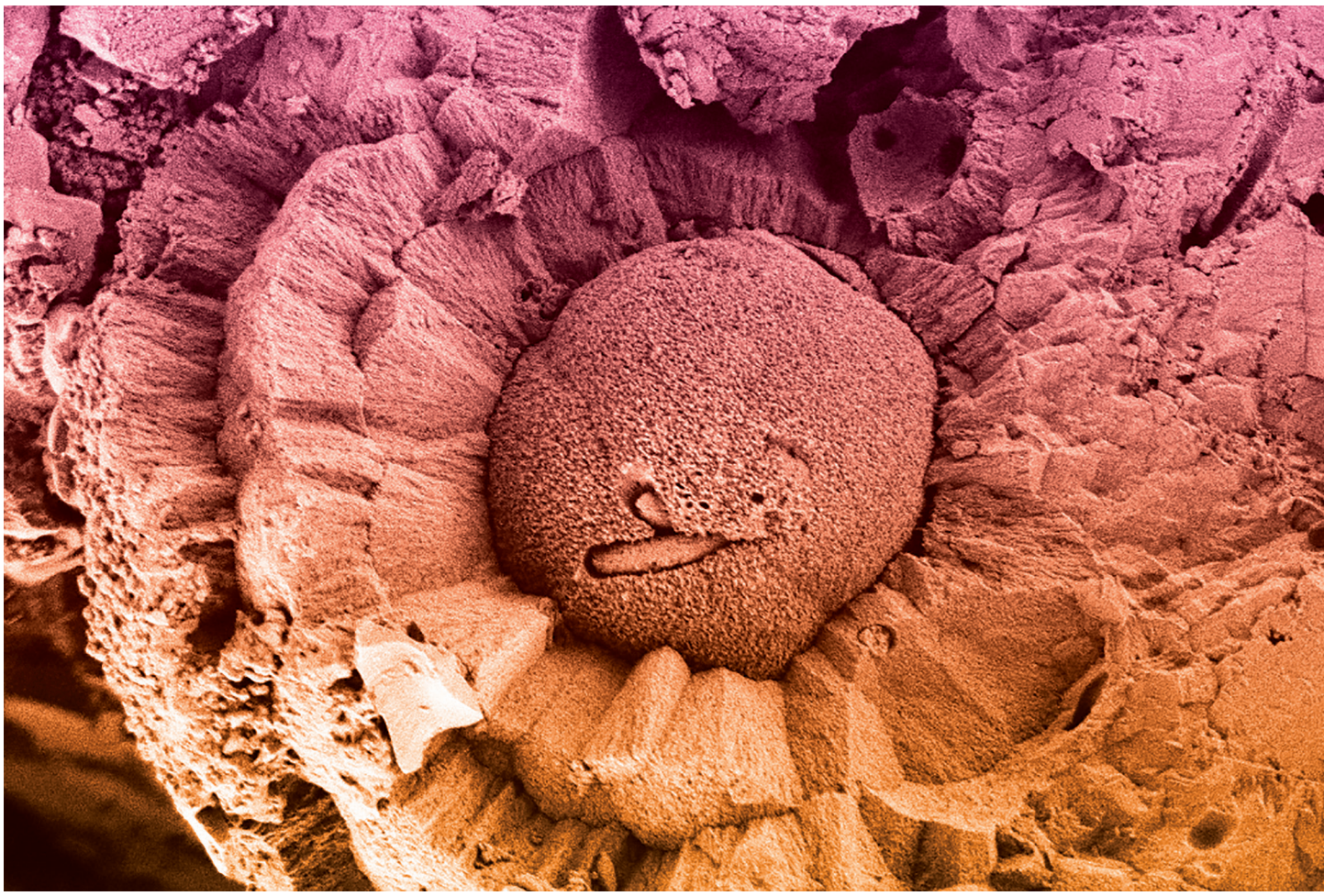
CENTER FOR BIOFILM ENGINEERING

2018 Annual Report



CENTER FOR BIOFILM ENGINEERING

MONTANA STATE UNIVERSITY

MONTANA STATE UNIVERSITY · IN THE PEOPLE'S INTEREST · 125 YEARS

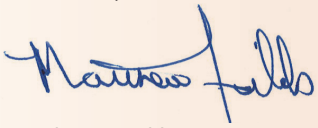
FROM THE DIRECTOR

FY2018 marked by expansion of biofilm science, growth in funding

Fiscal Year 2018 was especially productive here at the Center for Biofilm Engineering. Our researchers and students deepened our understanding of biofilms harmful to human health, including those that prevent chronic wounds from healing. And we also found new ways to exploit other biofilms for our benefit, such as one developed here at the CBE that hardens into limestone capable of plugging oil and gas leaks deep underground. Another truly year-defining success is that the U.S. Environmental Protection Agency adopted a developed method for testing the efficacy of anti-biofilm products on non-porous surfaces. And I am delighted to share with you that Connie Chang, assistant professor of chemical and biological engineering and CBE faculty, won a prestigious CAREER award from the NSF. The five-year, $500,000 grant is the agency's highest honor in support of early career faculty.

I am happy to report that in FY2018 we received $7.8 million in new grants, more than double the $3.1 million from last year. This reflects the outstanding work our researchers are conducting every day to expand the biofilm science and engineering. As I announced in our Montana Biofilm Meeting in July, we implemented a modest rate increase for membership in our Industrial Associates program – the first such increase in more than 4 years. Membership dues from our IAs directly support the center's infrastructure to enable both fundamental and applied research, methods development, and administrative functions that facilitate our scientists and students to continue their important work.

Looking ahead, the CBE will be collaborating closely with the National Biofilms Innovation Centre, a consortium of 31 laboratories in the United Kingdom focused on biofilm, as well as in Copenhagen and Singapore. We hope to work closely with biofilm researchers around the US and world to promote a biofilm network that promotes and empowers research, education, and outreach.



Matthew W. Fields
Director, Center for Biofilm Engineering
Professor, Department of Microbiology & Immunology
Montana State University
and Research Fellow, National Center for Genome Resources, Santa Fe, NM

RESEARCH

Research at the Center for Biofilm Engineering is driven by industrial, environmental, and health issues of national importance. CBE research has contributed new insights into microbial processes in a wide variety of contexts.

EPA adopts CBE model for testing anti-biofilm products

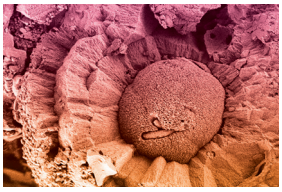
Data provided by the CBE provided the scientific backbone for new antimicrobial testing standards recently adopted by the US Environmental Protection Agency, according to CBE faculty member Darla Goeres, an associate research professor of chemical and biological engineering. The standards are the first to apply specifically to bacterial biofilms.

The standards provide a certification framework for companies to verify that their products are effective against biofilm bacteria and to label them accordingly.

The standards, which are an outgrowth of research that Goeres has conducted for nearly 17 years, provide a certification framework for companies to verify that their products are effective against biofilm bacteria and to label them accordingly, with a statement similar to the "Kills 99.9% of bacteria" found on bottles of bleach and other cleaners. The new labels could appear on products within a year.

According to CBE biostatistician Al Parker, antimicrobial manufacturers are eager to attain the certification because of growing awareness about bacterial biofilms. Public health entities such as hospitals — which routinely sterilize medical equipment such as surgical devices — are particularly interested, he said.

"There's been a paradigm shift," said Parker, whose statistical analysis played a central role in shaping the testing framework.



ON THE COVER

On the Cover: Calcium carbonate crystallizes around a bacterium to form biocement, which the CBE is using to seal leaking oil wells. See Page 4. Image courtesy CBE Microscopy Lab.

IN MEMORIAM

Mark E. Shirtliff, a former CBE researcher and longtime friend to many who continue to work here, died July 12, 2018. He was 49.

MSU researchers receive $1.8 million to study methane-converting microbes

Robin Gerlach, CBE faculty and professor of chemical and biological engineering, is the principal investigator of the BuG ReMeDEE research project. MSU photo by Kelly Gorham.

CBE received $1.8 million from the National Science Foundation for a collaborative project to study methane-consuming microbes and develop ways of using them to make commercial products such as plastics. The project, called Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep and Extreme Environments – abbreviated as BuG ReMeDEE and pronounced "bug remedy" – alludes to where the researchers will look for the microbes: in the thermal features of Yellowstone National Park and underground in a former South Dakota gold mine.

"It's not well understood what organisms are involved in the conversion of methane in these environments," said Robin Gerlach, CBE faculty and project principal investigator.

Methane conversion is increasing in scientific interest because the gas is a potent greenhouse agent whose contribution to climate change is second only to that of carbon dioxide. While large amounts of methane are emitted by natural wetlands, agriculture, oil and coal extraction, and landfills, relatively little is known about its production deep underground and in other environments once thought uninhabitable to methane-converting microbes.

"Yellowstone is a huge reservoir of microbial capabilities that we've barely explored," said Brent Peyton, CBE faculty and director of MSU's Thermal Biology Institute. He's also a member of the research team. "We're looking for microbes that are just barely being discovered."

Other CBE faculty on the project include Ross Carlson, professor of chemical and biological engineering; Connie Chang, assistant professor of chemical and biological engineering; Matthew Fields, professor of microbiology and immunology and director of the CBE; Roland Hatzenpichler, assistant professor of chemistry and biochemistry; Ellen Lauchnor, assistant professor of environmental engineering; and Jim Wilking, assistant professor of chemical and biological engineering.

CBE PRIMARY AREAS OF RESEARCH

- biofilm control strategies
- energy solutions
- environmental technologies
- health/medical biofilms
- industrial systems and processes
- standardized methods
- water systems

NEW RESEARCH GRANTS in fy2018

$7.8 million*

in research grants

*an increase of 152% from fy2017

New CBE mobile lab enables CBE researchers to test innovative biocement on leaking oil wells

Catherine Kirkland (right), CBE faculty and assistant research professor of civil engineering, and Abby Thane, research lab manager, prepare equipment inside a new mobile laboratory prior to a trip to Indiana to test a new biocement developed at the CBE to repair leaking oil and gas wells. MSU photo by Adrian Sanchez-Gonzalez.

In 2018, a team of CBE researchers towed a new mobile lab — a 28-foot-long, double-axle trailer outfitted with pumps, a generator and specialized equipment — to Indiana for the inaugural set of field tests designed to advance a new way to fix leaking oil and natural gas wells using rock-forming bacteria.

The field trials represent a major step toward commercializing the technology following a successful experiment in 2016. CBE faculty Adrienne Phillips, assistant professor in the Department of Civil Engineering and one of the principal investigators, first demonstrated that the harmless bacteria, called *Sporosarcina pasteurii*, could seal tiny, hard-to-reach cracks in the thin cement shell that encases metal well-bore pipe. Once injected into a well with a water-based solution the microbes produced calcite, the bacteria fill the microscopic cracks and harden into a mineral similar to limestone.

"There's a big market for this technology," said CBE research engineer Randy Hiebert. "We're seeing a lot of strong interest."

The mobile lab allowed the team to cultivate many gallons of bacteria solution in tanks while en route.

RESEARCH PUBLICATIONS

37 publications **33** journals in fy2018

Four CBE faculty draw large research grants, accolades

CONNIE CHANG, assistant professor of chemical and biological engineering, won a prestigious National Science Foundation's Faculty Early Career Development (CAREER) award to advance her research in the field of microfluidics. The five-year, $500,000 grant is the agency's highest honor in support of early-career faculty.

"This award recognizes Dr. Chang for her outstanding work over the past few years, and it acknowledges her incredible potential going forward," said Jeffrey J. Heys, department head of chemical and biological engineering.

The research will draw heavily from Chang's work with microfluidics, the technology of manipulating tiny droplets of water and oil using networks of tubes etched in plates of glass. These palm-sized, glass "chips" can handle millions of droplets per minute.

CHRISTINE FOREMAN, associate professor in chemical and biological engineering, was recently awarded a grant from the NASA Research Opportunities in Space Science, Exobiology Program.

Foreman and her team will study icy environments in Greenland and in the MSU SubZero labs, creating a spectral library of life in ice to compare to NASA's datasets, helping facilitate site selection for future missions in search of life on other planets. The project is called SLICE: Spectral Signatures of Life in Ice and the award provides $600,000 over three years.

continued on next page

Anne Camper, a founding researcher of the CBE, retires

Anne Camper, a Regents Professor of Engineering and associate dean for faculty and administration in the Norm Asbjornson College of Engineering, spent the entirety of her career on Montana State University's campus, from earning undergraduate (1975) and master's degrees (1977) in environmental microbiology and a PhD in civil engineering (1995). She has been instrumental in the success of the Center for Biofilm Engineering since its inception in 1989. She retired in January 2019.

When did you decide upon a career in science?

I was about 10 years old. In high school, I had done a science project on water quality on the Bitterroot River, and that got me into the international science fair in Baltimore. And that cemented it for me. I came to MSU to pursue a degree in microbiology in 1971, and in 1975 I started my master's degree. Then I worked as a researcher for years and years and I decided to go back for a PhD in 1989, which required that I pick up a lot of undergraduate coursework in engineering before starting my PhD program. I was married by then, and a mother to a young daughter. Plus, we were building a house when I was working on my PhD, so that year almost killed me! I was the general contractor. That was a hard year. We still live in that house.

When I was an undergraduate women had to have our parent's permission on file to be out of the dorm after midnight. Married women couldn't have credit cards in their own name, either.

How has the gender culture changed since you first came to campus as an undergrad?

Today, there are a whole lot more role models of women in science than there were back then. The image I had of a scientist when I was growing up was some guy with crazy hair wearing a lab coat. When I was an undergraduate, almost all of my faculty were men. Married women couldn't have credit cards in their own name, either. And undergraduate women had to have our parent's permission on file to be out of the dorm after midnight. Years later, when I started at the CBE, there were only two women in the labs. I have to give credit to my parents, though, who said I could do whatever I wanted regardless of gender. And they let me stay out after midnight.

Are you happy with advancements that were made in the field of water quality during the span of your career?

We've made a lot of progress, but there's never enough. When I started looking at microorganisms in drinking water, we didn't understand the dynamics. We were studying cultures in test tubes. Today, we're looking at whole system ecologies and how organisms interact with one another. And the molecular tools we now have are incredible. Another big difference is that the concept of biofilm is well established – when I started, the field was brand new.

ROLAND HATZENPICHLER, assistant professor of chemistry and biochemistry, is leading a project to collect microbe-rich sediments from the floor of Guaymas Basin, located in the Gulf of California. Hatzenpichler and his colleagues will use a $1 million National Science Foundation grant to research the microbes' role in carbon cycling.

"One teaspoon of deep-sea mud harbors more species of microorganisms than there are species of mammals on our entire planet," Hatzenpichler said. "Those microorganisms help break down dead biomass – from fish to algae – that fall to the ocean floor or, in the case of natural oil or hydrocarbon gases, seep up from below-ground reservoirs."

What scientists don't really know, he said, is what role different microorganisms play in breaking down these complex carbon molecules, because it's nearly impossible to re-create the natural ecosystem in a laboratory setting.

PHIL STEWART, professor of chemical and biological engineering, was recently awarded the Distinguished Professorship award by the Norm Asbjornson College of Engineering (NACOE).

NACOE Dean Brett Gunnink said he views the honor as a "lifetime achievement award" as he announced Stewart as the 2018 recipient.

Stewart, who served as the director of the CBE from 2005 to 2015, is the most-cited researcher at MSU by a wide margin, having published 174 papers to date that have been cited more than 35,000 times, according to Google Scholar.

"I would argue that Dr. Stewart has potentially the most distinguished research record at Montana State University," Heys said. "The numbers are difficult for me to fathom."

Stewart's most-cited paper, titled "Bacterial biofilms: a common cause of persistent infections," has been cited nearly 10,000 times.

Stewart and CBE colleague Garth James, recently won an NIH grant for a collaborative research project between nursing and medical investigators at University of Florida. The project aims to enhance the health outcomes of older individuals with chronic non-healing wounds.

EDUCATION

CBE students receive training in experimental design and laboratory research under the direction and mentorship of world-renowned faculty researchers.

CBE raises qualifications, hires MSU alumna to operate microscopy lab

When the CBE upgraded its Microscopy Facility in 2018, it not only invested heavily in state-of-the-art hardware that will help its researchers further their understanding of biofilm, it also raised the qualifications to run the growing laboratory.

Enter Heidi Smith, who was named to the position after a six-month nationwide search. Smith earned her doctorate in land resources and environmental sciences at Montana State University in 2016, and had worked closely with her predecessor, Betsey Pitts, both as a student and a postdoctoral researcher. Pitts, who served as manager of the microscopy lab for nearly 25 years, helped shape its reputation as a world-class facility before retiring in early 2018.

"Prior to starting the search, the CBE decided to make this a PhD position," Smith says. "Because I'm relatively new in my career, I'm working closely with CBE principal investigators, who are mentoring me and bringing me into their research. Betsey Pitts, my predecessor, was also a prominent mentor in my career. Her enthusiasm and commitment to training, teaching, and research has set the facility and me up to continue the successes she started."

In her new position, Smith oversees a multi-million-dollar microscopy facility that provides services to all researchers in the CBE, each working to unlock the mysteries of biofilm from the perspective of their own areas of scientific inquiry. The microscopy facilities include four separate laboratories—the Optical Microscopy Lab, the Confocal Microscopy Lab, the Chemical Imaging Lab, and the Microscope Resource Room and Digital Imaging Lab. Instrumentation in the facility includes two confocal microscopes, digital imaging equipment that can create time-lapse movies of microscopic samples, a Raman confocal microscope, and multiple high-end optical microscopes and stereo microscopes.

"Being able to visualize the processes that you're studying adds an important dimension to your research," Smith says. "We recently added Raman confocal microscopy, which allows us to interrogate the chemical composition of both biological and mineralogical samples. This is a huge advancement, as it adds important insight to spatially resolved chemical mechanisms at play within biofilm. Our capabilities have evolved alongside the advancements in the technologies, offering CBE scientists unprecedented insight into the functionality of biofilm communities. It is a very exciting time for the CBE microscopy facility as our existing infrastructure and experience poises us to broaden the scope of our research and grow new areas of program development."

Smith says the new equipment also enables CBE researchers to pursue scientific questions previously impractical, if not impossible.

"Today, we are able to understand how different microorganisms within complex microbial communities interact in a diversity of different environments," she says. "We have the techniques and technology at the CBE to go after these more complex questions about multiple organisms within each system. This will help us to accurately reproduce the diverse systems that are studied across the CBE. Rather than visualizing microorganisms in samples such as drinking water or a biofilm that's preventing chronic wounds from healing, we're better able to understand these complex communities, and how organisms interact within the environment."

BY THE NUMBERS

1,087
students trained
since 1990

fy2018 STUDENT SNAPSHOT

60
Undergraduates
29 men • 31 women

54
Graduate students
28 men • 26 women

10 DEPARTMENTS

Chemical & Biological Engineering
Chemistry & Biochemistry
Civil & Environmental Engineering
Ecology
Land Resources & Environmental Sciences
Material Sciences
Mathematical Sciences
Mechanical & Industrial Engineering
Microbiology & Immunology
Modern Languages & Literature

Fields, Foreman recognized for strong student mentorship

Matthew Fields, CBE director and professor in MSU's Department of Microbiology and Immunology, was among the winners of the top 2018 faculty and staff awards at the university. Fields received the Provost's Award for Graduate Research and Creativity Mentoring, which recognizes a faculty member who engages graduate students in this valuable learning process.

Fields' mentoring of graduate students across campus is significant. He has served as adviser to 15 graduate students, eight of whom have earned a doctorate from MSU. In spring semester 2017, he was advising six doctoral students. Fields has additionally served on the thesis and dissertation committees of 30 graduate students from multiple departments. Beyond his advising duties, Fields has co-authored 35 papers with MSU graduate students and shared in more than 50 presentations or awards with MSU graduate students.

Christine Foreman, CBE faculty, associate professor of chemical and biological engineering, and associate dean of the NACOE, was the 2018 recipient of the Lloyd Berg Faculty Mentorship award for her work with undergraduate students.

"She has also been a strong advocate for the success of women graduate students, having served as the primary advisor and committee chair for Heidi Smith and Safiye Selen Özcan, and the co-chair for Michelle Tigges," wrote Anne Camper, CBE faculty and Regents Professor of Engineering in her letter nominating Foreman for the honor. "This level of commitment is even more extraordinary because Dr. Foreman is on a 50 percent faculty appointment."

During the academic year 2017/18, Foreman mentored eight undergraduate students in projects relating to her research into polar-ice cores.

Top: Matthew Fields (right) and graduate student Jacob Valenzuela sample microbes in the Yellowstone backcountry. **Bottom:** Christine Foreman (right) helps master's student Safiye Selen Özcan in the lab. MSU photos by Kelly Gorham.

Barkan Sidar, a PhD student, says the key to advancing the scientific horizon for using organoids in research may be in finding a way to eliminate their waste. MSU photo by Adrian Sanchez-Gonzalez.

STUDENT SPOTLIGHT

PhD student seeks to unlock the limitations of 'organoids'

Barkan Sidar is a PhD student who works with "organoids" in the lab of CBE faculty Jim Wilking, assistant professor of chemical and biological engineering. Sidar collaborates closely with Diane Bimzcok, assistant professor of microbiology and immunology, and Seth Walk, associate professor of microbiology and immunology.

What are organoids?

Organoids are three-dimensional, millimeter-scale tissue cultures that reproduce much of the structure and function of human organs such as the stomach, kidney, and brain. These tissues are distinct from more traditional engineered tissues in that they self-assemble from stem cells and contain the key cell types and some of the spatial organization representative of particular organs.

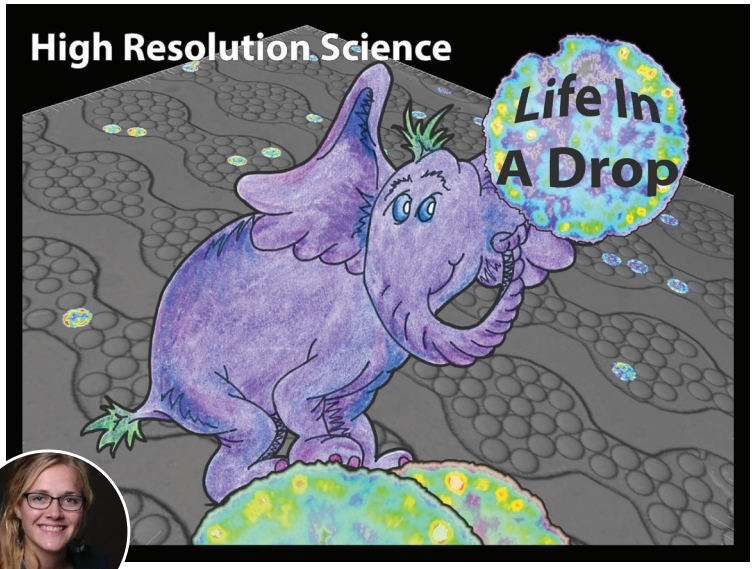
Why are organoids of scientific interest?

Human gastrointestinal organoids hold tremendous promise for a variety of fields, including the study of the gut microbiome, which is our area of interest. However, because organoids are sealed shut – think of a soccer ball or a balloon – their metabolic waste has no way to exit, thus it builds up inside ultimately shutting down all functions. Better understanding how waste builds up will help us determine ways to introduce flow through organoids and eliminate the waste. If we can do this, it will open up a whole new range of previously inaccessible experiments.

CBE STUDENTS IN ACTION

Providing CBE undergraduate and graduate students alike the opportunity to present their work to researchers and industry is a cornerstone of our mission, viewed by faculty and administrators as of equal importance than their experiences in the lab.

Arda Akyel (left), a CBE PhD student studying chemical and biological engineering, presents at a poster session as part of the 2018 Montana Biofilm Meeting hosted annually by the CBE. Photo courtesy the CBE.



Shawna Pratt, CBE PhD student studying chemical and biological engineering, won the campus-wide Three-Minute Thesis competition for her presentation titled "High Resolution Science: Life in a Drop." Pratt also won the Graduate Student Competition in the Microbes at Biomedical Interfaces session at the American Institute for Chemical Engineering's annual meeting.

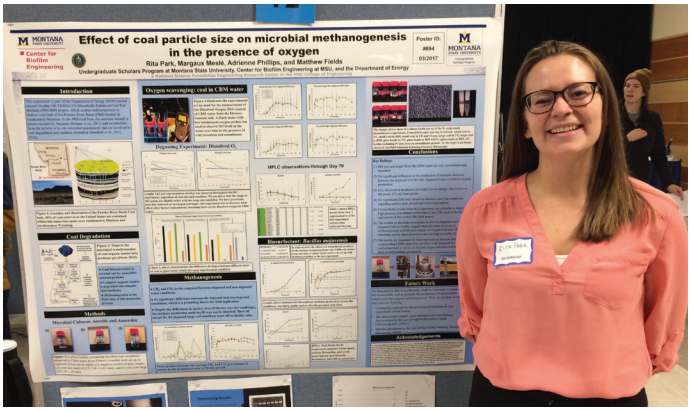
Natalya Polukoff, a CBE undergraduate student majoring in microbiology and immunology, presented at MBM. Photo courtesy the CBE.

Ryanne Daily, a CBE graduate student studying chemical and biological engineering, demonstrates biocement solidification during the MBM poster session. Photo courtesy the CBE.

Jeff Simkins, a CBE PhD student studying chemical and biological engineering, presented at MBM. Photo courtesy the CBE.

Sobia Anjum (right), a CBE PhD student studying chemical and biological engineering, presents during the MBM poster session. Photo courtesy the CBE.

Youra Moeun, an undergraduate student studying chemical and biological engineering, works in the lab of CBE faculty member Jim Wilking. MSU Photo by Adrian Sanchez-Gonzalez.



Rita Park, an undergraduate studying microbiology and immunology who works at the CBE, participated in MSU's annual Student Research Celebration. MSU photo by Jill Story.

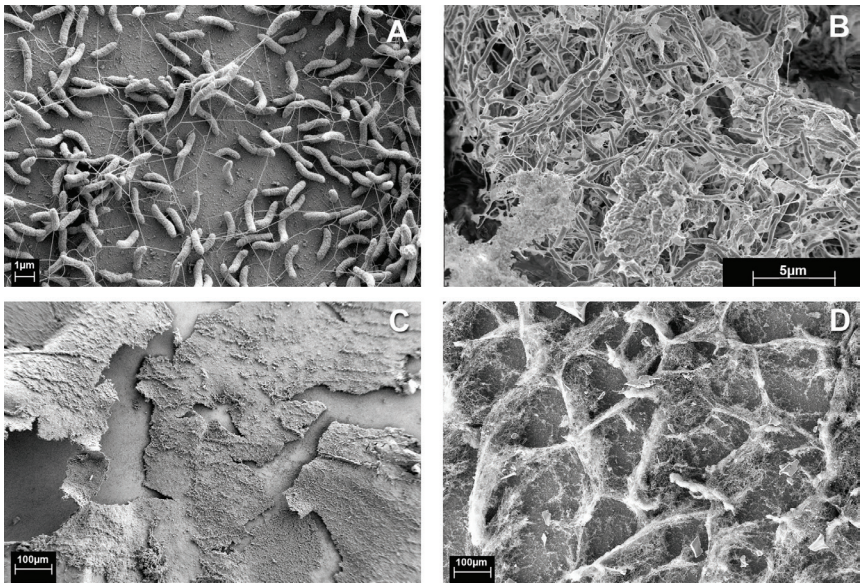
The CBE collaborates with top biofilm researchers around the world, as well as provides a hub for research for visiting students, scientists, and faculty.

Goeres elected chairwoman of ASTM Committee

CBE faculty Darla Goeres, associate research professor in chemical and biological engineering, was elected chairwoman of ASTM International Main Committee E35 for a two-year term that began Jan. 1, 2018. ASTM International, formerly known as the American Society for Testing and Materials, is a globally recognized leader in the development and delivery of international voluntary consensus standards. Committee E35 is responsible for the development of standard definitions, classifications, appropriate test methods, and recommended practices relating to efficacy, safety, quality, and impact in appropriate environments of pesticides, antiseptic and antimicrobial agents, biological agents, devices, and equipment.

CBE image on display in Amsterdam's NEMO Science Museum

A published image taken by Kristen Brileya, CBE researcher and technical operations manager, is included in the exhibition "Life in the Universe" at the esteemed NEMO Science Museum in Amsterdam, the Netherlands. A portion of the exhibit is dedicated to extremophiles, which are organisms that thrive in extreme conditions that are detrimental to most life on Earth. The selected image shows a biofilm of *Desulfovibrio vulgaris*, a sulfate-reducing bacterium that can have an extreme diet of metals. The image was obtained by Kristen Brileya, an MSU-CBE doctoral graduate and current CBE technical operations manager, using a scanning electron microscope from MSU's Image and Chemical Analysis Lab. The image is part of a larger figure in the article "Biofilm growth mode promotes maximum carrying capacity and community stability during product inhibition syntrophy," published by *Frontiers in Microbiology* in 2014. Brileya was first author on the paper. The exhibit is expected to run for at least five years.



(A,C) Monocultures of *Desulfovibrio vulgaris* biofilm from continuous culture (5,420X and 101X, respectively).
(B,D) Coculture biofilm of *D. vulgaris* and *M. maripaludis* (10,000X and 100X, respectively).

VISITING RESEARCHERS

JONTANA ALLKJA
PhD Student
University of Porto, Portugal

TIBOR BENEDEK
Postdoctoral Researcher
Szent István University
Gödöllö, Hungary

KRISTINA BLOCK
Master's Student
Berlin Technological University, Germany

MARTA BOTTAGISIO
PhD Student
University of Milan, Italy

STACI CAPOZZI
Postdoctoral Researcher
University of Maryland, Maryland

CAROLINA DEQUECH GARCIA
Undergraduate Student
Montana State University, Montana

MARKETA HULKOVA
PhD Student (Fulbright)
Masaryk University, Czech Republic

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ELIZABETH LEE
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ALBERT ENRIQUE TAFUR RANGEL
PhD Student
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LENNO VAN DEN BERG
PhD Student
Delft University, The Netherlands

AYRAT ZIGANSHIN
Faculty
Kazan Federal University, Russia

ELVIRA ZIGANSHINA
Faculty
Kazan Federal University, Russia

Our Industrial Associates are important partners in our mission of scientific discovery and technology transfer. These relationships help us connect our research solutions with real-world problems.

Testing project for medical anti-biofilm product shows how CBE partners with industry

Note: Due to its proprietary nature, the work performed for companies by CBE researchers is highly confidential. However, with the permission of the client, we can occasionally report on certain projects to serve as an example of how we partner with industry.

Next Science Group, an Australian biotechnology firm, recently entered into an exclusive worldwide distribution agreement with 3M Health Care for technology tested at the Center for Biofilm Engineering designed to improve outcomes for patients with chronic wounds. Next Science is a CBE Industrial Associate. According to Next Science, the product BlastX™ Antimicrobial Wound Gel contains Xbio™ Technology, the key ingredient, which was tested at the CBE.

"BlastX Wound Gel applies an innovative material science approach that first deconstructs the bacterial biofilm matrix – a major barrier to healing – before destroying harmful bacteria within the gel ..." according to a press release issued by Next Science.

"Biofilms often develop on chronic wounds, such as sores on the feet of patients with diabetes, and limit the effectiveness of treatment," says Garth James, principal investigator at CBE's Medical Biofilms Laboratory and an associate research professor of chemical and biological engineering. "Without overcoming the biofilm, doctors have limited treatment options, which all too often leads to negative patient outcomes."

James said he and his colleagues in CBE's Medical Biofilms Laboratory performed extensive efficacy tests for Next Science over a period of several years. The tests came prior to the company seeking approval from the FDA to market products using Xbio as a medical anti-biofilm technology.

Industrial Associates have access to the latest research developments in the field of biofilm, including that of CBE faculty Garth James (right), associate research professor of chemical and biological engineering. James is the principal investigator of the CBE Medical Biofilms Lab. MSU photo courtesy the CBE.

CBE Member Benefits

- Access to the latest research and CBE investigators
- Invitations to specialized workshops
- Exclusive invitations to CBE's Montana Biofilm Meeting and regulatory meeting in Washington, D.C.
- Two days of individualized/custom consultation per year by CBE researchers
- Opportunities for sponsored research to address specific concerns
- Access to state-of-the-art tools for biofilm analyses

2017–2018 INDUSTRIAL ASSOCIATES

3M • Accuratus Lab Services* • American Chemet* • BASF / Ciba Specialty Chemicals • Baxter Healthcare, Inc. • Boston Scientific Urology • Chem-Aqua • Church & Dwight Co., Inc. • CleanSpot, Inc.* • Decon7 Systems* • DeLaval • Dow Microbial Control • Ecolab • ICU Medical, Inc. • Lonza • Masco Corporation • Medentech • NASA • Next Science* • Olympus • PPG Industries • Procter & Gamble Company • SANUWAVE Health* • Sharklet Technologies* • Smith & Nephew • Solvay • Sterilex* • STERIS • The Sherwin-Williams Company • Zimmer Biomet

* Small Business Member ■ New Member

fy2018 **$752,207** 60 testing projects 29 sponsors

2018 CBE conference in Washington, DC helped industry navigate regulatory bodies

At a one-of-a-kind conference hosted in Washington, D.C., annually by the CBE, top federal officials exchanged ideas with university researchers, industry representatives, and medical practitioners about ways to move life-saving technologies into the marketplace. The 2018 conference, titled "Anti-Biofilm Technologies: Pathways to Product Development," focused on medical disinfectants and was the fifth such gathering that the CBE has organized in Washington area since 2014.

"We want to see good science inform regulatory decision-making," said Paul Sturman, a research professor and industrial coordinator at the Center for Biofilm Engineering.

The 2018 conference convened about 100 people, including the top biofilm scientists from the US Food and Drug Administration and US Environmental Protection Agency. EPA regulates surface disinfectants such as those used in hospitals, while FDA regulates prosthetics and other products used within the human body.

> We want to help companies move their products through the regulatory process.
>
> — Paul Sturman
> CBE Industrial Coordinator

"Biofilms are a big deal," Sturman said, because the thin, slimy mats of microbes can make bacteria more resistant to traditional disinfectants. It is increasingly evident that a large fraction of infections — such as the tens of thousands that result each year from prosthetic joint surgeries, many of which prove fatal — are caused by biofilm bacteria, he said.

That has generated interest among researchers and medical companies in developing biofilm-specific disinfectants, which must be tested and approved by the EPA or FDA before they are adopted for widespread use, Sturman said. The agencies, meanwhile, are having to adjust their product-approval protocols, which have been geared toward ensuring their effectiveness against bacteria in a liquid or dried on a surface, but not biofilm bacteria.

"We want to help companies move their products through the regulatory process," Sturman said.

An example of a successful outcome, he noted, was the EPA's approval in 2017 of the first-ever set of testing procedures for surface disinfectants that are designed to be effective against biofilm bacteria (see Page 2). The standards provide a certification framework for companies to verify that their products are effective against biofilm bacteria and to label them accordingly, with a statement similar to the "Kills 99.9% of bacteria," found on bottles of bleach and other cleaners.

More than a decade of work by MSU researchers provided the scientific backbone for the policy. A team led by CBE faculty Darla Goeres, an associate research professor of chemical and biological engineering, developed an apparatus for producing the standardized biofilm samples, provided detailed statistical analysis and recommended testing protocols to EPA. According to Goeres, new products with the certification could be used by hospitals and others within a year.

The new EPA biofilm guidelines "are a perfect example of how open dialogue leads to success," Goeres said, noting that previous Center for Biofilm Engineering conferences contributed to the extensive collaboration between MSU researchers, EPA and industry that ultimately produced the certification framework. "These meetings are so critical because they provide a forum for each side to express their viewpoints and their criteria for success."

SAVE THE DATES!

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Feb. 5-6, 2019
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Bozeman, Montana

Center for Biofilm Engineering
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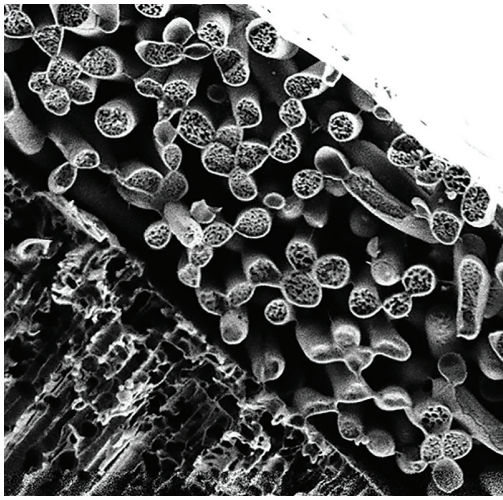

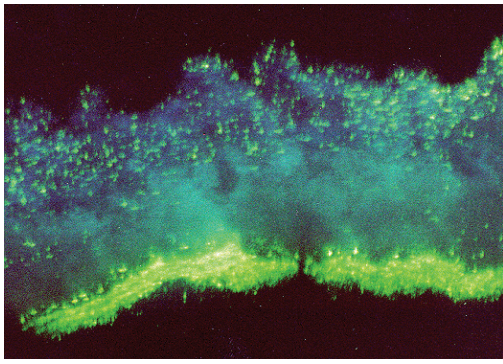

Above: Scanning Electron Microscope image of calcium carbonate precipitates (false color), formed inside microdroplets, Neerja Zambare, 2016. **Top Right:** Cryo TEM image of a *E. coli* biofilm sliced to see the interior, Adrienne Phillips, 2018. **Bottom Right:** Confocal Microscopy image of a *K. pneumoniae* biofilm cross sectioned and stained for *APase* activity, Ching-Tsan Huang, 1996.

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