

Impact Report

Biodesign Swette Center for Environmental Biotechnology



July 1, 2016 – June 30, 2017

Strategic Investment - Annual Impact Report



Executive Summary

The Biodesign Swette Center for Environmental Biotechnology (BSCEB) carries out leading-edge research and development that involves partnering with microorganisms to preserve people and our environment.

Our research allows us to understand microbial communities: who are the important microorganisms, what they do, and how they work together. We apply this understanding to manage the microbial communities so that they provide society with essential services: generating renewable energy and chemicals, cleaning up contaminated water and soil, and improving human health. All of these services make human society more sustainable. The research ranges from fundamental to applied, and we seek to link the fundamentals to the applications as much as possible, which embodies the concept of “use-inspired research.”

Over the past year, approximately 99% of the Swette funds spent provided direct support of three major research initiatives in BSCEB:

- Microalgae-based renewable energy and chemicals: 36%
- Technologies for water sustainability: 29%
- Mathematical modeling to support the other two themes: 34%

The other 1% was spent on promoting safety in the Center.

Most of the precious funding supports the salaries, benefits, and supplies of key personnel working in these areas. Some of the funds provide partial support of salaries for faculty, research scientists, and post-doctoral associates; they advance new research areas by developing preliminary results and writing proposals. We also use some funds to supplement stipends for students who are primarily supported by external fellowships that have inadequate stipends (e.g., from CONACyT in Mexico) or that end before the student has finished her/his degree.

Additionally, BSCEB also hosts six or more visiting scholars from around the world each year. While BSCEB bears no burden for their salary or travel expenses, it uses some of the funds to support their research efforts, which dovetail with the Center’s research themes and help us advance new topics and establish long-standing collaborations.



Visiting scholars Guowen Wang, Hua Xu, Juan Sebastian Arcila Henao, Jianfang Wang, and Rashmi Chandra

Dr. Bruce Rittmann is Director of the Biodesign Swette Center for Environmental Biotechnology and leads nearly 100 faculty, staff, students, and volunteers who are dedicated to improving the environment through innovative collaborations and projects.

Thanks to the generous financial support of the Swette family, we are pleased to provide an impact report of BSCEB activities over the past year, to highlight notable environmental advancements.

How has the Swette investment promoted Environmental Biotechnology research?

The most challenging part of doing research in leading-edge, inter-disciplinary topics (which is almost everything in BSCEB) is establishing the validity of the topic and the capability of the researchers. This is needed to get funders to accept the idea and be willing to consider funding it. Doing these things demands investments in exceptional people and new ideas. We need to develop preliminary results, publish seminal papers, give breathtaking talks, and have time to write proposals. These are the activities that the Swette Strategic Investment Fund supports. BSCEB has the flexibility to recruit outstanding researchers, integrate them with the core of the BSCEB team, help all of us start new areas, and keep everyone going until external support can be attained.

Over the years, we have used the Swette funds to do all of these things. The topics on which we focus shift from year to year, but the strategy remains in place. For example, in past years we supported new efforts in the human intestinal microbiome. This paid off with a nearly \$4-million grant from NIH and a \$1.3-million grant from DoD. We also invested in our microbial photobioenergy team, and this led to a \$1-million grant from DoE. We continue to invest in the microbial photobioenergy area, because we have excellent ideas for how to greatly enhance the productivity of those systems.

The investment also put us in a position to lead large ASU efforts. For example, we are at the lead in three DECISIVE white papers, the Future H2O Initiative, the morocco/UM6P Initiative, and the initiative for a large water center in cooperation with Ben-Gurion University.



Dr. Krajmalnik-Brown was invited to give a talk about the microbiome at Harvard Medical School



Dr. Krajmalnik-Brown's presentation at Ben-Gurion University of the Negev

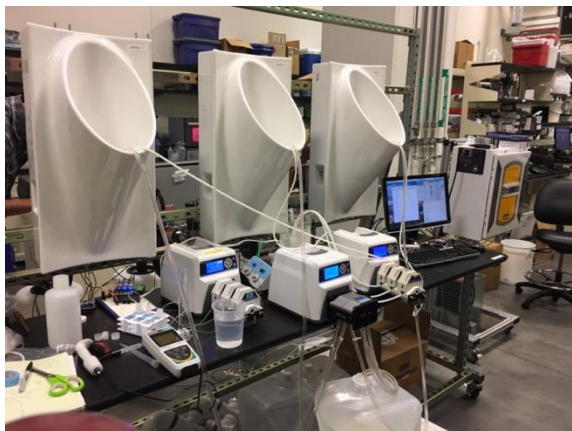


Drs. Marcus and Krajmalnik-Brown visiting with Dr. Zeev Ronan of Ben-Gurion University

What's new?

New Faculty/Staff Appointments

Dr. Treavor Boyer (@BoyerLabASU) joined BSCEB in July 2016. Dr. Boyer's academic appointment is as an associate professor (with tenure) in the School of Sustainable Engineering and the Built Environment (SSEBE). Dr. Boyer is an expert in the recovery of nutrients from water and wastewater. His expertise in this area is complementary to the deep expertise that BSCEB already has in microbiological recovery of energy from wastewater and biomass. Dr. Boyer also has taken the lead for initiating the new BS degree in Environmental Engineering.



The Boyer Lab Urinal Testbed is used to study urine chemistry in non-water urinals and plumbing systems. Wireless sensors connected to the cloud are used to monitor pH and conductive in real-time.

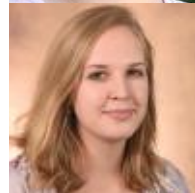
Dr. César Torres received tenure in August of 2016. He is an associate professor in the School of Energy, Matter, and Transport Engineering (SEMTE).

Dr. Anca Delgado was appointed a new assistant professor of environmental engineering in SSEBE, beginning in August 2017. Dr. Delgado has been an assistant research scientist in BSCEB. She is an expert in bioremediation of soils and water, as well as in the new area of biogeotechnics.

Sarah Arrowsmith became the Center's Laboratory Coordinator in the spring of 2017. Sarah replaced Diane Hagner, who retired in the fall of 2016 after close to ten years of service in BSCEB.



Dr. Boyer participated in Fulton Schools of Engineering E2 camp that engages first-year students.



New Projects

Faculty in BSCEB have been very successful leveraging the Swette strategic investment to obtain new research projects, including a number of large awards. Major new projects are listed below.

Sponsor	Principal Investigator	Title and Award Amount
National Institutes of Health, HHS-NIH 1R01DK105829-01A1	Krajmalnik-Brown, co-PIs Rittmann, Marcus	<i>Integrating Quantitative Energetics Determines the Microbiomes Contribution to Energy Balance, \$3,936,800</i>
Department of Energy, DOE-EERE DE-EE0007093	Rittmann, co-PI Lackner	<i>Atmospheric CO2 Capture and Membrane Delivery, \$1 million</i>
Department of Energy, DOE DE-EE0007562	Lammers, co-PI Krajmalnik-Brown	<i>A novel platform for algal biomass production using cellulosic mixotrophy, \$995,346</i>
National Science Foundation, NSF-ENG 1509933	Rittmann	<i>Targeted saturated fatty acids synthesis by microbial biohydrogenation and its superior extraction from microalgae biomass through fermentation, \$309,443</i>
National Science Foundation, NSF-ENG 1702445	Rittmann	<i>Enhancing Biodegradation of Quaternary Ammonium Compounds (QAC), \$329,738</i>
National Science Foundation, NSF-ENG 1603656	Rittmann, co-PI Torres	<i>Engineering the Hollow-Fiber Membrane Biofilm Reactor to Convert Syngas to Valuable Products, \$209,022</i>
National Science Foundation, NSF-ENG-EEC 1449501	Kavazanjian, Co-PIs Krajmalnik-Brown, Torres, Rittmann	<i>Center for Bio-mediated and Bio-inspired Geotechnics, \$18-million</i>
Department of Defense, DOD-NAVY-ONR N00014-15-1-2702	Torres	<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	Torres	<i>Development of Substrate-loaded Microbial Fuel Cells for Powering Remote Sensors, \$399,775</i>
Department of Defense, DOD-ARMY-USAMRAA W81XWH-16-1-0492	Adams, co-PI Krajmalnik-Brown	<i>Treating Gastrointestinal and Autism Symptoms in Adults with Autism Using Microbiota Transfer Therapy (MTT), \$1,293,794</i>
Department of Defense, DOD-SERDP W912HQ-17-C-0013	Rittmann	<i>Synergistic Reductive Dechlorination of 111-Trichloroethane and Trichloroethene, \$200,000</i>
ASU Foundation, 30007312	Adams, co-PI Krajmalnik-Brown	<i>Long-term Follow-up on Beneficial Bacteria Treatment Study, \$28,008</i>
ASU Foundation, 70004519	Krajmalnik-Brown	<i>ZVI-Mediated Reductions of Chlorinated Compounds: Fundamental Understanding and Strategies for Bioremediation, \$49,000</i>

Milestones

- Thanks to the vital Swette investment to protect and preserve our environment, BSCEB researchers published more than 50 peer-reviewed papers in the past year.
- Dr. Krajmalnik-Brown was selected for a blue-ribbon panel of the National Academies Committee on Advancing Understanding of the Implications of Environmental-Chemical Interactions with the Human Microbiome.
- Dr. Rittmann was invited to deliver eight keynote talks at international conferences, representing the Swette investment throughout the globe.
- Dr. Torres was invited to deliver seven keynote talks at conferences.
- BSCEB hosted three Swette Undergraduate Sustainability Interns for 15-month research programs.
- Drs. Krajmalnik-Brown and Kang were featured in the webinar [Autism Live](#).
- Dr. Krajmalnik-Brown, et.al. "Insights into butyrate production via gene predictions" was published on mSystems and came out as an "Editor's pick," and also featured on the cover of the journal. Dr. Krajmalnik-Brown and Sofia Esquivel Elizondo were featured in [Multitasking Microbes video](#).
- Drs. Krajmalnik-Brown and Zehra Ilhan published Distinctive microbiomes and metabolites linked with weight loss after gastric bypass, but not gastric banding in the [ISME journal](#).
- Drs. Krajmalnik-Brown and Marcus travel to Israel as part of a collaboration with Ben Gurion University.
- Drs. Krajmalnik-Brown and Rittmann receive patent for Reducing short-chain fatty acids and energy uptake in obese humans by managing their intestinal microbial communities (9,549,955).
- Dr. Torres was voted to the Board of Directors for the International Society for Microbial Electrochemistry and Technology.



Drs. Kang, Adams, and Krajmalnik-Brown appeared on Autism Live to discuss promising fecal transplant results.

New Teaching Programs

The strategic Swette investment is helping to grow future environmental leaders. Dr. Boyer led the formation and approval of the new BS degree in Environmental Engineering. It was approved by the Board of Regents and began in Fall 2017. Other faculty participating in the implementation of the new program are Professors Rittmann, Krajmalnik-Brown, and Delgado.

Biology Behind Bars – BSCEB Ph.D. students Steven Hart, Blake Dirks, and Ethan Holland teach in a biology program within the Browning Unit of the Eyman Prison. See Steven's 4/5/16 [blog entry](#).



BSCEB Awards and Recognition

Leaders at the Biodesign Swette Center for Environmental Biotechnology received many national and international distinguished awards during the past year.

Bruce Rittmann:

Fellow, Association of Environmental Engineering and Science Professors (AEESP) (2017)

Fellow, National Academy of Inventors (2017)

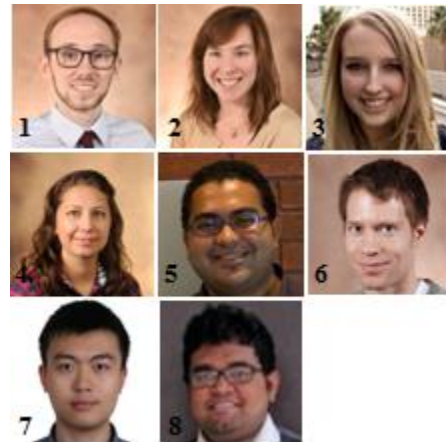
Daniel Jankowski Legacy Award, Ira A. Fulton Schools of Engineering, Arizona State University (2017)

Perry L. McCarty/AEESP Founders' Award, AEESP (2016)



Drs. Krajmalnik-Brown and Torres named 2016 Fulton Schools [Faculty Exemplars](#)

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|-----------|--------------------|---|
| Students: | Dean's Scholars: | 1. Ethan Howley,
2. Caitlyn Hall,
3. Taylor Davis |
| | PhD Graduates: | 4. Zehra Ilan,
5. Mohamed Mahmoud,
6. Levi Straka |
| | Masters Graduates: | 7. Zhoulin Liu,
8. Sam Nandakumar |



Conclusion

The impact of the Swette strategic investment to ASU's Biodesign Institute continues to yield significant results in the field of Environmental Biotechnology through the people, projects, and activities listed herein, as well as through a myriad of local, national, and international collaborations with people and organizations who are committed to preserving people and our planet.

For additional information, please visit environmentalbiotechnology.org/ to read Center [NEWS](#), [BLOGS](#), and [SAFETY UPDATES](#), or follow us on social media: Twitter @envirombiotech, @BoyerLabASU and Facebook [Dr. Rosy's Lab](#), [Cadillo Lab](#).