davis (Rittmann)
Blake Dirks (Krajmalnik-Brown)
Sofia Esquivel Elizondo (Krajmalnik-Brown)
Caitlyn Hall (Rittmann)
Steven Hart (Torres)
Ethan Howley (Krajmalnik-Brown, Torres)
Neha Jagtap (Boyer)
Justin Kidd (Krajmalnik-Brown)
Christine Lewis (Torres)
Yuanzhe Liu (Lai, Rittmann)
Yihao Luo (Rittmann)
Evelyn Miranda (Delgado, Lai)

Srivatsan Mohana Rangan (Delgado, Krajmalnik-Brown)
Isaias Peraza (Rittmann)
Erik Poppleton (Delgado)
Hannah Ray (Boyer)
Mark Reynolds (Cadillo-Quiroz, Krajmalnik-Brown)
Rain Richards (Boyer)
Daniella Saetta (Boyer)
Analissa Sarno (Cadillo Quiroz)
Avni Solanki (Boyer)
Thiago Stangherlin Barbosa (Eustance, Lai, Rittmann)
Levi Straka (Rittmann)
Burcu Yavuz (Rittmann)
Michelle Young (Rittmann)
Julian Yu (Cadillo Quiroz)

Masters

Francisco Brown-Munoz (Torres)
Gururaj Daptardar (Rittmann, Eustance, Lai)
Rebecca Dietz (Boyer, Saetta)
Rick Kupferer (Torres, Ki)
Sayalee Joshi (Delgado)
Zeni Ramirez (Cadillo Quiroz)

Shefali Rao (Delgado and Krajmalnik-Brown)
Urusha Regmi (Boyer)
Aide Robles (Delgado)
Tarun Shesh (Rittmann, Eustance, Lai)
Wenxia Xu (Krajmalnik-Brown, Zeng)
Chenwei Zheng (Rittmann, Zhou)

Post-Doctoral Researchers

Everett Eustance (Rittmann)
Dongwon Ki (Torres)

Outi Lähteenoja (Cadillo Quiroz)
Chao Zeng (Krajmalnik-Brown)

Research Scientists

Daewook Kang (Krajmalnik-Brown)
Yen-Jung Lai (Rittmann)

Chen Zhou (Rittmann)

Undergraduates

Ana Aragon-Sierra (Krajmalnik-Brown, Kang)
Omar Arafa (Rittmann, Calvo Martinez), FURI
Jordan Canning (Cadillo Quiroz)
Debbie Chang (Dirks, Krajmalnik-Brown)
Sheridan Davis (Boyer, Solanki, Saetta)
Alex Drew (Cadillo Quiroz)
Angela Egan (Boyer, Ray, Saetta)
Fred Elick (Cadillo Quiroz)
Sam Greenberg (Boyer, Ray)
Savannah Hull (Rittmann, Barbosa)
Patricia Ibaló (Torres, Howley)
Ibrahim Ibrahim (Delgado, Mohana Rangan)
Brielle Januszewski (Rittmann, Chen), FURI
Evan Jones (Rittmann, Lai)

Nikita Kowal (Boyer, Saetta)
Raja Mabry (Delgado, Robles)
Jade Martinez (Boyer, Ray)
Lincoln Mtemeri (Torres, Ki)
Jigar Patel (Krajmalnik-Brown, Kang)
Lidea Peon (Torres, Howley)
Neil Rastogi (Rittmann, Liu), FURI
Andrea Russell (Torres, Brown-Munoz)
Riley Tesman (Boyer, Solanki)
Ben Wik (Marcus)
Collette Wilson (Torres, Hart)
Theodora Yellowman (Delgado)
Kai Yin (Marcus, Papacharalampos)
Diana Zermeno (Torres)

High School Students

Samihan Dani (Rittmann, Eustance, Lai), Hamilton High School
Leila Kahn (Krajmalnik-Brown, Zeng), Scottsdale Preparatory Academy
Lily Mobasher (Rittmann, Calvo Martinez), Basis Phoenix

Teachers

Allison McCaw, Mtn View HS (Rittmann, Lai)

Volunteers

Chris Connot (Krajmalnik-Brown, Kang)

Yesenia Moreno Caro (Krajmalnik-Brown, Kang)

Brad Lusk (Rittmann, Zhou)

Staff

Sarah Arrowsmith (Krajmalnik-Brown)
Chris Connot (Krajmalnik-Brown)
Carole Flores (Rittmann)
Garrett Montoya (Rittmann, Yavuz)
Carlos Leyva (Boyer)

Yesenia Moreno Caro (Krajmalnik-Brown)
Jigar Patel (Krajmalnik-Brown)
Matt Scholz PhD (Rittmann)
Rob Stirling (Rittmann)

Visiting scholars

(Mentors in parentheses)

1. Melanie Hekeu, PhD student from Marche Polytechnic University, Italy (Rittmann, Yavuz)
2. Min Long, PhD student from the College of Environmental Science and Engineering, Tongji University (Rittmann, Zhou)
3. Kun Zhang PhD, College of Power and Energy Engineering, Harbin Engineering University (Rittmann, Lai)
4. Xiong Zheng PhD, College of Environmental Science and Engineering, Tongji University (Rittmann, Zhou)
5. Nianbing Zhong PhD, College of Optical and Electronic Technology, Chongqing University of Technology (Rittmann, Zhou)

Special activities

We launched our re-designed website: environmentalbiotechnology.org.

Anca Delgado, Treavor Boyer. Core Committee Member of 2019 Association of Environmental Engineering and Science Professors (AEESP) Research and Education Conference, Tempe, AZ, May 2019

Sarah Arrowsmith and Everett Eustance, Compliance Officers

Open Door: Dongwon Ki (exhibit leader), Sean Lai, Hannah Ray, Everett Eustance (exhibit leader), Megan Altizer (exhibit leader), Blake Dirks (exhibit leader), Taylor Davis, Francisco Brown Munoz, Min Long, Carole Flores (Biodesign Open Door Committee), Urusha Regmi, Neha Javadi, Daniella Saetta, Angela Egan, Nikita Kowal, Sheridan Davis, Shefali Rao, Sayalee Joshi, Carlos Leyva

Megan Altizer

- Partnership with Geosyntec on researching electrokinetic bioremediation

Francisco Brown-Munoz

- Toured 21 English and math teachers visiting ASU as part of a training program from Saudi Arabia, June 26
- Taught the Introduction to Engineering 10th grade class for the Barrett Summer Scholars summer program. <https://eoss.asu.edu/bss>
- Noche de Ciencias (STEM) Night at Phoenix Coding Academy (February 23, 2018) and Western Valley Middle School (March 23, 2018) as part of the Society of Hispanic Professional Engineers (SHPE) at ASU outreach. Presented 3 on-site STEM challenges to 6-12th grade students and hosted a bilingual parent workshop titled “Helping Your Child on Their Journey to College”. <http://www.shpedeasu.org/>
- Hosted a panel about college life and pursuing an engineering career for sophomores, juniors, and senior of the CompuPower Summer Program as part of the Society of Hispanic Professional Engineers, ASU chapter.
- Helped presenting a tour for local middle school students to The Biodesign Institute and BSCEB to motivate students to pursue a career in engineering.
- Lead and organized a tour of Biodesign Swette Center for Environmental Biotechnology for 17 students as part of the Introduction to Engineering 10th grade class of the Barrett Summer Scholars summer program. <https://eoss.asu.edu/bss>
- Active member of the Society of Water and Environmental Leaders. <https://fso.engineering.asu.edu/project/society-of-water-and-environmental-leaders-swel-2/>

Diana Calvo

- Starting collaborations with Universidad de los Andes for possible future projects.

Neng long Chan

- 2018 May Joint FAO/IAEA programme intern, Soil and Water Management & Crop Nutrition Section, United Nations Food and Agriculture Organization/International Atomic Energy Agency, Vienna, Austria

Taylor Davis

- Volunteered for SEMTE’s open house for potential chemical engineering doctorate students

Everett Eustance

- Track Chair for upcoming Algae Biomass Summit 2018

Caitlyn Hall

- California Environmental Protection Agency Hazard Resilience Presentation, *Presenter*
- City of Vancouver Resilience Meeting, *Presenter*
- National Environmental Protection Agency Hazard Resilience Presentation, *Presenter*
- Association for Environmental and Engineering Geologists Chapter Meeting, *Presenter*
- NSF National I-Corps Program, NSF

- AAAS Catalyzing Advocacy in Science and Engineering Workshop, AAAS
- European Geosciences Union Young Hydrologic Society, *Board Member*
- American Geophysical Union Hydrology Section Student Subcommittee, *Vice Chair*
- National Science Policy Network, *Member*
- ASU Arizona Science Policy Network, *Founder*
- Graduate Students for the Environment, *Vice President*
- CBBG Student Leadership Council, *President*

Steven Hart

- Student Coordinator, Prison Biology Education Program. Myself along with Ethan Howley and Blake Dirks helped teach an introductory biology course at the Rynning Unit of the Eyman state prison complex in Florence, AZ.

Ethan Howley

- BioSciences Core Governance Board Student Representative

Dongwon Ki

- Night of the Open Doors, Leader for coordinating Center's activities, Biodesign Institute, ASU, Feb, 2018
- Active reviewer for the following journals: Scientific Reports, Separation Science and Technology, Water Research, Environmental Engineering Science

Rosa Krajmalnik-Brown, Blake, Dirks, Taylor Davis

- Translational Research Institute for Metabolism and Diabetes collaboration, visit to Orlando, FL to meet with collaborators and tour facilities in May, 2018. Participants explored the Life of a Patient, Mathematical Modeling, Methane and Hydrogen Measurements, as well as discussed publications.

Rosa Krajmalnik-Brown

- National Academies of Science, Engineering, and Medicine Committee on Advancing Understanding of the Implications of Environmental-Chemical Interactions with the Human Microbiomes

Yen-Jung (Sean) Lai

- Poster Section reviewer for upcoming Algae Biomass Summit 2018

Evelyn Miranda

- Western Alliance to Expand Student Opportunities workshop about grants and where the money comes from

Isa Peraza

- As part of a Climate Change course he took this Spring, Isa wrote a research paper titled: The different theories to explain the great Maya collapse influenced by climatic events. Isa is from the Yucatan, is a Mayan scholar, and teaches about the Mayan language.
- Collaborated to create a curriculum for a summer class in fundamental of scientific research in the natural sciences a class planned to high School students that are a subsection of the Yucatan State University

Hannah Ray

- Secretary for the Graduate Students for the Environment (GSE), February–Present
- Scottsdale Community College student tours, March 8, 2018

Matthew Reynolds

- Center for Bio-mediated and Bio-inspired Geotechnics at Capitol Elementary Schools's End of the Year Science Fair.

Bruce Rittmann

- Fellows Steering Committee, Association of Environmental Engineering and Science Professors

Matthew Scholz

- The Swette Center continues to provide infrastructure support to the Sustainable Phosphorus Alliance, an organization that functions as an industry nonprofit that promotes the sustainable use, recovery, and recycling of phosphorus in the food system. Leveraging that support, the Alliance hosted its second annual Phosphorus Forum event on the Tempe campus on February 26th, attracting some 60 participants, mostly from industries across the US and Canada. The event brought these participants from across the phosphorus value chain together for knowledge sharing and networking. Video footage of the day's events is available at <https://youtu.be/8A9NFkSwji8>.

Chen Zhou

- Traveled in China for assisting Bruce to establish collaboration with **Chinese governments and universities**.
- Promoting technology transfer for **Precient Technology, LLC.**, a company co-founded by Bruce and me and others.

Awards and accolades

(alphabetical by person after Fulton Schools of Engineering Dean's Fellows)

- Fulton Schools of Engineering Dean's Fellows:
 - a. Megan Altizer (SSEBE)
 - b. Taylor Davis (SEMTE)
 - c. Caitlyn Hall (SSEBE)
 - d. Ethan Howley (SSEBE)
 - e. Burcu Yavuz (SSEBE)

- Diana Calvo Martinez
 - a. GPSA Travel Grant Fellowship for \$950
 - b. GPSA Kick-starter Grant for \$500

- Neng long Chan
 - a. 2018 Feb Graduate College Travel Award (\$500)
 - b. 2018 Feb Career Development Grant, Graduate and Professional Student Association (GPSA) (\$550)
 - c. 2018 Feb Travel Award, School of Life Sciences (\$400)

- Hannah Ray
 - a. NSF Graduate Research Fellowship Program 2018 Honorable Mention
 - b. 1st Place AZ Water Research Committee Annual Workshop Poster Competition

- Mark Reynolds
 - a. Best Graduate Student poster (Runner up) - American Society of Microbiology (ASM), Arizona/Southern Nevada Branch Meeting (3/2018)

- Bruce Rittmann. Stockholm Water Prize

- Aide Robles. Environmental Engineering M.S., Master's Opportunity in Research Engineering (MORE) awardee, Spring2018, Fall 2018.

- Chen Zhou, I won the 2nd prize of The Entrepreneurship Competition held by the Zhangjiagang government in Beijing, China (\$3,000 equivalent)