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# 2013

# APPENDIX

Reporting period:  
June 1, 2012 – May 31, 2013

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Center for Biofilm  
Engineering

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Montana State  
University

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RESEARCH:  
 CBE RESEARCH AREAS

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**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.

**CBE RESEARCH:**

- is motivated by industrial concerns and involvement of industry partners;
- is conducted at multiple scales of observation, from molecular to field-scale;
- involves interdisciplinary investigations;
- provides relevant research opportunities for undergraduate and graduate students;
- is enhanced by productive collaborations with researchers at other institutions;
- is funded by competitive grants and industrial memberships; and
- produces both fundamental and applied results.

The CBE's long history of research success results from **adaptability** to new information and analytical technologies and **flexibility** in addressing biofilm issues in comprehensive ways, using its deep bench of **MSU researchers with diverse specialties** in biofilm studies.

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## APPLIED RESEARCH AREAS & PROJECTS

**Biofilm control strategies** antimicrobial efficacy | biocides | bioelectric effect | disinfectants | inhibitory coatings | nitrous oxide

**Energy solutions** biofuels | microbial fuel cells

**Environmental subsurface technologies** bioremediation | wetlands | CO<sub>2</sub> sequestration | biobarriers

**Health/medical biofilms** chronic wound healing | catheter infections | oral health | food safety

**Industrial systems & processes** biofouling | biocorrosion | product contamination | microbe-metal interactions | biomineralization

**Standardized methods** product claims | regulatory issues | ASTM methods acceptance

**Water systems** drinking water quality | premise plumbing | water treatment | distribution systems

## FUNDAMENTAL TOPICS

**Biofilms in nature** microbes in cold environments | role of biofilms in natural processes | thermophiles

**Cellular/intracellular** phenotype | genetics | metabolic pathways | proteomics

**Ecology/physiology** population characterization | spatial and temporal population dynamics

**Multicellular/extracellular** flow and transport in biofilm systems | material properties | quorum sensing | structure-function | heterogeneities | matrix

## ANALYTICAL TOOLS & TECHNIQUES

**Instrumentation** microscopy | nuclear magnetic resonance imaging | gas chromatography | ToF-SIMS | micro-dissection

**Methods development** experimental design | variability | ruggedness | repeatability | statistical evaluation

**Modeling** cellular automata modeling | mathematics | hydrodynamics

**Basic microbiology techniques** total and direct counts | MIC determination | viable cell counts

**Molecular biology techniques** DNA extraction | PCR | DGGE | microarrays | sequencing

RESEARCH:  
 2012–2013 CBE RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Biofilms in Nature	Heidi Smith's NASA Fellowship	Foreman	NASA
Biofilms in Nature	Collaborative research: Integrated high resolution chemical and biological measurements on the Deep WAIS Divide Core. * <sup>3</sup>	Foreman	NSF
Education	Improving Montana community health through graduate education	Camper	NIH
Energy Solutions	Montana biodiesel initiative	Peyton	DOE
Energy Solutions	Extremophilic microalgae: Advanced lipid and biomass production for biofuels and bioproducts	Peyton Fields	DOE
Energy Solutions	EFRI-HyBi: Fungal processes for bioconversion	Peyton	NSF-ARRA
Energy Solutions	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	Church & Dwight
Energy Solutions	CBE collaboration with Little Bighorn College: Cultivation and characterization of oil producing algae	Peyton	LBHC
Energy Solutions	SEP collaborative research: Alkaliphilic microalgae-based sustainable & scalable processes for renewable fuels and products	Gerlach, Peyton & Fields	NSF
Energy Solutions	Direct conversion of lignocellulosic feedstocks to lipids and high-value products using a propriety microbial process	Macur	Sustainable Bioproducts
Energy Solutions	Nutrient and water integration and recycling for sustainable and algal biorefineries	Gerlach, Peyton & Fields	DOE
Environmental Technologies	Environmental responses to geologic CO <sub>2</sub> sequestration	Cunningham	DOE EPSCoR
Environmental Technologies	Basic science of retention issues, risk assessment & measurement, monitoring & verification for geologic CO <sub>2</sub> sequestration	Cunningham	DOE
Environmental Technologies	ZERT II - Cunningham Task II	Cunningham	DOE-ZERT
Environmental Technologies	Plant, season, and microbial controls on complete denitrification in treatment wetlands	Stein	NSF
Environmental Technologies	Microbial activity and precipitation at solution-solution mixing zones in porous media	Gerlach	DOE-ERSP
Environmental Technologies	Cultivation and characterization of phototrophs for renewable organic fertilizer	Macur	DOE-AIREI
Environmental Technologies	MSU selenium biogeochemistry investigation	Peyton	Teck Coal
Environmental Technologies	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface	Codd	US DOE
Medical Biofilms	Development of novel anti-biofilm compounds for treating chronic wounds	James	NIH
Medical Biofilms	<i>Staphylococcus aureus</i> biofilms mediate keratinocytes apoptosis	Kirker	NIH
Methods Development	Antimicrobial test methodology	Goeres	EPA

Research Area	Title	Principal Investigator	Funding Agency
Modeling	CMG research	Klapper	NSF
Physiology & Ecology	Role of non-coding RNAs in <i>P. aeruginosa</i> biofilm development* <sup>1</sup>	Franklin	NIH
Physiology & Ecology	Virtual institute for microbial stress & survival	Fields	Lawrence Berkeley National Lab
Physiology & Ecology	Role of IbpA in maintaining viability of <i>P. aeruginosa</i> biofilm persister cells* <sup>1</sup>	Franklin	NIH
Physiology & Ecology	Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS divide replicate core	Foreman	NSF
Physiology & Ecology	Multidimensional -omics characterization of microbial metabolism and dissolved organic matter	Foreman	NSF
Physiology & Ecology	Phototroph-heterotroph interactions	Carlson	US DOE Pacific Northwest Laboratory

\* Denotes a project running through a different MSU department, but involving collaboration with CBE researchers and/or use of CBE facilities.

<sup>1</sup>MSU Department of Microbiology

<sup>2</sup>MSU Department of Chemical and Biological Engineering

<sup>3</sup>MSU Department of Land Resources & Environmental Sciences

#### **List of Acronyms**

<b>DOE</b>	U.S. Department of Energy
<b>EPA</b>	U.S. Environmental Protection Agency
<b>LBHC</b>	Little Big Horn College
<b>MBRCT</b>	Montana Board of Research and Commercialization Technology
<b>NASA</b>	National Aeronautics and Space Administration
<b>NIH</b>	National Institutes of Health
<b>NSF</b>	National Science Foundation
<b>USDA</b>	U.S. Department of Agriculture
<b>USDOE</b>	U.S. Department of Energy
<b>ZERT</b>	Zero Emissions Research and Technology

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## FY13 New CBE Research Grants (July 1, 2012 to June 30, 2013)

Sponsor	Title	PI	Period	Amount
NIH	Improving Montana community health through graduate education	Camper	3 yrs	\$379,203
Little Big Horn College	CBE collaboration with Little Bighorn College: Cultivation and characterization of oil producing algae	Peyton	1 yr	\$25,485
US DOE w/Vista Clara Inc. (SBIR/STTR)	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface	Codd	1 yr	\$25,000
NIH w/Agile Sciences (STTR)	Development of novel anti-biofilm compounds for treating chronic wounds	James	1 yr	\$95,003
Church & Dwight Co. Inc.	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	1 yr	\$121,680
NSF	Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS divide replicate core	Foreman	2 yrs	\$162,266
Sustainable Bioproducts	Direct conversion of lignocellulosic feedstocks to lipids and high-value products using a propriety microbial process	Macur	6 mos	\$49,036
NIH	<i>Staphylococcus aureus</i> biofilms mediate keratinocytes apoptosis	Kirker	3 yrs	\$216,000
US DOE	Nutrient and water integration and recycling for sustainable and algal biorefineries	Gerlach, Peyton & Fields	3 yrs	\$781,895
NSF	SEP Collaborative Research: Alkaliphilic microalgae-based sustainable & scalable processes for renewable fuels and products	Gerlach, Peyton & Fields	4 yrs	\$690,000
US DOE Pacific Northwest Laboratory	Phototroph-heterotroph interactions	Carlson	1 yr	\$55,179
Teck Coal	MSU selenium biogeochemistry investigation	Peyton	1.5 yrs	\$189,994
DOE AIREI	Cultivation and characterization of phototrophs for renewable organic fertilizer	Macur	3 yrs	\$104,854
NSF	Multidimensional -omics characterization of microbial metabolism and dissolved organic matter	Foreman	3 yrs	\$270,040
Lawrence Berkeley National Laboratory	Virtual Institute for Microbial Stress & Survival	Fields	1.75 yrs	\$370,000*
<b>Total grant awards to CBE for FY 2013</b>				<b>\$3,535,635</b>

\*Represents additional funding received for this grant in May 2013. Grant original start date: December 2007.

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## RESEARCH: NEWS

### Collaborative project reveals medically relevant iron-induced biofilm phenomenon

A paper recently published in *Proceedings of the National Academy of Sciences (PNAS)*, representing a collaborative project between researchers at the University of Michigan and Montana State University's Center for Biofilm Engineering, sheds new light on biofilm processes with important medical implications.

The article, "Iron induces bimodal population development by *Escherichia coli*" (corresponding author: Matthew R. Chapman of the University of Michigan), was published in the February 12, 2013, issue of *PNAS*. Several CBE researchers contributed research, analytic tools, and data analysis for this project: **Hans Bernstein**, PhD candidate in chemical and biological engineering, **Steve Fisher**, research assistant, **Garth James**, medical projects manager, and **Phil Stewart**, CBE director.

The study describes an iron-induced biofilm phenomenon that leads to the formation of two distinct, spatially separated populations within biofilms formed by the uropathogenic *Escherichia coli* strain UT189. It provides an in-depth understanding of biofilm formation processes, physical structure, and responses to iron and/or oxidative stress, which is important for the development of antibacterial agents.

At the CBE, researchers employed oxygen microsensors, capable of measuring dissolved oxygen microprofiles at the microscale, to establish defined oxygen gradients within these biofilms that correspond to the positions of the two distinct bacterial populations.

This project has important medical implications, since it relates fundamental biofilm formation processes to iron limitation. Iron is often sequestered by the host organism during bacterial infections and is therefore a critical limiting nutrient to be considered in host-pathogen interactions.

Read the [full article](#) from the February 12, 2013 issue of *PNAS* 2013; 110(7):2629-2634.

Authors: WH DePas<sup>a</sup>, DA Hufnagel<sup>b</sup>, JS Lee<sup>b</sup>, LP Blanco<sup>c</sup>, HC Bernstein<sup>d</sup>, ST Fisher<sup>d</sup>, GA James<sup>d</sup>, PS Stewart<sup>d</sup>, MR Chapman<sup>b,1</sup>

Departments of <sup>a</sup>Microbiology and Immunology, <sup>b</sup>Molecular, Cellular, and Developmental Biology, and <sup>c</sup>Internal Medicine, Rheumatology Division, University of Michigan, Ann Arbor, MI 48109; and <sup>d</sup>Center for Biofilm Engineering, Montana State University, Bozeman, MT 59717

### CBE earns second cover of *Biotechnology and Bioengineering*

A CBE confocal microscope image is featured on the cover of the December 2012 issue of *Biotechnology and Bioengineering*. This is the second CBE image on the cover of *Biotechnology and Bioengineering* in the past year. Both images were submitted to the journal with the article, "Hydrodynamic deformation and removal of *Staphylococcus epidermidis* biofilms treated with urea, chlorhexidine, iron chloride, or dispersinB," authored by **Eric Brindle**, CBE PhD 2009 graduate, **David Miller**, CBE faculty member, mechanical engineering, and CBE director **Phil Stewart**, chemical and biological engineering. Statistical analysis provided by CBE statistician **Al Parker**.

The cover image shows fully hydrated *Staphylococcus epidermidis* biofilm imaged by confocal microscopy showing microcolonies (yellow clusters) and extracellular matrix material (red). Each microcolony contains thousands of bacteria. (Image courtesy of **Betsey Pitts**, **Willy Davison**, Paul Perry, and **Phil Stewart**).

View the CBE cover image on the current issue of *Biotechnology and Bioengineering*, December 2012; (109)12: <http://onlinelibrary.wiley.com/doi/10.1002/bit.v109.12/issuetoc>

Read the related article in the December 2011 issue at the Wiley Online Library: <http://onlinelibrary.wiley.com/doi/10.1002/bit.v108.12/issuetoc>

*Biotechnology and Bioengineering*, December 2011; (108)12:2968–2977.

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RESEARCH:  
 CBE Associated Faculty and Their Specialties, 2012–2013

NAME	DEPARTMENT	SPECIALTY
Jennifer Brown	Chemical & Biological Engineering	Rheology and biofilm mechanics
Mark Burr	Land Resources & Environ Sciences	Microbial community analysis
Anne Camper	Civil Engineering	Biofilms in environmental systems
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic networks
Sarah Codd	Mechanical & Industrial Engineering	Magnetic resonance imaging
Kevin Cook	Mechanical & Engineering Technology	Tool and machine design
Al Cunningham	Civil Engineering	Subsurface biotechnology and bioremediation
Jack Dockery	Mathematical Science	Mathematical models of biofilms
Matthew Fields	Microbiology	Physiology and ecology
Christine Foreman	Chemical & Biological Engineering	Microbial ecology in cold temperature environments
Michael Franklin	Microbiology	Molecular genetics, gene expression, alginate
Gill Geesey	Microbiology	Molecular and cellular interactions at interfaces
Robin Gerlach	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Darla Goeres	Chemical & Biological Engineering	Standardized biofilm methods
Marty Hamilton	Statistics	Applied biostatistical thinking
Jeff Heys	Chemical & Biological Engineering	Fluid-structure interactions
Garth James	Chemical & Biological Engineering	Medical biofilms
Warren Jones	Civil Engineering	Water distribution systems
Isaac Klapper	Mathematical Science	Mathematical modeling
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
Richard Macur	Chemical & Biological Engineering	Biofuels, geochemistry, geomicrobiology
Aurélien Mazurie	Microbiology	Bioinformatics
Bruce McLeod	Electrical & Computer Engineering	Bioelectric effect
David Miller	Mechanical & Industrial Engineering	Experimental mechanics
Andy Mitchell	Civil Engineering	Geomicrobiology
Al Parker	Statistics	Statistical models in biofilm systems
Brent Peyton	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Elinor Pulcini	Chemical & Biological Engineering	Medical biofilms
Barry Pyle	Microbiology	Environmental, water, and food microbiology
Abbie Richards	Chemical & Biological Engineering	Environmental biotechnology
Rocky Ross	Computer Science	Web-based, active learning education
Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Otto Stein	Civil Engineering	Engineered waste remediation
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Sturman	Civil Engineering	Biofilms in waste remediation and industrial systems
Peter Suci	Microbiology	Fungal biofilms
Tianyu Zhang	Mathematics	Mathematical modeling



## CBE Associated Faculty Awards & News

### Two CBE faculty participate in ASM colloquium on water systems

College of Engineering associate dean and CBE faculty **Anne Camper**, civil engineering, was a member of the organizing committee for the ASM American Academy of Microbiology's Colloquium Program on Water Distribution Systems. CBE faculty **Ross Carlson**, associate professor, chemical and biological engineering, also participated in the colloquium. The American Academy of Microbiology is the honorific branch of the American Society for Microbiology, a non-profit scientific society with almost 40,000 members. Fellows of the AAM have been elected by their peers in recognition of their outstanding contributions to the field of microbiology.

The colloquium program provides an opportunity for individuals with expertise in evolutionary biology, genetic engineering, mycology, virology, microbial ecology, and other fields to discuss these issues and review the areas in which research is needed to fill gaps in our understanding. The colloquium took place in Boulder, Colorado in April 2012 with a final report published in fall 2012 based on the deliberations of experts who discussed questions about the microbiology of the built water distribution infrastructure.

Read the Colloquia report "Microbes in pipes: The microbiology of the water distribution system" (pdf):  
<http://academy.asm.org/images/stories/documents/mip.pdf>

### MSU 2013 Faculty Awards and Recognition

CBE faculty member, **Robin Gerlach**, associate professor, chemical and biological engineering, is among the winners of the top Montana State University 2013 faculty awards announced this week. The annual awards honor achievement in faculty research, teaching, outreach, and creative projects. This year's awards were presented at the 3<sup>rd</sup> annual MSU Spring Convocation on Thursday, January 10<sup>th</sup>, in MSU's Procrastinator Theater.

Gerlach is one of three recipients of the **2013 Cox Family Award for Creative Scholarship and Teaching** award. Each recipient will receive a \$2,000 honorarium from the Winston and Helen Cox Family Endowment, as well as an \$800 stipend to buy books dedicated in their honor at MSU's Renne Library.

Gerlach has an international reputation for groundbreaking research, from studying the complex network of interactions between biofilm growth and environmental conditions, to studying contaminant transport and transformation on surfaces. He has worked on using biofilms to create subsurface barriers for use in bioremediation of environmental contaminants, as well as in carbon sequestration and bioenergy. In addition to his affiliation with the Center for Biofilm Engineering, he is also director of the Environmental and Biofilm Mass Spectrometry Facility and has been repeatedly published in Environmental Science and Technology.

### 2013 CBE Outstanding Faculty Award

The CBE presented its **2013 Outstanding Faculty Award** to **Al Parker**, CBE bio-statistician and adjunct instructor in MSU's Department of Mathematical Sciences. Parker received this award in recognition of his enthusiastic and patient education of CBE participants in statistical analyses and experimental design, engagement with CBE industrial associates and EPA collaborators, teamwork, and productive contributions to numerous interdisciplinary projects.

### MSU College of Engineering 2013 Faculty Awards

Two CBE faculty were honored at the College of Engineering Luncheon on May 2, 2013. **Abbie Richards**, associate professor, chemical and biological engineering, received the **COE Faculty Award for Excellence in Advising**. **Sarah Codd**, professor, mechanical and industrial engineering, received the **COE Lloyd Berg Faculty Mentorship Award**.

CBE faculty member receives Lifetime Achievement Award for efforts to improve Montana drinking water

MSU-CBE faculty member **Warren Jones**, associate professor in civil engineering, was recently featured by Montana State University for his receipt of a Lifetime Achievement Award from the Montana Water Environment Association (MWEA) and the Montana Section of the American Water Works Association (MAWWA). The award was presented at the MWEA/MAWWA annual banquet on May 8, 2013 in Great Falls, Montana. Jones received the award for his many years of dedicated service, education, and support for Montana's water and wastewater operators. MSU College of Engineering associate dean and CBE faculty member Anne Camper presented the award and Katie Davis, Jones' current masters student in environmental engineering, accepted the award on his behalf.

After accepting the award, Davis was deeply touched by the audience's admiration of Jones, "I was honored last night to travel to Great Falls with Anne Camper to accept an award for Warren from the Montana Water Works Association. The award commemorated all of Warren's contributions and hard work over the years to help improve drinking water and sanitation treatment throughout the state. It brought tears to my eyes to see the standing ovation and to meet so many people whose lives have been touched by Warren's big heart and unrelenting efforts."

Read more about Jones' contributions to water quality in Montana at *MSU News*: ["MSU engineering professor receives lifetime achievement award"](#)

Editor's note:

The CBE mourned the loss of our dear friend and colleague **Warren Jones**, MSU professor of environmental engineering, and a founding faculty member of the Center for Biofilm Engineering. He died July 7, 2013, after a year-long battle with cancer. Warren showed his enormous dedication to education and his students by continuing to teach during the past year. His focus, fantastic attitude, and wit—along with his wide set of good friends and his family—sustained his efforts to contribute to teaching his students through the 2013 spring semester.

Known for his quick mind, incisive comments, love of training dogs, and playing bass in the local band Textbook Blues, Warren had a great sense of fun in addition to his professional expertise. He contributed to numerous water quality programs and councils, including the Governor's Advisory Council on Certification of Water and Wastewater Treatment Operators.

CBE faculty appointed director of MSU Thermal Biology Institute

CBE associated faculty member **Brent Peyton**, professor, chemical and biological engineering, was recently appointed director of MSU's Thermal Biology Institute (TBI). TBI conducts and promotes research and education focused on the biology and interrelated physical and chemical processes of geothermal environments in the Greater Yellowstone Ecosystem. Source: *MSU News Service*, March 7, 2013

CBE faculty member receives associate dean appointment in MSU's College of Engineering

The CBE is pleased to announce that one of its faculty members has joined MSU's College of Engineering (COE) leadership team. **Christine Foreman**, associate research professor, chemical and biological engineering, was recently appointed Associate Dean of Student Success for the COE. Foreman will be responsible for executing the shared mission of the college as it pertains to undergraduate students. She will provide administrative leadership for academic programs, student services, and diversity issues for the COE.

Foreman continues to be recognized by colleagues and students for her deep commitment to interdisciplinary research and education, exceptional mentoring of graduate and undergraduate students, and unselfish contributions to COE teamwork. She is described as a model of generosity, creativity, organization, and academic excellence. Foreman's appointment started January 1, 2013.

CBE faculty member awarded Fulbright Scholarship to study in Finland

**Darla Goeres**, assistant research professor in chemical and biological engineering, was featured by Montana State University for her recent award of a Fulbright Scholarship, the US government's flagship program in international educational exchange. Goeres will head to Finland next winter for a six-month exchange working in a pharmacy sciences laboratory at Åbo Akademi University in Turku, Finland. As a Fulbright scholar, Goeres' research will be identifying and eliminating biofilms as they pertain to pharmaceuticals.

Read the full *MSU News* story: ["Engineering professor wins Fulbright Scholarship to Finland"](#)

Recruitment and Retention in Ecology, Environmental Sciences, Engineering

**Anne Camper**, associate dean of the College of Engineering, submitted a proposal to the MSU Office of the Provost that received \$17,000 for a collaborative program that will increase Native American student recruitment and retention in ecology, environmental science, engineering and other science disciplines by strengthening relationships among science faculty, Native undergraduate and graduate students, Montana tribal colleges and community research partners. For more information about the campus awards, see: <http://www.montana.edu/news/11192/msu-provost-awards-104-000-to-projects-that-will-boost-native-american-recruitment-and-retention>

National engineering honor society recognizes CBE faculty member

**Abbie Richards**, associate professor, chemical and biological engineering, was selected as the **2012 National Outstanding Advisor** from the engineering honor society Tau Beta Pi. In addition to this national award, Richards also received the Excellence in Teaching Award from MSU's College of Engineering for 2011-12 academic year.

Richards' research has covered biofilm growth in extreme environments and exploring ways that microbes might be used to clean contaminated soils. She earned her doctorate in chemical engineering from Washington State University in 2007.

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RESEARCH:  
 PUBLICATIONS  
 June 2012–May 2013

2012 Publications

**NOTE:**

**2012-001 through 2012-025 are listed in 2012 Appendix. Current & past CBE students, staff, faculty and visitors highlighted in boldface.**

**Gardner RD**, Cooksey KE, **Mus F**, **Macur R**, **Moll K**, **Eustance E**, **Carlson RP**, **Gerlach R**, **Fields MW**, **Peyton BM**, "Use of sodium bicarbonate to stimulate triacylglycerol accumulation in the chlorophyte *Scenedesmus* sp. and the diatom *Phaeodactylum tricornutum*," *J Appl Phycol.* 2012; 24(5):1311–1320. 2012-026

**Bowen De León K**, **Young ML**, **Camilleri LB**, Brown ST, Skerker JM, Deutschbauer AM, Arkin AP, **Fields MW**, "Draft genome sequence of *Pelosinus fermentans* JBW45, isolated during *in situ* stimulation for Cr(VI) reduction," *J Bacteriol.* 2012; 194(19):5456–5457. 2012-027

Dodds WK, Robinson CT, Gaiser EE, Hansen GJA, Powell H, Smith JM, Morse NB, Johnson SL, Gregory SV, **Bell T**, Kratz TK, McDowell WH, "Surprises and insights from long-term aquatic datasets and experiments," *BioScience.* 2012; 62(8):709–721. 2012-028

Chin E, **Kirker K**, Zuck M, **James G**, Hybiske K, "Actin recruitment to the Chlamydia inclusion is spatiotemporally regulated by a mechanism that requires host and bacterial factors," *PLOS ONE.* 2012; 7(10):1-12. 2012-029

**Codd SL**, **Seymour JD**, "Nuclear magnetic resonance measurement of hydrodynamic dispersion in porous media: Preasymptotic dynamics, structure and nonequilibrium statistical mechanics," *Eur Phys J-Appl Phys.* 2012; 60(2): 24204 -24212. 2012-030

**Zhang T**, "Modeling of biocide action against biofilms," *Bull Math Biol.* 2012; 74(6):1427-1447. 2012-031

**Bernstein HC**, **Carlson RP**, "Microbial consortia engineering for cellular factories: *In vitro* to *in silico* systems," *CSBJ.* 2012; 3(4):1-8. 2012-032

**Secor PR**, **Jennings LK**, **James GA**, **Kirker KR**, **deLancey Pulcini E**, McInerney K, **Gerlach R**, Livinghouse T, Hilmer JK, Bothner B, Fleckman P, Olerud JE, **Stewart PS**, "Phevalin (aureusimine B) production by *Staphylococcus aureus* biofilm and impacts on human keratinocyte gene expression," *PLOS ONE.* 2012; 7(7):1-10. 2012-033

**Nagant C**, **Pitts B**, Nazmi K, Vandenbranden M, Bolscher JG, **Stewart PS**, Dehaye J-P, "Identification of peptides derived from the human antimicrobial peptide LL-37 active against biofilms formed by *Pseudomonas aeruginosa* using a library of truncated fragments," *Antimicrob Agents Chemother.* 2012; 56(11):5698-5708. 2012-034

Sengor SS, Gikas P, **Moberly JG**, **Peyton BM**, Ginn TR, "Comparison of single and joint effects of Zn and Cu in continuous flow and batch reactors," *J Chem Technol Biotechnol.* 2012; 87(3):374–380. 2012-035

**Valenzuela J**, **Mazurie A**, **Carlson RP**, **Gerlach R**, Cooksey KE, **Peyton BM**, **Fields MW**, "Potential role of multiple carbon fixation pathways during lipid accumulation in *Phaeodactylum tricornutum*," *Biotechnol Biofuels.* 2012; 5(1):40. 2012-036

Zadvornyy OA, Lucon JE, **Gerlach R**, Zorin NA, Douglas T, Elgren TE, Peters JW, "Photo-induced H<sub>2</sub> production by [NiFe]-hydrogenase from *T. roseopersicina* covalently linked to a Ru(II) photosensitizer," *J Inorg Biochem.* 2012; 106(1):151–155. 2012-037

**Ebigbo A**, **Phillips A**, **Gerlach R**, Helmig R, **Cunningham AB**, Class H, Spangler LH, "Darcy-scale modeling of microbially induced carbonate mineral precipitation in sand columns," *Wat Resour Res.* 2012; 48(7):1-17. 2012-038

Lindley B, Wang Q, **Zhang T**, "Multicomponent hydrodynamic model for heterogeneous biofilms: Two-dimensional numerical simulations of growth and interaction with flows," *Physical Review E.* 2012; 85(3):1027-1059. 2012-039

Wang Q, **Zhang TY**, "Kinetic theories for biofilms," *Discrete and Continuous Dynamical Systems - Series B* 2012; 17(3):1027-1059. 2012-040

Blaze MT, Aydin B, **Carlson RP**, Hanley L, "Identification and imaging of peptides and proteins on *Enterococcus faecalis* biofilms by matrix assisted laser desorption ionization mass spectrometry," *Analyst.* 2012; 137(21): 5018-5025. 2012-041

Tomasino SF, **Parker AE, Hamilton MA**, Hamilton GC, "Performance of the AOAC Use-Dilution method with targeted modifications: Collaborative study," *J AOAC International*. 2012; 95(6):1618-1628. 2012-042

Kim J-W, Kogure T, Yang K, Kim S-T, Jang Y-N, Baik H-S, **Geesey G**, "The Characterization of CaCO<sub>3</sub> in a geothermal environment: A SEM/TEM-EELS study," *Clay Clay Miner*. 2012; 60(5):484-495. 2012-043

Babauta J, Renslow R, **Lewandowski Z**, Beyenal H, "Electrochemically active biofilms: facts and fiction. A review," *Biofouling*. 2012; 28(8): 789-812. 2012-044

**Clark ME**, He Z, Redding AM, Joachimiak MP, Keasling JD, Zhou JZ, Arkin AP, Mukhopadhyay A, **Fields MW**, "Transcriptomic and proteomic analyses of *Desulfovibrio vulgaris* biofilms: Carbon and energy flow contribute to the distinct biofilm growth state," *BMC Genomics*. 2012; 13(138):1-17. 2012-045

**Carlson RP, Oshota OJ, Taffs RL**, "Systems analysis of microbial adaptations to simultaneous stresses," *Subcellular Biochemistry*. 2012; 64:139-157. 2012-046

## 2013 Publications

**Gardner RG, Lohman E, Gerlach R**, Cooksey KE, **Peyton BM**, "Comparison of CO<sub>2</sub> and bicarbonate as inorganic carbon sources for triacylglycerol and starch accumulation in *Chlamydomonas reinhardtii*," *Biotechnol Bioeng*. 2013; 110(1):87-96. 2013-001

**Faulwetter JL, Burr MD, Parker AE, Stein OR, Camper AK**, "Influence of season and plant species on the abundance and diversity of sulfate reducing bacteria and ammonia oxidizing bacteria in constructed wetland microcosms," *Microb Ecol*. 2013; 65(1):111-127. 2013-002

**Phillips AJ, Lauchnor E, Eldring J**, Esposito R, **Mitchell AC, Gerlach R, Cunningham AB**, Spangler LH, "Potential CO<sub>2</sub> leakage reduction through biofilm-induced calcium carbonate precipitation," *Environ Sci Technol*. 2013; 47(1):142-149. 2013-003

**Sanderlin AB, Vogt SJ**, Grunewald E, **Bergin BA, Codd SL**, "Biofilm detection in natural unconsolidated porous media using a low-field magnetic resonance system," *Environ Sci Technol*. 2013; 47(2):987-992. 2013-004

**Macur RE**, Jay Z, Taylor WP, Kozubal MA, Kocar BD, Inskeep WP, "Microbial community structure and sulfur biogeochemistry in mildly acidic sulfidic geothermal springs in Yellowstone National Park," *Geobiology*. 2013; 11(1):86-99. 2013-005

DePas WH, Hufnagel DA, Lee JS, Blanco LP, **Bernstein HC, Fisher ST, James GA, Stewart PS**, Chapman MR, "Iron induces bimodal population development by *Escherichia coli*," *PNAS*. 2013; 110(7):2629-2634. 2013-006

**Sandvik EL, McLeod BR, Parker AE, Stewart PS**, "Direct electric current treatment under physiologic saline conditions kills *Staphylococcus epidermidis* biofilms via electrolytic generation of hypochlorous acid," *PLOS ONE*. 2013; 8(2):1-14. 2013-007

**Lauchnor EG, Schultz LN, Bugni S, Mitchell AC, Cunningham AB, Gerlach R**, "Bacterially induced calcium carbonate precipitation and strontium coprecipitation in a porous media flow system," *Environ Sci Technol*. 2013; 47(3):1557-1564. 2013-008

**Cunningham AB, Lauchnor E, Eldring J**, Esposito R, **Mitchell AC, Gerlach R, Phillips AJ, Ebigo A**, Spangler LH, "Abandoned well CO<sub>2</sub> leakage mitigation using biologically induced mineralization: Current progress and future directions," *GHG*. 2013; 3(1):40-49. 2013-009

**Goeres DM**, Hartemann P, Dadswell JV, "Treated recreational water venues," In: Russell, Hugo & Ayliffe's: Principles and Practice of Disinfection, Preservation and Sterilization, Fifth Edition. A.P. Fraise, J.-Y. Maillard, and S.A. Sattar (editors). Blackwell Publishing, Ltd 2013; 15:478-484. 2013-010

Bardsley JM, **Parker A**, Solonen A, Howard M, "Krylov space approximate Kalman filtering," *Numer Linear Algebra Appl*. 2013; 20(2):171-184. 2013-011

**Stewart BD, Girardot C**, Spycher N, Sani RK, **Peyton BM**, "Influence of chelating agents on biogenic uraninite reoxidation by Fe(III) (Hydr)oxides," *Environ Sci Technol*. 2013; 47(1):364-371. 2013-012

**Vogt SJ, Sanderlin AB, Seymour JD, Codd SL**, "Permeability of a growing biofilm in a porous media fluid flow analyzed by magnetic resonance displacement-relaxation correlations," *Biotechnol Bioeng*. 2013; 110(5):1366-1375. 2013-013

Tedesco M, **Foreman CM**, Anton J, Steiner N, Schwartzman T, "Comparative analysis of morphological, mineralogical and spectral properties of cryoconite in Jakobshavn Isbræ, Greenland, and Canada Glacier, Antarctica," *Annals Glaciology*. 2013; 54(63):147-157. 2013-014

**Mus F, Toussaint J-P**, Cooksey KE, **Fields MW, Gerlach R, Peyton BM, Carlson RP**, "Physiological and molecular analysis of carbon source supplementation and pH stress-induced lipid accumulation in the marine diatom *Phaeodactylum tricornutum*," *Appl Microbiol Biotechnol*. 2013; 97(8):3625–3642. 2013-015

**Nagant C, Pitts B, Stewart PS**, Feng Y, Savage PB, Dehaye J-P, "Study of the effect of antimicrobial peptide mimic, CSA-13, on an established biofilm formed by *Pseudomonas aeruginosa*," *MicrobiologyOpen*. 2013; 2(2):318–325. 2013-016

Bardsley JM, Solonen A, **Parker A**, Haario H, Howard M, "An ensemble Kalman filter using the conjugate gradient sampler," *Int J Uncertainty Quantification*. 2013; 3(4):357-370. 2013-017

**Field EK, Gerlach R**, Viamajala S, **Jennings LK, Peyton BM**, Apel WA, Hexavalent chromium reduction by *Cellulomonas* sp. strain ES6: the influence of carbon source, iron minerals, and electron shuttling compounds," *Biodegradation* 2013; 24(3):437–450. 2013-018

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RESEARCH:  
 PRESENTATIONS  
 June 2012–May 2013

The following CBE graduate students presented posters at the 112<sup>th</sup> Meeting of the American Society of Microbiology, San Francisco, CA, June 16–19, 2012.

**Karen Moll**, MS graduate, microbiology, presented the poster “Diatom biofuel viability: An investigation on Si:C:N required for optimal lipid accumulation.”

**Luis Serrano Figueroa**, PhD student, microbiology, presented the poster “Characterization of new siderophores produced by a Soda Lake isolate.”

The following CBE faculty, staff, and students presented research at the 4<sup>th</sup> International Conference on Porous Media and its Applications in Science, Engineering and Industry, Potsdam, Germany, June 17–22, 2012:

**Robin Gerlach**, associate professor, chemical and biological engineering, as a platform speaker presented “The potential of microbial activity to increase the efficacy of geologic carbon capture and storage.” Co-authors: Connolly J, Ebigbo A, Klapper I, Lauchnor E, Mitchell AC, Phillips AJ, Schultz L, Spangler LH, Zhang T, Cunningham AB

**Robin Gerlach** presented the poster “The potential of microbial activity to increase the efficacy of geologic carbon capture and storage.” Co-authors: Connolly J, Ebigbo A, Klapper I, Lauchnor E, Mitchell AC, Phillips AJ, Schultz L, Spangler LH, Zhang T, Cunningham AB

**Ellen Lauchnor**, postdoctoral research associate, as a platform speaker presented “Microbially induced CaCO<sub>3</sub> mineralization and strontium co-precipitation in porous media reactors.” Co-authors: Schultz L, Mitchell AC, Gerlach R

**James Connolly**, PhD student, environmental engineering, as a platform speaker presented “The potential of microbial activity to increase the efficacy of geologic carbon capture and storage.” Co-authors: Rothman A, Jackson B, Klapper I, Cunningham AB, Gerlach R

**John Doyle**, CBE project coordinator, invited platform speaker presented “For as long as the grass shall grow and the rivers flow: Clean water, a sovereign responsibility.” National Congress of American Indians Policy Research Center, 7<sup>th</sup> Annual Tribal Leader/Scholar Forum, Lincoln, NE, June 19, 2012.

**Elliott Barnhart**, PhD student, microbiology, was one of four recipients of an Outstanding Student Oral Presentation award at the Secondary Biogenic Coal Bed Natural Gas International Conference in Laramie, Wyoming, June 20–21, 2012. Elliott presented “In situ and enriched microbial community composition and function associated with coal-bed methane from Powder River Basin coals.” He was selected from group of eleven student presenters. Elliott's attendance was sponsored by the United States Geological Service (USGS).

The following CBE staff and students presented posters at the NIH's National Institute of General Medical Sciences (NIGMS) 4<sup>th</sup> Biennial National IDeA Symposium of Biomedical Research Excellence (NISBRE), Washington, D.C. June 25-27, 2012:

**Eric Dietrich**, undergraduate student, civil engineering, presented “Utilizing historic data in spatial analysis of groundwater quality on the Crow Reservation.” Co-authors: Eggers M, Old Coyote TJ

**Mari Eggers**, PhD student, microbiology, presented “Using community-based risk assessment to reduce tribal health risks from water contamination.” Co-presenters: Old Coyote TJ, Doyle J, Young S, Ford T. Co-authors: Kindness L, Crow Environmental Health Steering Committee, Camper A

**John Doyle**, CBE project coordinator, presented “Reducing tribal health disparities through solving water infrastructure challenges.” Co-authors: Kindness L, Urban Bear Don't Walk, Realbird J, Eggers M, Crow Environmental Health Steering Committee, Ford T, Camper A

**Matthew Fields**, associate professor, microbiology, as an invited speaker presented “Characterization of microbial communities associated with Powder River Basin coals, United States,” Goldschmidt conference, Montreal, Canada, June 28 2012.

**Phil Stewart**, CBE director and professor, chemical and biological engineering, presented the seminar “Genetic basis of *Pseudomonas aeruginosa* biofilm antibiotic tolerance” at the University of Copenhagen, Copenhagen, Denmark, July 3, 2012.

The following CBE faculty, staff, and students presented research at the International Subcommittee on Antarctic Research (SCAR) Open Science meeting, Portland, OR, July 15–19, 2012:

**Christine Foreman**, associate research professor, land resources and environmental sciences, was co-chair of the scientific session “Ecosystem change in Antarctica: The importance of long-term data.”

**Christine Foreman** presented the poster “Science in a cultural context.” Co-authors: Kelly S, Priscu J, Vick T, Michaud A.

**Juliana D’Andrilli**, CBE postdoctoral researcher, presented the poster “Characterization of dissolved organic matter in the West Antarctic Ice Sheet (WAIS) Divide ice core.” Co-authors: Foreman C, McConnell J, Priscu J.

**Heidi Smith**, PhD student, land resources and environmental sciences, as invited speaker presented “Single-cell analysis of microbial synthesis and transformation of dissolved organic matter in a glacial environment.” Co-authors: Foreman C, Foster R, McKnight D.

**James Connolly**, PhD student, environmental engineering, as invited speaker presented “Imaging and analysis of microbially induced calcium carbonate precipitates and biofilm,” along with imaging techniques used by CBE researchers and students at the Microscopy and Microanalysis conference, Phoenix, AZ, July 29–August 3, 2012.

**Rich Macur**, research assistant professor, chemical and biological engineering, presented a session on “Carbon sequestration and carbon use,” American Indian Research and Education Initiative (AIREI) Energy Institute at the National Renewable Energy Lab in Golden, Colorado, August 12–18, 2012.

**Matthew Fields**, associate professor, microbiology, as an invited speaker presented two talks “Bacterial population dynamics in groundwater and surrogate sediments during biostimulation for Cr(VI) reduction,” and “Microbial conversion of biodiesel by-products to biofuel,” at the Society for Industrial Microbiology & Biotechnology (SIMB) 2012 Annual Meeting, Washington D.C., August 13–16, 2012.

**Kris Hunt** and **Heidi Schoen**, PhD students in chemical and biological engineering presented “Fungal processes for direct bioconversion of cellulose to hydrocarbons,” American Chemical Society conference, Philadelphia, PA, August 18–21, 2012.

The following CBE faculty and students presented research posters at the 14<sup>th</sup> International Symposium on Microbial Ecology (ISME), in Copenhagen, Denmark, August 19–24, 2012:

**Ross Carlson**, assistant professor, chemical and biological engineering, presented “Molecular level resource ratio analysis of in silico models of natural and synthetic microbial communities.”

**Elliott Barnhart**, PhD student, microbiology, presented “Genomic insight into the evolution of *Acetoclastic methanogenesis*.” Elliott also presented the poster “In-situ and enriched microbial community composition and function associated with coal-bed methane from Powder River Basin coals.”

**Heidi Schoen**, PhD student, chemical and biological engineering, presented “Fungal processes for direct bioconversion of cellulose to hydrocarbons.” Authors: B Peyton, R Carlson, G Strobel, N Mallette, K Hunt.

**Jacob Valenzuela**, PhD student, chemistry and biochemistry, presented “Potential role of multiple carbon fixation pathways during lipid accumulation in *Phaeodactylum tricornutum*.”

**Tisza Bell**, PhD student, microbiology, presented the poster “A community ecology approach to algal cultivation for biofuel production.”

**Hans Bernstein** won the Best Poster Award with the poster “Synthetic *Escherichia coli* consortia engineered for syntrophy demonstrate enhanced biomass productivity.” Co-authors: S Paulson, R Carlson.



**Hans Bernstein**, PhD student, chemical and biological engineering, presented poster “A multi-scale in situ analysis of oxygen transport and consumption in thermophilic, archaeal dominated acid iron oxide mats.” Co-authors: J Beam, M Kozubal, R Carlson, W Inskeep.

**Kristen Brileya**, PhD student, microbiology, presented the poster “Cooperation impacts structure and function in a syntrophic biofilm of *Methanococcus maripaludis* and *Desulfovibrio vulgaris*.”

**Laura Camilleri**, PhD student, microbiology, presented the poster “Genome characterization of *Pelosinus fermentans* JBW45 isolated during in situ stimulation for Cr(VI) reduction.”

**Kara De León**, PhD student, microbiology, presented the poster “Microbial population dynamics in groundwater and surrogate sediments during HRC® biostimulation for Cr(VI)-reduction.”

**Lauren Franco**, PhD student, microbiology, presented the poster “Chromium responses and biofilm formation in *Desulfovibrio vulgaris* RCH-1, a sulfate-reducing bacterium isolated from 100H chromium-contaminated groundwater, are temperature dependent.”

**Christine Foreman**, associate research professor, land resources and environmental sciences (LRES), **Michelle Tigges** and **Heidi Smith**, PhD students, LRES, presented the poster “An “omics” approach to characterizing dissolved organic matter from microbially derived sources in Antarctica.” Co-author: Brian Bothner.

**Heidi Smith** and **Christine Foreman** presented the poster “Microbial synthesis and transformation of dissolved organic matter in glacial environments.”

**John Doyle**, CBE project coordinator, as an invited platform speaker presented “Water quality on the Crow Reservation,” Chief Plenty Coup State Park Day of Honor, Pryor, MT, September 1, 2012.

**Phil Stewart**, CBE director, presented the keynote address “The science of biofilm control with antimicrobial agents,” International Biodeterioration and Biodegradation Society (IBBS), Winchester, England, September 10–11, 2012.

**Christine Foreman**, associate research professor, land resources & environmental sciences, as an invited speaker presented “Dissolved organic matter in the West Antarctic Ice Sheet (WAIS) Divide Ice Core,” West Antarctic Ice Sheet Divide annual project meeting at Scripps Institute in La Jolla, CA, September 10-14, 2012. Foreman also presented the poster “Montana State University WAIS-Divide Outreach.” Co-authors: Kelly S and Priscu J

CBE staff and graduate students presented research at the Algae Biomass Summit, Denver, CO, September 24–27, 2012:

**Rob Gardner**, CBE postdoctoral research associate, presented the poster “Review: Classical and modern methods used to determine biofuel potential of microalgal biomass.”

**Egan Lohman**, PhD student, chemical and biological engineering, presented the poster “A high-throughput, efficient, and scalable extraction and quantification method for algal derived biofuel.”

**Karen Moll**, MS student, microbiology, presented the poster “Diatom biofuels: Optimal nutrient requirements for lipid production.”

**Mike Franklin**, associate professor, microbiology, as invited seminar speaker, presented “Localized gene expression in biofilms,” Florida International University, Miami, FL, September 27, 2012.

**Joe Seymour**, professor, chemical and biological engineering, as an invited speaker presented “Magnetic resonance measurements of microfluidic colloid suspension flow: Transport and rheology,” NMR Imaging and Rheology Mini-Symposium, University of California Santa Barbara Materials Research Lab, Santa Barbara, CA, September 28, 2012.

**Sarah Codd**, associate professor, mechanical and industrial engineering, as an invited speaker presented “Magnetic resonance measurements of porous media: Biofilms, ceramics, subsurface,” University of California Santa Barbara Materials Research Lab, Santa Barbara, CA, September 28, 2012.

The following CBE faculty presented research at the 6<sup>th</sup> American Society of Microbiology Biofilms conference, Miami, FL, September 29–October 4, 2012.

**Phil Stewart**, CBE director, as invited speaker presented “Genetic basis of *Pseudomonas aeruginosa* biofilm antibiotic tolerance.”

**Mike Franklin**, associate professor, microbiology, as invited speaker presented “Biosynthesis of the extracellular polysaccharides, alginate, Psl, and Pel; and image analysis of matrices in *Pseudomonas aeruginosa* biofilms.”

**Elinor Pulcini**, assistant professor, chemical and biological engineering, presented the poster “Evaluation of fluid path colonization in needle free connectors and biofilm formation in central venous catheters.” Co-authors: Al Parker, Marcia Ryder, Alison Burcar, Garth James.

Assistant research professors **Darla Goeres** and **Elinor Pulcini**, chemical and biological engineering, **Diane Walker**, CBE research engineer, and **Al Parker**, CBE statistician hosted a pre-conference workshop “Biofilm standard methods and reactor systems for research,” to a group of 40 faculty, researchers, and students whose focus is medical biofilms. The goal of the workshop was to describe how reactors and methods are modified to answer a range of research topics. The CBE presenters were joined by Paul Stoodley, former CBE faculty in microbiology, now a lecturer at the University of Southampton in Southampton, England.

**Mari Eggers**, PhD student, microbiology, as invited platform speaker presented “Sampling the Wolf Mountains,” Montana Fall Water School, Bozeman, MT, October 4, 2012.

**Mari Eggers**, PhD student, microbiology, presented the poster “Elevated uranium and lead in wells in Big Horn County—A potential problem,” Montana Section, American Water Resources Association Conference, Butte, MT, October 11, 2012. Co-author: Moore-Nall, A (first author)

**Matthew Fields**, associate professor, microbiology, as invited speaker, presented “Application of molecular ecology for industrial purposes,” Swiss International Conference on Industrial Microbiology (MicroCon), Olten, Switzerland, October 14-18, 2012.

**Mari Eggers**, PhD student, microbiology, as invited speaker presented “Comprehensive community-based risk assessment of exposure to water-borne contaminants on the Crow Reservation,” EPA Tribal Environmental Health Research Program Webinar Series online broadcast, October 17, 2012.

**Elinor Pulcini**, assistant research professor, chemical and biological engineering, presented the poster “Removal of bacterial spore contamination from needleless connectors using disinfection devices,” Infectious Disease Week 2012 Conference, San Diego, CA, October 18–25, 2012. Poster was sponsored by Bard Access Systems.

**Garth James**, CBE medical biofilm laboratory manager, as invited speaker presented “Microbial biofilms in health and disease,” Minority Access to Research Careers (MARC) and Research Initiative for Scientific Advancement (RISE) Seminar Series, University of Puerto Rico, Humacao, Puerto Rico, October 20–24, 2012.

**Phil Stewart**, CBE director, as invited speaker presented “The biofilm paradigm of chronic infection,” Parenteral Drug Association's 7th Annual Global Conference on Pharmaceutical Microbiology, Bethesda, Maryland, October 22–24, 2012.

**Paul Sturman**, research engineer and industrial coordinator, as invited speaker presented “Legionella growth and survival in biofilms: Laboratory models and the environment,” Society for Industrial Microbiology and Biotechnology (SIMB) Recent Advances in Microbial Control meeting, Alexandria, VA, October 28-31, 2012.

As part of the MSU Algal Biofuels Group, **Casey Doney**, undergraduate, microbiology, presented the poster “Isolation and characterization of phototrophs for a renewable organic fertilizer,” American Indian Science and Engineering Society National Conference, Anchorage, AK, November 1-4, 2012. CBE Co-authors: R Macur, L Weeks, B Peyton

**Elle Pankratz**, undergraduate student, chemical and biological engineering, presented “Exploration of growth kinetics and hydrocarbon production by *Ascocoryne sarcoides*,” American Indians in Science & Engineering Society conference, Anchorage AK, October 31- November 4, 2012.

**Otto Stein**, professor, civil engineering, as invited speaker presented the following research at 13<sup>th</sup> International Conference on Wetland Systems for Water Pollution Control, Perth, Australia, November 25–29, 2012:

“Temperature, plant species, and residence time effects on nitrogen removal in model treatment wetlands.” Co-authors: Allen CR, Hook PB, Burr MD, Parker AE, Hafla EC

“The influence of plant root and microbe interactions on contaminant removal in treatment wetlands.” Co-authors: Faulwetter JL, Burr MD, Camper AK

**Adie Phillips**, CBE research engineer, was a recipient of an Outstanding Student Paper Award at the 2012 American Geophysical Union (AGU) fall meeting in San Francisco, California, December 3–7, 2012. Adie received the award for her presentation “Biofilm-induced calcium carbonate precipitation: Application in the subsurface.” AGU’s outstanding student paper awards are awarded to promote, recognize, and reward undergraduate, masters and PhD students for quality research in the geophysical sciences.

**Phil Stewart**, CBE director, as invited speaker presented, “Analysis of growth and gene expression in biofilms,” Biofilms 5 International Conference, Paris, France, December 10–12, 2012.

CBE faculty, staff, and students presented the following research at the National Institutes of Health (NIH) Summit on the Science of Eliminating Health Disparities, National Harbor, MD, December 17, 2012:

**Anne Camper**, professor and associate dean, college of engineering, **Mari Eggers**, PhD student, microbiology, and **John Doyle**, project coordinator, as invited speakers presented

“Addressing health disparities and learning science through community based participatory research, Crow Reservation, Montana.” Co-presenter: Tamra Old Coyote, Little Big Horn College

**Mari Eggers** presented the poster “Using community based risk assessment to address health risks from waterborne contaminants on the Crow Reservation.” Co-presenter: Tamra Old Coyote

**John Doyle** presented the poster “Addressing disparities in safe drinking water access on the Crow Reservation, Montana.”

**Al Parker**, CBE statistician, an invited speaker presented “Some implementation issues with Gaussian iterative samplers in finite precision,” Southern Uncertainty Quantification conference, Dunedin, New Zealand, January 7–10, 2013.

**Elliott Barnhart**, PhD student, microbiology, presented his research to the Joint Appropriations Committee on Education at the 63rd session of the Montana state legislature January 23, 2013. Barnhart highlighted his research on the technology of coal-bed methane production as it relates to renewal energy and job creation.

**Garth James**, professor, chemical and biological engineering, **Elinor Pulcini**, assistant research professor, chemical and biological engineering, **Al Parker**, CBE statistician, as invited speakers presented “Comparison of bacterial transfer and biofilm formation on intraluminal catheter surfaces among eight connectors in a clinically simulated in vitro model,” American Society for Parenteral and Enteral Nutrition (ASPEN) Clinical Nutrition Week, Phoenix, AZ, February 9-12, 2013. Co-presenter: Marcia Ryder

**John Doyle**, CBE project coordinator, as platform speaker presented, “Solving water infrastructure challenges in a reservation community,” Montana Rural Water Systems Annual Conference, Great Falls, MT, February 20–22, 2013. Co-authors: J Realbird, Urban Bear Don’t Walk, Crow Environmental Health Steering Committee, M Eggers, A Camper.

**Matthew Fields**, associate professor, microbiology, as invited seminar speaker presented “Using ecology and physiology to understand microbial responses at different levels of resolution,” University of Tennessee, Knoxville, TN, February 29- March 1, 2013.

**Phil Stewart**, CBE director, as invited speaker at the University of Michigan and NASA presented:

“Antibiotics vs. biofilms,” at the Collateral Damage: Antibiotics and Human Health Symposium, hosted by the Center for Molecular and Clinical Epidemiology of Infectious Diseases at University of Michigan in Ann Arbor, MI, April 4, 2013.

“Biofilm engineering,” Department of Civil and Environmental Engineering, Rice University, and NASA’s Johnson Space Center in Houston, Texas, April 15–16, 2013.

CBE researchers presented the following research at The Sherwin-Williams Company, Cleveland, OH, April 10, 2013:

**Darla Goeres**, assistant research professor, chemical and biological engineering, presented “Grow, treat, sample and analyze: Standardizing methods for routine use.”

**Al Parker**, CBE statistician, presented “Assessing the statistical properties of laboratory methods.”

**Darla Goeres**, assistant research professor, chemical and biological engineering, presented “Validation of ASTM Method E2871-12: Results the single tube method inter-laboratory study,” at the ASTM E35.15 committee meeting in Indianapolis, IN, April 16, 2013

**Natasha Mallette**, PhD candidate, chemical and biological engineering, presented the poster “Effects of culturing conditions on hydrocarbon production by *Ascocoryne sarcoides*,” 35th Symposium on Biotechnology for Fuels and Chemicals by the Society for Industrial Microbiology, Portland, OR, April 29–May 2, 2013. **Phil Stewart**, CBE director, presented the following

research as an invited speaker at Baylor College of Medicine and Nalco Champion presented:

“Antimicrobial tolerance of bacterial biofilms,” Baylor College of Medicine, Houston, Texas, May 8, 2013

“Biofilms in the oilfield,” Nalco Champion, Fresno, Texas, May 9, 2013.

The following CBE staff and students presented posters at the American Society of Microbiology (ASM) annual meeting in Denver, Colorado, May 18–21, 2013:

**Kara Bowen De León**, postdoctoral researcher presented “Microbial population dynamics in groundwater and surrogate sediment during injection of nitrate as a competing terminal electron acceptor during stimulation for Cr(VI) reduction.”

**Heidi Smith**, PhD candidate, land resources and environmental sciences, presented “Diel nitrogen fixation dynamics in an intertidal photosynthetic microbial mat from Great Sippewissett Marsh, MA.” Smith was invited to present by the Marine Biological Laboratory in Woods Hole, Massachusetts and funded by the Gordon and Betty Moore Foundation.

**Amber Schmit**, undergraduate, chemical and biological engineering, presented “Microbial diversity and ecophysiology of cryoconite sediments from the McMurdo Dry Valleys, Antarctica.” Schmit was invited to attend the meeting as recipient of an ASM research fellowship honorable mention in October 2012.

## EDUCATION:

Undergraduate Students: Summer 2012, Fall 2012, Spring 2013

## \*Graduating

1. Avera, Erika (James)	F	Cell Bio & Neurosci	Grass Valley, CA
2. *Bergin, Bridget (Seymour)	F	Mech & Indust Eng (USP)	Sidney, MT
3. Bermel, Emily (Foreman)	F	Chem & Bio Eng (McNair Scholar)	Big Fork, MT
4. Bleem, Alissa (Carlson)	F	Chem & Bio Eng (USP/Hughes/Goldwater)	Fort Collins, CO
5. Bodle, Kylie (Walker)	F	Chem & Bio Eng	Camano Island, WA
6. Davis, Steven (Carlson)	M	Chem & Bio Eng (McNair Scholar)	Billings, MT
7. *Dietrich, Eric (Camper)	M	Civil Engineering (INBRE)	Portland, OR
8. Doane, Danielle (Pulcini)	F	Nursing	Townsend, MT
9. Durch, Amanda (James)	F	Chem & Bio Eng (USP)	Newell, SD
10. Fritz, Blaine (Walker)	M	Chemistry/Biochemistry (USP)	Billings, MT
11. Lewis, Julia (Pulcini)	F	Microbiology	Tiffin, OH
12. Maier, Bailey (Gerlach)	F	Chem & Bio Eng	Boise, ID
13. McDonald, Daniel (Peyton)	M	Chem & Bio Eng	Tumwater, WA
14. *Moss, Jefferson (Stein)	M	Civil Engineering (USP)	Colorado Springs, CO
15. Murphy, Nathan (Peyton)	M	Chem & Bio Eng (USP)	Hardin, MT
16. *Nagy, Justin (Fields)	M	Microbiology	Sunburst, MT
17. Newhouse, Hannah (Peyton)	F	Chem & Bio Eng (USP)	Pocatello, ID
18. Orr, Danielle (Walker)	F	Microbiology	Bozeman, MT
19. Pabst, Breana (Stewart)	F	Chem & Bio Eng	Great Falls, MT
20. *Pankratz, Elle (Peyton)	F	Chem & Bio Eng (USP)	Clancy, MT
21. Pedersen, Todd (Peyton)	M	Chem & Bio Eng (USP)	Poulsbo, WA
22. Rao, Varsha (Codd/Seymour)	F	Chem & Bio Eng	Canada
23. Richards, Amanda (Franklin)	F	Microbiology	Salt Lake City, UT
24. *Rothman, Adam (Gerlach)	M	Chem & Bio Eng (USP)	Anchorage, AK
25. Schmit, Amber (Foreman)	F	Chem & Bio Eng (USP)	Sheridan, WY
26. *Sen, Emel (Peyton)	F	Chem & Bio Eng	Turkey
27. Sherick, Matthew (Codd/Seymour)	M	Chem & Bio Eng (INBRE, Goldwater)	Hudson, WI
28. Solomon, Benjamin (Peyton)	M	Chem & Bio Eng	Lone Tree, CO
29. Speakman, Keila (Fields)	F	Microbiology	Bozeman, MT
30. Stabio, Katie (Fields)	F	Microbiology	Billings, MT
31. Steinbeisser, Sadie (Fields)	F	Microbiology	Sidney, MT
32. (Morris) Topp, Dayla (Gerlach)	F	Chem & Bio Eng (USP)	Stockett, MT
33. Toussaint, Jean-Paul (Carlson)	M	Chem & Bio Eng (USP)	Charlo, MT
34. Warthen, Katherine (Gerlach)	F	Chem & Bio Eng (USP)	Laurel, MT
35. *Whitney, Erika (Fields)	F	Microbiology	Issaquah, WA
36. Yanardag, Sila (Franklin)	F	Chem & Bio Eng	Turkey
37. *Yanmaz, Leyla (Skorupa)	F	Chem & Bio Eng	Turkey
38. Ying Wee, Shu (Foreman)	F	Chem & Bio Eng	Malaysia
39. Zambare, Neerja (Lauchnor)	F	Chem & Bio Eng	India

### Undergraduates Summary: 2012–2013

<b>Department (Program)</b>	<b>Male</b>	<b>Female</b>	<b>Total</b>
Cell Biology & Neuroscience		1 F	1
Chemical & Biological Engineering	9 M	16 F	25
Chemistry & Biochemistry	1M		1
Civil Engineering	2 M		2
Mechanical & Industrial Engineering		1 F	1
Microbiology	1 M	7 F	8
Nursing (Bridges)		1F	1
<b>Totals</b>	<b>13 M</b>	<b>26 F</b>	<b>39</b>

## EDUCATION:

Graduate Students: Summer 2012, Fall 2012, Spring 2013

‡ Native American \*Received degree

**Masters Candidates**

1.	Blaskovich, John (Gerlach)	M	Chem & Bio Eng	Butte, MT
2.	Davis, Katie (Cunningham)	F	Civil Engineering	Green Creek, NC
3.	Eudave, Yanet (Camper)	F	Health & Human Dev	Phoenix, AZ
4.	‡ *Felicia, Dayle "Candy" (Camper)	F	Health & Human Dev	Wyola, MT
5.	Halverson, Luke (Gerlach)	M	Chem & Bio Eng	Lansing, IA
6.	Markwardt, Stephen (Camper)	M	Civil Engineering	Ely, MN
7.	*Moll, Karen (Peyton)	F	Microbiology	Fairport, NY
8.	Olson, Andrew (Camper)	M	Civil Engineering	Hill City, ID
9.	Schoen, Heidi (Peyton)	F	Chem & Bio Eng	Geneva, IL
10.	*Staven, Ari (Peyton)	F	Chem & Bio Eng	Georgetown, TX
11.	Tobar-Quezada, Lidice (Camper)	F	Health & Human Dev	Livingston, MT
12.	Weeks, Lisa (Peyton)	F	Chem & Bio Eng	Fort Fairfield, ME

**PhD Candidates**

1.	Akiyama, Tatsuya (Franklin)	M	Microbiology	Japan
2.	Allen, Chris (Stein)	M	Civil Engineering	Eldorado Hills, CA
3.	Arias Corredor, Luisa (Fields)	F	Microbiology (Fulbright)	Colombia
4.	Barnhart, Elliott (Fields)	M	Microbiology	Broadus, MT
5.	Beck, Ashley (Carlson)	F	Microbiology	Corning, IA
6.	Bell, Tisza (Fields/Peyton)	F	Microbiology	Littleton, CO
7.	*Bernstein, Hans (Carlson)	M	Chem & Bio Eng	Kalispell, MT
8.	*Brileya, Kristen (Fields)	F	Microbiology	Bozeman, MT
9.	Brutscher, Laura (Pulcini)	F	Cell Bio & Neurosci	Little Falls, MN
10.	Camilleri, Laura (Fields)	F	Microbiology	Ukiah, CA
11.	Connolly, James (Gerlach)	M	Environ Eng	Post Falls, ID
12.	*De León, Kara (Fields)	F	Microbiology	Bozeman, MT
13.	Eggers, Margaret (Camper)	F	Microbiology	California
14.	Franco, Lauren (Fields)	F	Microbiology	Moorpark, CA
15.	*Gardner, Robert (Peyton)	M	Chem & Bio Eng	Afton, WY
16.	Guerra, Fermin (James)	M	Chem & Biochem	Cuba
17.	Hunt, Kristopher (Carlson)	M	Chem & Bio Eng	Thorp, WI
18.	Jackson, Benjamin (Klapper)	M	Mathematics	Sheridan, OR
19.	Jennings, Ryan (Carlson)	M	LRES	Lexington, SC
20.	Kirkland, Catherine (Codd)	F	Environmental Eng	Bozeman, MT
21.	Krantz, Gregory (Fields)	M	Microbiology	Tinmouth, UT
22.	Lohman, Egan (Gerlach)	M	Chem & Bio Eng	Pine, CO
23.	Loudermilk, Derek (Fields)	M	Microbiology	St. Louis, MO
24.	Malette, Natasha (Peyton)	F	Chem & Bio Eng	Fayetteville, AR
25.	Moll, Karen (Peyton)	F	Microbiology	Fairport, NY
26.	Phillips, Adie (Gerlach)	F	Chem & Bio Eng	Bozeman, MT
27.	Plaggemeyer, Sara (Camper)	F	Microbiology	Big Timber, MT
28.	Rathore, Muneeb (Peyton)	M	Chem & Bio Eng (Fulbright)	Pakistan
29.	Sanderlin, Alexis (Codd/Seymour)	F	Chem & Bio Eng	Atlanta, GA
30.	*Sandvik, Elizabeth (McLeod)	s F	Chem & Bio Eng	Rapid City, SD
31.	Serrano Figueroa, Luis (Richards)	M	Microbiology	Puerto Rico
32.	Severson, Grant (James)	M	Microbiology	Claremore, OK
33.	Smith, Heidi (Foreman)	F	LRES	Westford, VT
34.	Spengler, Justin (Carlson/Camper)	M	Chem & Biochem	Jacksonville, FL
35.	Taffs, Reed (Carlson)	M	Chem & Bio Eng	Helena, MT
36.	Tigges, Michelle (Foreman)	F	Chem & Biochem	Battle Lake, MN
37.	*Valenzuela, Jacob (Fields)	M	Chem & Biochem	San Luis Obispo, CA
38.	VanKempen-Fryling, Rachel (Camper)	F	Microbiology	Grand Rapids, MI
39.	*Vogt, Sarah (Codd/Seymour)	F	Chem & Bio Eng	Rolla, MO
40.	Zelaya, Anna (Fields)	F	Microbiology	Russellville, AR

EDUCATION:  
 Graduate Students, 2012–2013

**1: Cell Biology & Neuroscience**

**PhD: 1**

1 F Brutscher, Laura: PhD, *Pulcini*

**16: Chemical & Biological Engineering**

**MS: 5**

2 M Blaskovich, John: MS, *Gerlach*  
 Halverson, Luke: MS, *Gerlach*

3 F Staven, Ari: MS, *Peyton*  
 Schoen, Heidi: MS, *Peyton*  
 Weeks, Lisa: MS, *Peyton*

**PhD: 10**

5 M Bernstein, Hans: PhD, *Carlson*  
 Gardner, Robert: PhD, *Peyton*  
 Hunt, Kristopher: PhD, *Carlson*  
 Rathore, Muneeb: PhD, *Peyton*  
 Taffs, Reed: PhD, *Carlson*

5 F Mallette, Natasha: PhD, *Peyton*  
 Phillips, Adie: PhD, *Gerlach*  
 Sanderlin, Alexis: PhD, *Codd/Seymour*  
 Sandvik, Elizabeth: PhD, *McLeod*  
 Vogt, Sara: PhD, *Seymour*

**4: Chemistry & Biochemistry**

**PhD: 4**

3 M Guerra, Fermin: PhD, *James*  
 Spengler, Justin: PhD, *Camper/Carlson*  
 Valenzuela, Jacob: PhD, *Fields*

1 F Tigges, Michelle: PhD, *Foreman*

**6: Civil / Environmental Engineering**

**MS: 4**

2 M Olson, Andy: MS, *Camper*  
 Markwardt, Stephen: MS, *Camper*

2 F Davis, Katie: MS, *Cunningham*  
 Kirkland, Catherine: PhD, *Codd*

**PhD: 3**

3 M Allen, Chris: MS, *Stein*  
 Connolly, James: PhD, *Gerlach*  
 Lohman, Egan: PhD, *Gerlach*

**3: Health & Human Development**

**MS: 3**

3 F Eudave, Yanet: MS, *Camper*  
 Felicia, Dayle (Candy): MS, *Camper*  
 Tobar-Quezada, Lidice: MS, *Camper*

**2: Land Resources & Environmental Sciences**

**PhD: 2**

1M Jennings, Ryan: PhD, *Carlson*

1F Heidi Smith: PhD, *Foreman*

**1: Mathematical Sciences**

**MS: 0**

**PhD: 1**

1 M Jackson, Benjamin: PhD, *Klapper*

**19: Microbiology**

**MS: 1**

1F Moll, Karen, MS, *Fields/Peyton*

**PhD: 18**

6 M Akiyama, Tatsuya: PhD, *Franklin*  
 Barnhart, Elliott: PhD, *Fields/Cunningham*  
 Krantz, Gregory: PhD, *Fields*  
 Loudermilk, Derrick: PhD, *Fields*  
 Serrano Figueroa, Luis: PhD, *Richards*  
 Severson, Grant: PhD, *James*

12 F Beck, Ashley: PhD, *Carlson*  
 Bell, Tisza: PhD, *Peyton/Fields*  
 Brileya, Kristen: PhD, *Fields*  
 Camilleri, Laura: PhD, *Fields*  
 Corredor Areas, Luisa: PhD, *Fields*  
 De León, Kara: PhD, *Fields*  
 Eggers, Margaret: PhD, *Camper*  
 Franco, Lauren: PhD, *Fields*  
 Moll, Karen: PhD, *Peyton*  
 Plaggemeyer, Sara: PhD, *Camper*  
 VanKempen-Fryling, Rachel: PhD, *Camper*  
 Zelaya, Anna: PhD, *Fields*

**TOTALS**

**Total Grads: 52**

Total MS: 4 M / 8 F

Total PhD: 19 M / 21 F

Total Male: 23

Total Female: 29



## EDUCATION:

Graduating with advanced degrees: June 2012–May 2013

**Ari Staven Popovitch, MS, Chemical and Biological Engineering, June 2012**

*Isolation and characterization of thermostable alkaline bacteria with ligninolytic potential*

**Rob Gardner, PhD, Chemical and Biological Engineering, June 2012**

*Control of triacylglycerol accumulation and bicarbonate-induced accumulation in microalgae*

**Karen Moll, MS, Microbiology, August 2012**

*Diatom biofuels: Optimal nutrient requirements for lipid production*

**Sarah Jane Vogt, PhD, Chemical and Biological Engineering, November 2012**

*Nuclear magnetic resonance studies of biological and biogeochemical processes*

**Kara Bowen De León, PhD, Microbiology, March 2013**

*Bacterial community dynamics during nutrient perturbations in a Cr(VI)-contaminated subsurface environment*

**Kristen Brileya, PhD, Microbiology, March 2013**

*Ecophysiology of Methanococcus maripaludis and Desulfovibrio vulgaris: The Role of structure in relation to function*

**Hans Bernstein, PhD candidate, Chemical and Biological Engineering, April 2013**

*Systems analysis of engineered and natural microbial consortia*

**Elizabeth Sandvik, PhD candidate, Chemical and Biological Engineering, April 2013**

*Electric current and magnetic field effects on bacterial biofilms*

**Jacob Valenzuela, PhD candidate, Chemistry & Biochemistry, May 2013**

*Investigation into the metabolic control of lipid accumulation in the marine diatom Phaeodactylum tricornutum*

## EDUCATION

### 2013 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration Thursday, April 18, 2013. Among the 250 students presenting research, numerous students presented results of their biofilm research connected with the Center for Biofilm Engineering. To read the abstracts, visit MSU's Research Celebration page <http://www.montana.edu/usp/pages/conference.html>

#### Topical Sessions

*Hughes Scholar Science Outreach Presentations*

SUB Room 235

11:00 a.m.–12:30 p.m.

11:15 a.m.

**Erika Whitney**, Plant Biology

“Alternative energy options: An online series”

Faculty mentor: **Matthew Fields**, Microbiology

11:45 a.m.

**Alissa Bleem**, Chemical Engineering

“Biofilm explorers: Sampling bacteria in the classroom”

Faculty mentor: **Ross Carlson**, Chemical and Biological Engineering

#### Morning Poster Presentations

**Todd Pedersen**: Chemical & Biological Engineering

“Analysis of TAG accumulation with the use of alternative grades of bicarbonate and alternative bicarbonate salts”

Mentors: **Brent Peyton**, **Rob Gardner**—Chemical & Biological Engineering, Center for Biofilm Engineering

**Eric Dietrich**, **Varsha Rao**: Civil Engineering

“Service learning to address drinking water quality through community-based participatory research on the Crow Reservation”

Mentors: **Anne Camper**, **John Doyle**, **Mari Eggers**, Tami Old Coyote—Center for Biofilm Engineering, Crow Environmental Health Steering Committee, Little Big Horn College

**\*1st Place Poster Winner**: IDeA Networks of Biomedical Research Excellence Program (INBRE) Undergraduate Poster Competition

**Varsha Rao**: Chemical & Biological Engineering

“Molecular weight characterization of alginate solutions”

Mentors: **Joseph Seymour**, **Jennifer Brown**, **Sarah Codd**—Chemical & Biological Engineering, Mechanical & Industrial Engineering

**Amanda Richards**: Microbiology

“Fluorescent imaging of *Pseudomonas aeruginosa* biofilms”

Mentor: **Michael Franklin**, Microbiology

**Erika Whitney**: Plant Sciences & Plant Pathology

“Isolation and characterization of a novel, benthic diatom for potential bio-oil production from Yellowstone National Park”

Mentor: **Matthew Fields**, Microbiology

### Afternoon Poster Presentations

**Neerja Zambare:** Chemical & Biological Engineering  
“Biofilm induced biomineralization in a radial flow reactor”  
Mentors: **Robin Gerlach, Ellen Lauchnor**—Center for Biofilm Engineering

**Katherine Warthen:** Chemical & Biological Engineering  
“Laboratory flow system of the human urinary system”  
Mentors: **Ellen Lauchnor, Robin Gerlach**—Center for Biofilm Engineering

**Dayla Topp:** Center for Biofilm Engineering  
“Application of a Michaelis-Menten based kinetics model on ureolysis by *Sporosarcina pasteurii*”  
Mentors: **Ellen Lauchnor, Robin Gerlach, Adrienne Phillips**—Center for Biofilm Engineering

**Nathan Murphy:** Chemical & Biological Engineering  
“Cryopreservation and staining methods to determine cell viability”  
Mentor: **Brent Peyton**, Chemical & Biological Engineering

**Daniel McDonald:** Chemical & Biological Engineering  
“Microbial characterization and health of biofilters in a large-scale fish hatchery”  
Mentor: **Brent Peyton**, Center for Biofilm Engineering

**Steven Davis:** Chemical & Biological Engineering  
“Syntrophic cyanobacteria and *E. coli* consortia”  
Mentor: **Ross Carlson**, Chemical & Biological Engineering

**Matthew Sherick:** Chemical & Biological Engineering  
“An examination of reaction front dynamics and microscale structure formation in diffusive microbial alginate gelation using magnetic resonance”  
Mentors: **Joseph Seymour, Jennifer Brown, Sarah Codd**—Chemical & Biological Engineering, Mechanical & Industrial Engineering

**Alissa Bleem:** Chemical & Biological Engineering  
“Response surface analysis of acetate inhibition in *Escherichia coli*”  
Mentors: **Ross Carlson, Jeffrey Heys**—Chemical & Biological Engineering

**Justin Spengler:** Chemical & Biological Engineering  
“Community-level metabolic network analysis of a cross-fed consortia”  
Mentors: **Ross Carlson**, Center for Biofilm Engineering

**Elle Pankratz:** Chemical & Biological Engineering  
“Growth kinetic studies on cellulose substrates by *Ascocoryne sarcoides*”  
Mentor: **Brent Peyton**, Chemical & Biological Engineering

**Hannah Newhouse:** Chemical & Biological Engineering  
“Strain identification and unialgal determination of Yellowstone green algae cultures using 454-pyrosequencing”  
Mentor: **Brent Peyton**, Chemical & Biological Engineering

**Emel Sen:** Center for Biofilm Engineering  
“Microbial community dynamics in open pond algal biofuel systems”  
Mentor: **Brent Peyton**, Center for Biofilm Engineering

**Mandi Durch:** Chemical & Biological Engineering  
“Analysis of efficacy for various solutions for negative pressure wound therapy with instillation against *S. aureus* biofilms”  
Mentors: **Garth James, Laura Boegli**—Chemical & Biological Engineering, Center for Biofilm Engineering

**Laura Brutscher:** Center for Biofilm Engineering  
 “Bacterial composition of chronic wounds”  
 Mentors: **Garth James, Elinor Pulcini**—Center for Biofilm Engineering

**Margaret Eggers, Dayle Felicia:** Microbiology  
 “Using community based risk assessment to address health risks from waterborne contaminants on the Crow Reservation”  
 Mentors: **Anne Camper, Tim Ford**—Center for Biofilm Engineering, University of New England

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## EDUCATION AWARDS AND NEWS:

### UNDERGRADUATES

#### CBE undergrads receive prestigious Goldwater Scholarships

CBE undergraduate students **Alissa Bleem** and **Matthew Sherick**, both in MSU’s Department of Chemical and Biological Engineering, were recently chosen as two of the four MSU recipients of the prestigious Goldwater Scholarship. The award is the nation’s premier scholarship for undergraduates studying math, natural sciences, and engineering. Bleem and Sherick will each receive up to \$7,500 a year for tuition, fees, books, and room and board.

Bleem works in the lab of CBE faculty member Ross Carlson, where she is pursuing a career as a researcher and teacher in biochemical engineering. Sherick works in the Magnetic Resonance Microscopy lab under the supervision of CBE faculty members Joe Seymour, Sarah Codd, and Jennifer Brown. His research involves gels that may someday benefit people with cystic fibrosis and be used in tissue engineering.

To read more about Bleem and Sherick’s accomplishments, read the full story at *MSU News*:  
[“Four MSU students receive Goldwater Scholarships”](#)

#### 2013 MSU Awards for Excellence: Dietrich and Jones

CBE undergraduate student **Eric Dietrich** and CBE faculty member **Warren Jones**, associate professor, both of MSU’s Department of Civil Engineering, are among the recipients of the **2013 Awards for Excellence** sponsored by the MSU Alumni Association and the Bozeman Chamber of Commerce. The award recognizes MSU’s top seniors and their faculty or staff mentors.

Honored students were nominated by faculty in their college or department. Qualified seniors must have at least a 3.5 grade point average on a 4.0 scale as well as demonstrated campus leadership and community service. In turn, the award-winning students each select a mentor who will be honored with them at the event. Dietrich selected Jones as his faculty mentor for his exceptional guidance and inspiration. This is the second Award for Excellence Jones has received from a student in the last three years.

#### Two CBE undergraduates named 2012-13 Hughes Scholars

**Alissa Bleem** and **Erika Whitney** were part of the 2012-13 Hughes Scholar program. Bleem’s mentor was CBE associated faculty member **Ross Carlson**, associate professor of chemical and biological engineering. Whitney’s mentor was **Matthew Fields**, associate professor, microbiology. The Hughes Scholars program, an undergraduate funding initiative within the Hughes Undergraduate Biology (HUB) Program, supports active research and outreach by undergraduate students in areas related to biomedical/bioscience research. Funded by the Howard Hughes Medical Institute, the Hughes Scholars initiative looks for Montana State University students who are considering careers in biomedical/bioscience research or a medical/health field.

CBE undergrads participate in Complex Biological Systems (CBS) 2012 summer program  
 Three MSU undergraduates participated in CBE biofilm projects as part of MSU's 2012 CBS Summer Undergraduate Research Program. Open to MSU freshmen, sophomores, and juniors, the Complex Biological Systems Summer Undergraduate Research Program (CBS-SURP) is a structured, 10-week, summer research program that introduces undergraduates to the rigors and challenges of scientific research in a mentor-based environment. **Michael Gross** participated as a visiting researcher, working with research staff member **Kelly Kirker** and (former CBE postdoctoral researcher) **Mary Cloud Ammons**, assistant research professor, chemistry and biochemistry. **Justin Nagy** and **Erika Whitney**, both undergraduates in microbiology, worked under the mentorship of Matthew Fields, associate professor, microbiology.

#### MSU College of Engineering 2013 Student Awards

MSU's College of Engineering (COE) honored its students at its annual awards luncheon on May 2, 2013. Two CBE undergraduate students—**Eric Dietrich**, civil engineering, and **Breana Pabst**, chemical and biological engineering—were recognized as Gold Medal Finalists by the Montana Society of Engineers. Gold Medal awards are given to outstanding engineering seniors. The criteria used to select outstanding seniors are—1) distinguished academic record; 2) involvement in extracurricular activities; 3) leadership in extracurricular activities; 4) commitment to the practical use of the sciences in the execution of engineering work; 5) promise of service to their profession with integrity, devotion to high standards, and a sense of obligation to humanity engineering senior.

#### CBE undergrad receives scholarship to conduct research at Procter & Gamble

CBE undergraduate student **Mandi Durch**, chemical and biological engineering, received a scholarship to spend three months this summer working at Procter & Gamble (P&G), one of the nation's leading consumer products companies. Durch will be working in research and development conducting microbial tests. Durch spent last summer conducting the same type of research at Reckitt-Benckiser in Montvale, New Jersey. Reckitt is also a leading consumer products company in the US.

Durch has countless hours of lab experience in the CBE medical biofilms lab and often volunteers to present lab demonstrations for tours and the Montana Biofilm Meeting. She enjoys the fast pace of the industry work environment and feels fortunate to have the opportunity to conduct research on products that have the potential to be in every US household. Durch plans to graduate from MSU in December 2013. Both Procter & Gamble and Reckitt-Benckiser are members of the CBE Industrial Associate Program.

#### CBE undergrad and faculty honored at MSU's 90<sup>th</sup> Annual Day of Student Recognition

Montana State University honored student achievement in leadership, involvement in various campus-wide activities, and community service at the 90<sup>th</sup> Annual Day of Student Recognition.

CBE undergraduate **Matthew Sherick**, chemical and biological engineering, was one of seven students inducted into Septemviri, an honorary society which recognizes outstanding juniors based upon extraordinary scholarship, leadership and service to MSU. CBE faculty member **Otto Stein**, professor, civil engineering, was honored as the Student Organization Advisor of the Year for his outstanding support, assistance, and investment in the registered student organization Engineers Without Borders. Honorees received their awards at a reception held on Tuesday, April 9<sup>th</sup> on the MSU campus.

#### CBE undergrad receives ASM research fellowship honorable mention

CBE undergraduate student, **Amber Schmit**, chemical and biological engineering, was recently selected as a 2012 Honorable Mention recipient of the American Society for Microbiology (ASM) Research Fellowship. This fellowship is aimed at highly competitive students who wish to pursue graduate careers in microbiology. This year, one hundred twenty-two applications were received and fifty-six fellowships were awarded. Amber was one of eight students who were recognized at Honorable Mentions. The ASM will recognize all Honorable Mentions by printing their names in the magazine *Microbe*, allowing them access to the ASM Education Board ListServ, and providing an invitation to all 2013 ASM General Meeting activities in Denver, Colorado. Amber is an active student-researcher. She received an MSU Undergraduate Scholars Program (USP) scholarship to fund collaboration with faculty on her biofilm research project "Microstructure of cryoconite granules and associated biofilm communities." Amber's advisor is CBE faculty member **Christine Foreman**, associate professor in land resources and environmental sciences.

### CBE undergrad selected for Capitol Hill Poster Event

CBE undergraduate student Neerja Zambare, chemical and biological engineering, will present her research at the Council on Undergraduate Research's Posters on the Hill program in Washington D.C. April 23–24, 2013. Her poster "Biofilm induced biomineralization in a radial flow reactor," is one of eighty competitively selected from students around the country to be displayed on Capitol Hill at the US Capitol. Zambare and her CBE faculty mentor **Robin Gerlach**, associate professor, chemical and biological engineering, will have an opportunity to visit with representatives and senators during the event.

Read more about Zambare and her research on how bio-cement can effectively seal cracks near wells and drilling sites, go to *MSU News*: "[MSU student's research on bio-cement selected as one of the top posters in U.S.](#)"

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## GRADUATES

### CBE recognizes PhD graduate for number of journal publications

At the Montana Biofilm Meeting in February, the CBE honored **Sarah Jane Vogt**, recent PhD graduate in chemical and biological engineering, with a special award for Exceptional Publication Productivity. As a masters and PhD student, Vogt's research has been published in four journals: *Environmental Science and Technology*, *Journal of Biotechnology*, *Biotechnology and Bioengineering* (first author), and *Organic Geochemistry*. Vogt currently has research in-press for publishing in *Macromolecules* (first author), *Magnetic Resonance in Chemistry*, *Physical Review E*, and *Advances in Water Resources*. In addition to Vogt's high-volume of research activity, she successfully mentored undergraduate students and conducted collaborative research with MSU and national labs. Vogt graduated from MSU in December 2012. To view the abstracts of Vogt's publications, [click here](#)

### MSU-CBE microbiologist earns doctorate studying microbes to remove water contaminants

**Kara De León**, recent MSU-CBE doctoral graduate in microbiology, was recently featured by Montana State University for her research of the remote hot spots of Yellowstone National Park and the radioactive ground at the Hanford Nuclear Reservation in Hanford, Washington. De León and other MSU scientists have been assisting an effort to use microbes to keep contaminated groundwater from migrating into the Columbia River. The article also highlights the opportunities for hands-on research and industry collaboration for students at MSU and the CBE. Read the full *MSU News* story: "[MSU microbiologist earns doctorate studying microbes of Yellowstone and Hanford, Wash.](#)"

### American Geophysical Union award winner

**Adie Phillips**, PhD candidate in chemical and biological engineering, received an **Outstanding Student Paper Award** at the 2012 American Geophysical Union fall meeting in San Francisco, California, December 3–7, 2012. Adie received the award for her presentation "Biofilm-induced calcium carbonate precipitation: Application in the subsurface." AGU's outstanding student paper awards are awarded to promote, recognize, and reward undergraduate, masters, and PhD students for quality research in the geophysical sciences.

### 2013 W.G. Characklis Outstanding Student Award

**Kara Bowen De León**, PhD candidate, microbiology, received the 2013 W.G. Characklis Award in recognition of her leadership and teamwork—within her own research group, but also among other CBE research groups—in the acquisition and training in analysis of molecular data; her excellence in research, participation in CBE conferences, and interaction with industry partners.

**Liz Sandvik**, PhD candidate, chemical engineering, received the 2013 W.G. Characklis Award in recognition of her highly interdisciplinary research project, her intellectual curiosity and initiative in designing experiments, her training of many students in laboratory methods and techniques, and outstanding contributions to industrial interaction through tours and workshops.

The W.G. Characklis Award is presented annually to one or more CBE doctoral students for their contributions to research and education. The award honors Center Founder Bill Characklis, who envisioned students working in interdisciplinary teams, participating in innovative educational programs, interacting with industry, and assuming leadership roles.

#### CBE Student Citizen Award

**Kristen Brileya** and **Kara Bowen De León**, both CBE PhD students in microbiology, received the **2012 CBE Student Citizen Award** in July. The award is presented in honor of John Neuman, the CBE's Technical Operations Manager from 1994–2008, and recognizes a student who exhibits exceptional responsibility and good citizenship in his or her work at the CBE. Kristen and Kara were nominated in recognition of their commitment to lab protocols and safety, their willingness to help others, their leadership in teamwork, and their contributions to CBE research as a valuable resource for implementation of FISH techniques (Kristen) and implementation of python scripts for data analyses (Kara).

#### GEhMS Scholars

The **Graduate Education in Health for Minority Scholars** (GEhMS) program at Montana State University (MSU) is designed to increase community capacity to reduce health disparities in our state by supporting underrepresented minority (URM) graduate students in biomedical and behavioral sciences who have strong ties to underserved Montana communities. Housed at MSU's **Center for Biofilm Engineering** (CBE), the program supports new and continuing URM graduate students in MSU health programs by facilitating opportunities to conduct community-based participatory research on health issues in their home communities, as well as by providing academic, financial, and social support. GEhMS graduate student scholars for 2012-13 included **Dayle Felicia**, **Lidice Tobar-Quezada**, and **Yanet Eudave-Marin**. **Dayle Felicia** received her master's degree in family and community health in May 2013.

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EDUCATION:  
 CBE Seminar Series: Fall 2012

**Montana State University, Roberts Hall 218, 4:10pm**

Date	Speaker	Affiliation	Topic
August 30	No seminar: First week of classes		
September 6	Carol Schmidt	Assistant Director, MSU News Service, University Communications, MSU	News Media 101: A 50-minute crash course in media relations
September 13	Dr. Lu (Lucy) Qi	CBE visiting postdoctoral researcher	Expression regulation of toll-like receptors on monocytes after stimulation of <i>Pseudomonas aeruginosa</i> quorum-sensing molecule
September 20	Dr. Jennifer McIntosh	Acting Assistant Department Head, Associate Professor, Department of Hydrology and Water Resources, University of Arizona, Tucson	Hydrologic controls on microbial degradation of organic carbon in the deep subsurface
September 27	Conchita Perez-Jorge Peremarch	PhD student, clinical microbiology, Department of Clinical Microbiology IIS-Fundacion Jimenez Diaz Hospital, Madrid, Spain	Bacterial adhesion to fluorine modified surfaces of titanium alloy
October 4	Daryl Paulson	President/CEO, BioScience Laboratories, Inc.	Biofilms
October 11	Dr. Terry Papoutsakis	Eugene DuPont Chair, Chemical Engineering; Professor, Biological Sciences, University of Delaware	Microbial alloys: Engineering cells with hybrid machineries and properties
October 18	Dr. Bharath Prithviraj	Research Associate, Dept. of Environmental Engineering, University of Colorado, Boulder	Spatio-temporal patterns of microbial dispersion to niche specific disturbance events - A high-throughput approach
October 25	Dr. Wenying Shou	Assistant Member, Division of Basic Sciences, Fred Hutchinson Cancer Research Center, Seattle, WA	Using engineered systems to explore the ecology and evolution of symbiosis
November 1	Dr. Tomas Gedeon	Professor, Department of Mathematical Sciences, MSU	Modeling emergent properties of synthetic microbial consortia
November 8	Dr. Bill Inskeep	Professor, Department of Land Resources and Environmental Sciences, MSU	Integrating genomics, microbial physiology and geochemistry to understand microbial communities of high temperature iron oxide and sulfur sediment environments
November 15	No seminar		
November 22	No seminar: Thanksgiving		
November 29	Hans Bernstein	Ph.D. Candidate, Chemical and Biological Engineering, CBE, MSU	Microsensor analysis of artificial phototrophic biofilm consortium reveals mutualistic behavior with respect to oxygen respiration
December 6	No seminar: Last week of classes		



EDUCATION:  
 CBE Seminar Series: Spring 2013

**Montana State University, Roberts Hall 301, 4:10pm**

Date	Speaker	Affiliation	Topic
January 10	No seminar--First week of classes		
January 17	Dr. Ron June	Assistant Professor, Mechanical and Industrial Engineering, MSU	Toward understanding and treating joint disease: Mechanobiology, modeling, and drug delivery
January 24	No seminar—All CBE meeting		
January 31	Dr. Phil Stewart	Director, CBE; Professor, Chemical and Biological Engineering, MSU	The science of biofilm control with antimicrobial agents
February 7	No seminar: Montana Biofilm Meeting		
February 14	Dr. Denise M. Akob	Research Microbiologist, US Geological Survey, National Research Program	Linking microbes to the fate of Cold War Era heavy metal contamination
February 21	No seminar		
February 28	Maria Rosaria Mattei	Visiting PhD scholar, University of Cassino, Cassino, Italy	Modeling of multispecies biofilm: Application to wastewater treatment
March 7	Undergraduate Day	Alissa Bleem, Chemical and Biological Engineering  Dani Orr, Microbiology; Blaine Fritz, Chemistry/Biochemistry	A survey of acetic acid substrate and product inhibition kinetics for <i>Escherichia coli</i> K-12 MG1655 wild-type and select gene deletion mutants  Resemblance, repeatability, and responsiveness: A three R validation of the single tube method (ASTM E2871-12)
March 14	No seminar--Spring break		
March 21	James Connolly	PhD candidate, Chemical & Biological Engineering, MSU	Image-based modeling and analysis of biofilm-induced calcium carbonate precipitation
March 28	Jacob Valenzuela	PhD candidate, Chemistry & Biochemistry, MSU	Using "Omics" techniques to understand nutrient induced Bio-oil accumulation in <i>Phaeodactylum tricornutum</i>
April 4	Adrienne Phillips	PhD candidate, Chemical & Biological Engineering, MSU	Biofilm-induced calcium carbonate (CaCO <sub>3</sub> ) precipitation: Application in the subsurface and well cement
April 11	Haluk Beyenal	Associate Professor, Chemical and Biological Engineering, Washington State University	Electrochemically active biofilms
April 18	Dr. Matthew Chapman	Assoc. Professor, Molecular, Cellular and Developmental Biology, University of Michigan	The ins, outs, and in-betweens of functional amyloid formation
April 25	Egan Lohman	PhD student, Civil Engineering, MSU	Quantification and analysis of lipids derived from microalgae for biofuels

TECHNOLOGY TRANSFER:  
Industrial Associates, 2012–13  
Bold, new \*Small business member

3M

Bard Access Systems

BASF

Bausch & Lomb

Baxter Healthcare

BCG Solutions \*

Bend Research \*

**BP**

CareFusion (*formerly Cardinal Health*)

Church & Dwight Company

Colgate-Palmolive

Covidien

Dow Corning Corporation

Dow Microbial Control / Rohm and Haas

**Ecolab**

ExxonMobil

ICU Medical, Inc.

**Johnson & Johnson Consumer and Personal Products**

Kane Biotech, Inc.\*

KCI

Kimberly-Clark

Masco Corporation

**Microbial Defense Systems \***

NASA

NCH Corporation

Novozymes

Procter & Gamble

Reckitt Benckiser

Sample6 Technologies \*

**Sani-Marc, Inc.**

Sealed Air Corporation

Semprus BioSciences \*

STERIS

**The Clorox Company**

The Sherwin-Williams Company

Unilever

W.L. Gore & Associates

WuXi AppTec, Inc. \*

TECHNOLOGY TRANSFER:  
 Montana Biofilm Meeting  
 July 17–19, 2012

**Monday, July 11**

6:00–8:30 p.m.

**Pre-registration and welcome reception**

Larkspur Foyer, Hilton Garden Inn, Bozeman

**Tuesday, July 12**

7:30–8:00 a.m.

**Registration and continental breakfast**

Larkspur Foyer, Hilton Garden Inn

8:00–8:10

**Introductory remarks**

Larkspur Ballroom  
*Paul Sturman*, CBE Industrial Coordinator  
*Harsh Trivedi*, IA Chair, Cogate-Palmolive  
*Phil Stewart*, CBE Director

**SESSION 1:**

**Anti-Biofilm Coatings**

8:10–8:40

**Vascular access product with non-leaching betaine modification reduces microbial attachment**

*Roger Smith*, Head of Microbiology, Semprus BioSciences

8:40–9:10

**Linking antimicrobial peptides to implant surfaces**

*Dirk Lange*, Assistant Professor, Urologic Services, University of British Columbia

9:10–9:40

**Evaluation of antimicrobial PICC catheters using an ovine model**

*Elinor Pulcini*, CBE Medical Research Manager, Assistant Research Professor, Chemical & Biological Engineering, MSU

9:40–10:10 Break

10:10–10:40

**N-halamine biocidal copolymers for coatings and latex paints**

*Idris Cerkez*, Postdoctoral Researcher, Auburn University

**SESSION 2:**

**Industrial Biofilms**

10:40–11:10

**Online biofilm monitoring in industrial systems**

*Paul Sturman*

11:10–11:40

**From corrosion to pathogenesis: The role of bacterial nanowires in diverse microbial biofilms**

*Yuri Gorby*, Associate Professor, Marine Environmental Biology, University of southern California

11:40–12:10

**Application of molecular ecology for industrial purposes**

*Chiachi Hwang*, Industrial Research Scientist, CBE

12:10–1:10

**Catered lunch, Hilton Garden Inn**

**CBE Open House**

CBE Laboratories, 3<sup>rd</sup> Floor EPS Building, MSU

2:00–5:00

Lab demonstrations & poster session  
 \*Detailed schedule provided at registration

**Wednesday, July 13**

7:30–8:00 a.m.

**Registration and continental breakfast**

Larkspur Foyer, Hilton Garden Inn

**SESSION 3:**

**Wound Biofilms**

8:00–8:40

**Wound biofilms: Clinical insights attained from animal models**

*Robert Galiano*, Assistant Professor, Plastic Surgery, Feinberg School of Medicine, Northwestern University

8:40–9:20

**Interbacterial communication in chronic wounds**

*Alex Rickard*, Assistant Professor, Biological Services, University of Michigan

9:20–10:00

**Molecular diagnostics and personalized medicine in wound care: Assessment of outcomes**

*Randy Wolcott*, MD, Medical Director, Southwest Regional Wound Clinic

10:00–10:30 Break

10:30–11:10

**Antimicrobial vs. polymicrobial biofilms: In vitro studies using wound-colonizing bacteria**

*Garth James*, CBE Medical Projects Manager, Associate Research Professor, Chemical & Biological Engineering, MSU

11:10–11:40

**Interfering with quorum sensing: Exploring the potential of combination therapy to treat biofilm infection in chronically infected wounds**

*Giles Brackman*, Postdoctoral Researcher, Laboratory of Pharmaceutical Microbiology, University of Ghent, Belgium

11:40–12:00

**State of the CBE address**

*Phil Stewart*

12:00–12:10

**CBE Award Presentations:**

*Outstanding Researcher and Student Citizen*, Phil Stewart

12:10–1:10

**Catered lunch, Hilton Garden Inn**

**SESSION 4:**

**Energy & Environmental Biofilms**

1:10–1:35

**Overview of CBE energy and environmental biofilm work**

*Al Cunningham*, Professor, Civil Engineering, CBE

1:35–2:00

**Well leakage mitigation using biomineralization**

*Robin Gerlach*, Associate Professor, Chemical & Biological Engineering, CBE

**2:00–2:25**  
**Imaging, microanalysis, and modeling of the microbially induced CaCO<sub>3</sub> precipitation process**  
*James Connolly*, PhD Candidate, Environmental Engineering, CBE

**2:25–2:50**  
**In situ and laboratory enriched microbial community composition and function associated with coal bed methane from Powder River Basin coals**  
*Elliott Barnhart*, PhD Student, Microbiology, CBE

**2:50–3:15**  
**Potential role of multiple carbon fixation pathways during bio-oil accumulation in *Phaeodactylum tricornutum***  
*Jake Valenzuela*, PhD Student, Chemistry & Biochemistry, CBE

**3:15–3:30 Break**

**3:30-4:30**  
**CBE Industrial Associates Business Meeting**

**6:00–9:00**  
**Banquet** Rockin TJ Ranch, Bozeman

**Thursday, July 14**

**7:30–8:00 a.m.**  
**Continental breakfast**  
 Hilton Garden Inn reception area

**SESSION 5:**  
**Biofilm Methods**  
**8:00–8:30**  
**In vitro studies of *Legionella pneumophila* grown as mono- and multi-species biofilms**  
*Danielle Orr*, Undergraduate Student, Microbiology, CBE

**8:30–9:00**  
**A new flow cell for time-lapse confocal microscopy**  
*Betsy Pitts*, Senior Research Scientist, Microscope Facilities Manager, CBE

**9:00–9:30**  
**Correlation of the single tube method and the treatment flow cell: Log reductions and confocal microscopy**  
*Kelli Buckingham-Meyer*, Research Assistant, CBE

**9:30–10:00 Break**

**SESSION 6:**  
**Biofilm Control**

**10:00–10:30**  
**Antimicrobials vs. biofilms: A review**  
*Phil Stewart*,

**10:30–11:15**  
**Ignorance, bliss, and antibiotic tolerance of nutrient-limited bacteria**  
*Pradeep Singh*, Associate Professor, Microbiology, University of Washington

**11:15–11:45**  
**Microbial Defense Systems: Advanced biofilm eradication technology**  
*Chris Samuel*, Vice President, Sales and Marketing, Microbial Defense Systems

**12:00-12:10**  
**Meeting Wrap Up**

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**WORKSHOP:**  
**Oral Biofilms Workshop**  
**July 16, 2012**

<b>9:00–9:15</b>	<b>Welcome</b> – <i>Phil Stewart, CBE Director</i> Group introductions	EPS 323
<b>9:15–10:15</b>	<b>Oral Microbial Ecology</b> – <i>Garth James</i>	EPS 323
<b>10:15–10:30</b>	<i>Morning Refreshments</i>	EPS 323
<b>10:30–11:30</b>	<b>Oral Biofilm Model Systems</b> – <i>Alessandra Agostinho &amp; Elinor Pulcini</i>	EPS 323
<b>11:30–12:00</b>	<b>The Fluxion Model</b> – <i>Alex Rickard*</i>	EPS 301
<b>12:00–1:15</b>	LUNCH	COB 429
<b>1:15–1:45</b>	<b>DFR Setup</b> – <i>Kelly Kirker</i>	EPS 337
<b>1:45–3:15</b>	<b>DFR Sampling</b> – <i>Elinor Pulcini, Laura Boegli, Alessandra Agostinho, Kelly Kirker, Steve Fisher, MBL Interns</i>	EPS 323
<b>3:15–3:30</b>	<i>Afternoon Refreshments</i>	EPS 323
<b>3:30–4:00</b>	Experimental design and statistical analysis of in vitro models of oral biofilms <i>Al Parker</i>	EPS 323
<b>4:00–4:30</b>	<b>Imaging Oral Biofilm</b> – <i>Alessandra Agostinho</i>	EPS 323
<b>4:30–5:00</b>	<b>Wrap-Up/Discussion</b>	EPS 323

\*Guest Instructor

TECHNOLOGY TRANSFER:  
 Montana Biofilm Meeting  
 February 5–6, 2013

**Monday, February 4**

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**6:00–8:30 p.m.**  
**Pre-registration and  
 welcome reception**  
 Hilton Garden Inn, Bozeman

**Tuesday, February 5**

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**7:30–8:00 a.m.**  
**Registration and  
 continental breakfast**  
 Hilton Garden Inn—Larkspur Foyer

**8:00–8:10**  
**Introductory remarks**  
 Larkspur Ballroom  
 Paul Sturman, CBE Industrial  
 Coordinator  
 Tony Rook, IA Chair, The Sherwin-  
 Williams Company  
 Phil Stewart, CBE Director

*SESSION 1:*

**Skin Biofilms**

**8:10–8:15**  
**Session introduction**  
*Garth James*, CBE Medical Projects  
 Manager; Associate Research  
 Professor, Chemical & Biological  
 Engineering, MSU

**8:15–8:45**  
**Biofilm in comedonal and  
 inflammatory *Acne vulgaris*; In vivo  
 identification and characterization**  
*Manisha Patel*, Assistant Professor,  
 Dermatology, School of Medicine,  
 Johns Hopkins University

**8:45–9:15**  
**Imaging biofilms in tissue**  
*Garth James*

**9:15–9:45**  
**Metagenomic study of the human skin  
 microbiome associated with acne**  
*Huiying Li*, Assistant Professor,  
 Molecular & Medical Pharmacology,  
 University of California, Los Angeles

**9:45–10:15 Break**

*SESSION 2:*

**Industrial Biofilms**

**10:15–10:20**  
**Session introduction**

*Paul Sturman*

**10:20–10:50**  
**Manganese sulfide inclusions and pit  
 initiation during microbially  
 influenced corrosion**  
*Recep Avci*, Director, Imaging &  
 Chemical Analysis Laboratory (ICAL),  
 Research Professor, Physics, MSU

**10:50–11:15**  
**Temperature and electronic-acceptor  
 availability affect biofilm structure  
 and chromium responses in  
*Dusulfovibrio vulgaris* RCH-1**  
*Lauren Franco*, PhD student,  
 Microbiology, CBE

**11:15–11:40**  
**Characterization of *Desulfovibrio*  
*alaskansis* G20 physiology and biofilm  
 metabolism on glass and steel  
 surfaces**  
*Greg Krantz*, PhD student,  
 Microbiology, CBE

**11:40–12:10**  
**Systems-based analysis of industrially  
 relevant microbes**  
*Ross Carlson*, Associate Professor,  
 Chemical & Biological Engineering, CBE  
*Abbie Richards*, Assistant Professor,  
 Chemical & Biological Engineering, CBE

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**12:10–1:10**  
**Lunch catered at the Hilton Garden  
 Inn**

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*SESSION 3:*

**Environmental Biofilms/Mineral  
 Biofilms**

**1:10–1:20**  
**Session introduction**  
*Brent Peyton*, Professor, Chemical &  
 Biological Engineering, CBE; Associate  
 Director, Thermal Biology Institute,  
 MSU

**1:20–1:50**  
**Microbial ecology of mine waste  
 environments**  
*Lisa Kirk*, Research Scientist, CBE

**1:50–2:20**  
**Planktonic and biofilm community  
 dynamics in situ**  
*Kara DeLeón*, PhD student,  
 Microbiology

***SPECIAL PRESENTATIONS:***

**2:20–2:50**  
**2012 ASM Biofilms meeting digest**  
*Phil Stewart*

**2:50–2:55**  
**Update: Biofilm methods index**  
*Darla Goeres*, Assistant Research  
 Professor, Chemical & Biological  
 Engineering, CBE

**Laboratory open house and poster  
 session**  
**3:15–5:00**  
 CBE Laboratories, 3rd Floor EPS  
 Building, MSU

**Wednesday, February 6**

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**7:30–8:00 a.m.**  
**Registration and  
 continental breakfast**  
 Hilton Garden Inn—Larkspur Foyer

*SESSION 4:*

**Pathogen Persistence in Biofilms**

**8:00–8:25**  
**Session introduction/overview**  
*Anne Camper*, Associate Dean, College  
 of Engineering, Professor, Civil  
 Engineering, CBE

**8:25–8:55**  
**Root associated biofilms: Physical  
 gradients and nutrient cycling**  
*Chris Allen*, PhD student, Civil  
 Engineering, CBE

**8:55–9:25**  
**Pathogen-biofilm-root  
 interactions for common  
 constructed wetland plants**  
*Rachel VanKampen-Fryling*, PhD  
 student, Microbiology, CBE

**9:25–9:55 Break**

*SESSION 5:*

**Next Generation Biomaterials**

**9:55–10:05**  
**Session introduction**  
*Phil Stewart*

**10:05–10:35**

**A porous biomaterial approach to biofilm infection control**  
 Andrew Marshall, Director & Chief Technology Officer,  
 Healionics

**biofilm implant-related infection**

Dustin Williams, Postdoctoral  
 Research Associate, School of  
 Medicine, University of Utah

**10:35–11:05**

**SLIPS—Omniphobic, slippery  
 surfaces to prevent bacterial  
 surface attachment**  
 Ben Hatton, Assistant Professor,  
 Materials Science & Engineering,  
 University of Toronto

**11:35–12:05**

**Using self-assembled monolayers  
 to inhibit Staphylococcus aureus  
 biofilm growth on a stainless steel  
 alloy (316L)**  
 Kristen Kruszewski, Research  
 Chemist, PPG Industries

**11:05–11:35**

**In vivo analysis of a novel  
 antimicrobial coating to prevent**

**12:05–12:15**

**Meeting Wrap-up**

**WORKSHOP:**  
**Microbial Ecology for Industrial Applications**  
**February 4, 2013**

9:00 – 9:15	Welcome – Phil Stewart, CBE Director Group introductions	EPS 323
9:15 – 10:00	Industrial Microbial Ecology: Evaluating microbial communities using molecular techniques – Brent Peyton	EPS 323
10:00 – 10:20	Morning Refreshments	EPS 323
10:20 – 11:15	Industrial Ecology: Mine Wastes 101 – Lisa Kirk	EPS 323
11:15 – 11:45	Field Collection for Lab Analysis – Lisa Kirk & Dana Skorupa	EPS 323
11:45 – 1:00	LUNCH	EPS 347
1:00 – 2:15	Microbial Ecology Methods – Dana Skorupa & Chiachi Hwang	EPS 337
2:15 – 3:00	Bioinformatics and Data Interpretation – Dana Skorupa & Chiachi Hwang	EPS 333
3:00 – 3:15	Afternoon Refreshments	EPS 323
3:15 – 3:30	Microscopy at the CBE – Betsey Pitts	EPS 323
	Laboratory Rotations:	
	<u>Group 1</u> <u>Group 2</u>	
3:30 – 3:50	A	B
3:50 – 4:10	B	A
	A. Microscopy tools to analyze samples from the environment to industry – Karen Moll	EPS 323
	B. Imaging Syntrophic Biofilms with FISH– Laura Camilleri	EPS 326/7
4:10 – 4:30	Wrap-up/Discussion	EPS 323

## TECHNOLOGY TRANSFER: NEWS

### CBE faculty member issued patent for microbial diagnostics

CBE faculty member **Anne Camper**, associate dean of the College of Engineering, and Andreas Nocker, former CBE postdoctoral associate, were issued a US patent for “Use of phenanthridium derivatives for distinguishing between live and dead cells,” on June 12, 2012. For details on the patent (no. 8,198,040) [click here](#)

### CBE faculty member leads ASTM inter-laboratory study

CBE assistant research professor **Darla Goeres**, chemical and biological engineering, is leading an inter-laboratory study (ILS) for ASTM Test Method E2871-12 “Standard test method for evaluating disinfectant efficacy against *Pseudomonas aeruginosa* biofilm grown in CDC biofilm reactor using single tube method.”

This method, originally developed in the US EPA’s Office of Pesticide Programs (OPP) Microbiology Laboratory Branch, was approved by ASTM Committee E35 during the April 2012 committee meeting in Phoenix, Arizona. The method uses *Pseudomonas aeruginosa* ATCC 15442 biofilm grown on borosilicate glass coupons in the CDC Biofilm Reactor and was a collaboration between the EPA and the CBE’s Standardized Biofilm Methods Laboratory. The method’s performance was first tested in a pilot study conducted at the EPA and CBE.

Although the initial study provided useful and promising results, it is ASTM standard practice to require methods to be validated in a full collaborative study that includes a minimum of six laboratories and three classes of disinfectants. Nine laboratories, including one international lab, are participating in the study. ASTM is also supporting **Al Parker**, CBE biostatistician, to conduct statistical analysis and an associated report of the results. The final outcome will be a precision-and-bias statement for the method.

Goeres began the study with training for participating labs on July 16, 2012 at the CBE, which allowed participants to view a demonstration of the test method and provided ample time to discuss each step of the test method in detail. The goal of the training was to significantly reduce any procedural variations due to individual interpretations of any particular step.

Experiments are currently being conducted at the participating labs and will continue through December 2012. All data will be collected, analyzed, and reported by Goeres and her CBE team to the ASTM E35 committee at their semi-annual meeting in April 2013. The final precision-and-bias statement will then be submitted to ballot.

Goeres serves as a committee member and secretary for ASTM E35 committee. ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. The purpose of Committee E35 is 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.

This is the fifth method approved by ASTM that the Center for Biofilm Engineering has helped to develop since 2002. The previous four methods include:

- E2799 MBEC™ Assay Method, first approved in 2011
- E2647 Drip Flow Reactor Method, first approved in 2008
- E2562 CDC Biofilm Reactor Method, first approved in 2007
- E2196 Rotating Disk Reactor Method, first approved in 2002

ASTM international standards are available for purchase at <http://www.astm.org/Standard/index.shtml>

### CBE faculty awarded NSF-Small Business Innovation award

The National Science Foundation-Small Business Innovation Research program recently awarded CBE faculty members **Rich Macur** and **Brent Peyton**, as well as Mark Kozubal of Sustainable Bioproducts LLC, \$150,000 for the project “Direct conversion of lignocellulosic feedstocks to lipids and high-value products using a proprietary microbial process.” The research investigates a simple, novel, and economical process for converting lignocellulosic feedstocks, such as wheat straw, to lipids and ethanol using a minimal number of steps compared to current technologies.

### What happens when you rinse?

A movie image taken from the CBE’s new Leica confocal microscope was featured in *Cell* journal’s online Cell Picture Show. The movie “What happens when you rinse?” shows oral bacteria in a biofilm losing fluorescence as mouthwash penetrates the biofilm clusters. The movie was obtained by **Shoji Takenaka**, DDS, visiting faculty from Niigata University in Japan, **Betsey Pitts**, CBE research scientist and microscope facilities manager, and **Phil Stewart**, CBE director and professor, chemical and biological engineering.

View movie (slide #10 of 14) at the Cell.com Cell Picture Show: [http://www.cell.com/cell\\_picture\\_show-biofilms](http://www.cell.com/cell_picture_show-biofilms)

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## OUTREACH: Visiting Researchers

**The MSU Algal Biofuels Group in partnership with Little Bighorn College (LBHC)** is working with Native American students from across Montana on a project titled “Phototrophs for carbon capture from the coal liquefaction process.” The overall objective of the project is to develop fast growing strains of nitrogen-fixing cyanobacteria to help advance carbon capture and sequestration (CCS) technologies. The two-year program is funded by the US Department of Energy and the American Indian Research and Education Initiative (AIRO) and is designed to support the Crow Nation as it evaluates opportunities for coal-to-liquid fuel (CTL) and CCS projects.

The Crow Nation contains 3% of the US coal reserves and is actively exploring multiple avenues to utilize this resource in an environmentally sound manner. The specific objectives of the project include collection of nitrogen-fixing cyanobacteria from natural field sites, isolation of pure cultures, characterizing growth and carbon sequestration in photo-bioreactors and evaluating the resultant biomass as an organic fertilizer for crop production. The participants are: LBHC staff member **Tammy Old Coyote**, LBHC undergraduate students **Verleen Holds** and **Gizelle Kellum**, and MSU undergraduate students **Casey Doney** and **Kyle Rosseler**. CBE mentors for the project are **Rich Macur**, research professor and **Brent Peyton**, professor, both of MSU's Department of Chemical and Biological Engineering.

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During summer 2012, the CBE hosted a high school student researcher as part of the American Indian Research Opportunities (AIRO) Montana Apprenticeship Program (MAP). **Kaycee Cooper**, a senior at Lincoln County High School (Eureka, Montana) is studying constructed wetlands with CBE faculty member **Mark Burr**, research assistant professor, land resources and environmental sciences.

MAP is a structured, six-week, hands-on summer research experience for both students and teachers under the direction of active science research mentors at Montana State University. The goal of MAP is to increase the number of Native American high school students who want to pursue careers in science, technology, engineering, and math career fields. Funding for MAP is provided in part by the Howard Hughes Medical Institute.

**Scott Chimileski**, PhD student from the University of Connecticut in Storrs, CT conducted research at the Center under the supervision of CBE host **Mike Franklin** in July–August 2012.

**Adyary Fallarero** from the Department of Biosciences, Åbo Akademi University located in Turku, Finland spent March 2013 working under **Darla Goeres**, assistant research professor, chemical and biological engineering, and her Standardized Biofilm Methods Laboratory (SBML). Dr. Fallarero conducts research in pharmaceutical sciences with a focus on the early stages of the drug discovery process. While at the CBE, Dr. Fallarero will be collaborating with the SBML on the development and application of biofilm methods specific to her research area.

**Roberto Fernandez-Crespo**, undergraduate student from the University of Navarra, Pamplona, in Navarra, Spain worked at the Center under the supervision of CBE host **Phil Stewart** in July–August 2012.

In January 2012, the Biofilm Control Lab welcomed visiting graduate student **Fernanda Godoy**. Fernanda is a microbiology student at the Universidade Federal de Vicosa in Brazil where she is pursuing research on an antimicrobial peptide for controlling staphylococcal infection. She will be investigating staph biofilms for one year under the direction of **Phil Stewart**, CBE director.

**Yuri Gorby**, associate professor in the Department of Civil and Environmental Engineering at Rensselaer Polytechnic Institute in Troy, New York, spent July–August 2012 conducting research with CBE faculty member **Matthew Fields**.

**Michael Gross**, MSU undergraduate student in cell biology and neuroscience, completed a 10-week apprenticeship in the CBE Medical Biofilms Lab as part of the Complex Biological Systems Summer Undergraduate Research Program (CBS-SURP). The apprenticeship, open to MSU freshmen, sophomores, and juniors, is a structured summer research program that introduces undergraduates to the rigors and challenges of scientific research in a mentor-based environment. Students work fulltime on an independent research project, and participate in a weekly seminar, extracurricular activities, and a full-day trip to Yellowstone National Park. This interdisciplinary program supports students from all fields of scientific interest including cell biology, neuroscience, microbiology, chemistry, biochemistry,

immunology, biofilm engineering, mathematics, and psychology. Funding is provided by the Howard Hughes Medical Institute. Michael was mentored by **Kelly Kirker**, CBE Research Scientist. His research focused growing methicillin resistant *Staphylococcus aureus* (MRSA) in different conditions, ultimately trying to determine why bacteria grown in biofilms are more resistant to antibiotics than when they're grown in a planktonic state.

**Rainer Helmig** and **Johannes Hommel** from the Institute for Modeling Hydraulic and Environmental Systems at the University of Stuttgart, Germany, visited the CBE November 28–December 3, 2012. The purpose of their visit was to update the CBE's biomineralization research group regarding simulation model development and testing which is relevant to this research. The biomineralization research group is led by CBE faculty members **Al Cunningham**, professor, civil engineering, and **Robin Gerlach**, associate professor, chemical and biological engineering. Helmig is the department head of hydromechanics and hydraulic modeling systems at the institute in Stuttgart.

**Maureen Kesaano**, PhD student from Utah State University in Salt Lake City, Utah worked under the direction of CBE host **Rob Gardner** from November 2012–January 2013.

**Fidel Martínez Gutiérrez** has returned to the CBE to conduct research with **Garth James** and the Medical Biofilms Lab (MBL). He will be working in the lab June 12–29, 2012. Dr. Gutiérrez is a research professor from the Universidad Autónoma de San Luis Potosí in San Luis Potosí, México. His first visit to the MBL was in May 2011.

**Maria Rosaria Mattei**, PhD student, environmental engineering, University “Federico II” in Naples, Italy will be working with CBE faculty member **Robin Gerlach** from February–September 2013. Maria has been working on a

1-D multispecies biofilm model, which has been evaluated under dynamic conditions to show biofilm thickness, distribution of bacterial species, and trends of substrate concentrations inside biofilm. Her research at the CBE will combine mathematical modeling of biofilm systems with experimental research aimed at collecting data for model calibration.

In April 2013, CBE welcomed visiting graduate student **Stéphanie Pedrosa**. Stéphanie is studying for a degree in Biology and Biotechnology at the Université Paris Sud in Orsay, France. She spent three months at the CBE working with the Biofilm Control group and as well as the Medical Biofilms Lab.

**Conchita Perez** arrived at the CBE in August 2012 for three months of research in the Medical Biofilms Lab (MBL) with **Garth James**. Conchita is a PhD student in pharmacy at Complutense University in Madrid, Spain. She is working with the MBL on the effects of anodized titanium alloys on biofilm formation of *Staphylococcus epidermidis* and *Staphylococcus aureus*. The application for this research is orthopedic implants.

**Lucy Qi**, attending medical doctor at the Chongqing Medical University and Children's Hospital in Chongqing, China is working with **Phil Stewart** and **Mike Franklin** on the role of protein repair mechanisms in maintaining bacteria dormancy in biofilms. Dr. Qi works with newborns in the neonatal unit at the Children's Hospital. She arrived at the CBE on October 25, 2011 and stayed for one year.

**Philipp Schumann**, PhD student from the University of Duisberg-Essen in Germany worked under the supervision CBE host **Anne Camper** in July–August 2012.

**Joao Sousa**, PhD student from the University of Campinas in Brazil worked under the direction of CBE host **Ross Carlson** from May–December 2012.

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## OUTREACH:

### Tours

As part of MSU's TEAMS (Teaching Engineering Applications in Math and Science) program, math and science teachers from Montana toured the CBE on Friday, June 15, 2012. **Ann Willis**, CBE technical operations manager, led a tour for fifteen K–12 teachers from several Montana towns. The visit included an overview of the CBE's industrial associates program, a tour of the bioprocess and biofilm methods labs, and viewing biofilm images on posters throughout the CBE. Highly impressed at the conclusion of the tour, the teachers commented that they plan to bring their students to the CBE for a tour and they also plan to incorporate engineering into their classrooms.

TEAMS was created for teachers and students to gain a greater knowledge of math and science content using real-world engineering applications, as well as gain an awareness of what engineers do, what careers are available as an engineer, and how to best prepare for a career in engineering.

Ron Sims and Terence Smith from Utah State University and Dr. Jim Burns from Alliant Techsystems, Inc. (ATK) toured the CBE on June 29, 2012. **Rob Gardner**, CBE postdoctoral researcher, led the group with an introduction of the industrial associate program and a tour of the algal biofuel lab. Jim Burns is a senior staff scientist studying motor booster shelf life (rocket fuel aging) in the aerospace division of ATK. Ron Simms is the department head of the biological engineering department at Utah State and Terence is a graduate student with a desire to study algal biofilms for biofuel applications.

**Ann Willis** led tours of the CBE to the following student groups:

As part of the federally funded TRIO program, Educational Talent Search (ETS), forty high school seniors from Billings, Montana toured the CBE on Thursday, July 12, 2012. ETS is designed to assist 7<sup>th</sup>-12<sup>th</sup> grade students prepare for and attend a post-secondary institution of their choice upon high school graduation. The ETS program is located at Montana State University Billings and serves 600 eligible students in Yellowstone County.

A group of Japanese high school students touring Yellowstone and Glacier National Parks with Yellowstone Glacier Adventures visited the

CBE on Monday, July 30, 2012. Their lab tour highlighted the various environmental and medical applications of CBE research, including using algae to produce biofuels. The group was interested to see the types of biofilm we work with, and how we grow and test them.

On August 14, 2012, **Ann Willis** led a tour for **Steve Daines**, local businessman and 2012 US congressional candidate, and **Jane Gillette**, DDS, research clinician and practitioner. Daines and Gillette were particularly interested in the CBE's successful business model of a collaborative team of researchers interacting with industry partners. Daines (an MSU engineering graduate) met with CBE faculty members **Al Cunningham**, professor, civil engineering, and **Brent Peyton**, professor, chemical and biological engineering and discussed the changes and challenges MSU and the CBE currently face with respect to research, funding, and growth.

On Tuesday, August 28, 2012 Montana Governor Brian Schweitzer hosted the state's first Governor's Innovation Day at Montana State University-Bozeman. A high level panel of industry and academic leaders discussed investing in and fostering Montana's innovation economy and toured Montana State University's science and engineering programs. **Ann Willis** led the group on a tour of the CBE.

**Jim Kirksey** and **Wayne Rowe** of Schlumberger, a leading oilfield services provider, visited the CBE on September 12, 2012. They met with CBE faculty members **Al Cunningham** and **Robin Gerlach** and their CBE biomineralization research team to discuss the experimental design of a newly-funded Department of Energy (DOE) project "Field test and evaluation of engineered biomineralization technology for sealing existing wells."

Drs. **Mark Colonna** and **Dave Dodrill** from the Montana Center for Laser Dentistry in Whitefish, MT, toured the CBE on September 28, 2012. They met with CBE director **Phil Stewart** as well as with the team from the CBE Medical Biofilms Lab.

On October 17, 2012, **Ann Willis** led a tour for students from the 2012 Kumamoto Kita High School Super Science Group in Japan. The group, accompanied by their principal and office of international programs coordinator, Makiko Diehl, enjoyed seeing the variety of experiments underway in the CBE labs. They were

especially intrigued by the vast scale of our tools and techniques, ranging from the ability to dispense one microliter of liquid on a surface to the huge “super wrench” used to tighten a pressure vessel. The Super Science designation is awarded to schools that prioritize science, technology, and math as part of their curriculum.

On October 8, 2012, the CBE hosted industrial visitors from Zimmer, Inc. and Microbion Biosciences Corporation. Zimmer, located in Warsaw, Indiana, specializes in joint replacement technologies and was particularly interested in biofilm control methods regarding joint replacement devices. Microbion is a Bozeman-based research partner that develops topical anti-infective products used in biofilm control.

**Ann Willis** hosted a tour for thirty students from the 2013 Okinawa Global Leadership Program on March 5–6, 2013. The group was part of a leadership training institute offered through MSU’s Office of International Programs (OIP) for the Okinawa Board of Education (BOE). The institute provides an opportunity for high school students from Okinawa, Japan to improve English skills while developing leadership skills, sharing culture through presentations, and observing MSU classes and laboratories. Students were enthused to see some of the research projects at the Center and learn how those projects are related to their daily activities and observations.

The CBE hosted a lecture and tour for a group of dentists and dental hygienists from the Bozeman chapter of the Montana Dental Hygienists Association (MDHA) on March 7, 2013. CBE medical biofilms lab manager **Garth James** presented current dental-related biofilm issues and facilitated discussion related to patient treatment efficacy. Ann Willis led their lab tour and the attendees enjoyed the scope of the tour and were impressed by the access to advanced research and technology at MSU. Attendees received two Continuing Education Units (CEUs) for the lecture and tour.

On March 21, 2013 twenty-three participants from the Leadership MSU program visited the CBE research labs as part of a three-part tour of MSU’s College of Engineering. The Leadership MSU program focuses on knowledge about the university, its mission and vision, with the goal to better understand how colleges and departments across the university work together. **Ann Willis** guided the tour and shared the story that makes the Center so unique and successful.

CBE director **Phil Stewart** conducted a Center tour for members of the MSU Alumni Foundation on April 8, 2013.

The CBE presented “Biofilms: The science of slime,” to forty participants from Bozeman’s Wonderlust program on April 15, 2013. Through a partnership between MSU’s Extended University, Museum of the Rockies, and Bozeman’s Country Bookshelf bookstore, Wonderlust promotes the development and delivery of exciting learning opportunities for people who want to study with others. Classes involve preparation and active participation by students, and facilitation by knowledgeable experts from a wide variety of backgrounds. The format is a mix of discussion and lecture. CBE faculty member **Elinor Pulcini**, assistant research professor, chemical and biological engineering, and CBE research scientist **Lisa Kirk** provided classroom instruction on the science of biofilms. Lab tours were led by CBE personnel—**Ann Willis**, technical operations manager, **Diane Walker**, research engineer, **Dana Skorupa**, postdoctoral researcher, and Lisa Kirk.

**Ann Willis**, CBE technical operations manager, gave the following visitor tours in April:

April 8, 2013: As part of MSU’s Science, Technology, Engineering and Math (STEM) club, a group of fourth graders from a local Bozeman elementary school toured the CBE labs.

April 11, 2013: MSU’s Engineering Ambassadors hosted a group of middle school students from Livingston, Montana on a tour of the CBE labs.

April 18, 2013: Bozeman Senior High students from the Project Lead the Way (PLTW) program. PLTW is the leading provider of rigorous and innovative Science, Technology, Engineering, and Mathematics (STEM) education curricular programs used in middle and high schools across the U.S.

April 19, 2013: MSU students from the IDEa Networks of Biomedical Research Excellence (INBRE) program. INBRE focuses on increasing the biomedical research capacity of Montana by building research infrastructure, supporting faculty and student research and fostering a state-wide collaborative network.

CBE medical biofilms lab manager **Garth James** hosted Dr. Jason Tanguay, DDS, from the Mint Dental Studio in Bozeman, Montana on May 31, 2013. Dr. Tanguay visited with the CBE’s Medical Biofilm Laboratory researchers to discuss potential collaborative projects.

CBE faculty and students participate in science education for students and teachers

CBE faculty member **Christine Foreman**, associate research professor, land resources & environmental sciences (LRES), and MSU education coordinator Susan Kelly, LRES, presented a three-hour short course to teachers at the National Science Teachers Association Conference in San Antonio, Texas, April 12, 2013. The course “Science is cool: Bringing climate science to the elementary classroom,” used polar science to teach engaging hands-on activities, cutting-edge science, and connections to best practices in inquiry-based teaching.

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A team of CBE faculty and students participated in the third annual Crow Education Partnership Fieldtrip at MSU-Bozeman on April 18, 2013. **Christine Foreman** and CBE PhD candidates **Heidi Smith** (LRES), **Michelle Tigges** (chemistry & biochemistry), and **Anna Zelaya** (microbiology) helped guide students from Hardin Intermediate School through the various exhibits and lab demonstrations on campus. Hardin is situated on the Crow reservation located in southeast Montana. MSU education coordinator Susan Kelly, LRES, led the event which brought nearly 200 students to MSU to engage in hands-on Science, Technology, Engineering, and Math (STEM) activities. View images on Facebook (no account necessary): <http://on.fb.me/1166Uq0>

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## OUTREACH: Web image library use

Requests for CBE graphics use were submitted from **33** of the United States:

Arizona	Maryland	Ohio
Arkansas	Massachusetts	Oklahoma
California	Michigan	Pennsylvania
Connecticut	Mississippi	South Carolina
Colorado	Missouri	Texas
Delaware	Montana	Wisconsin
Florida	Nebraska	Utah
Georgia	New Jersey	Virginia
Idaho	New Mexico	Washington, D.C.
Illinois	New York	
Indiana	North Carolina	
Iowa	North Dakota	

There were requests from an additional **32** countries:

Argentina	Holland	Oman
Australia	India	Saudi Arabia
Austria	Ireland	Singapore
Brazil	Italy	South Africa
Canada	Japan	Spain
Chile	Kazakhstan	St. Vincent and the Grenadines
Croatia	Korea	Sweden
Egypt	Malaysia	Thailand
France	Mexico	Turkey
Germany	New Zealand	United Kingdom (England)
Greece	Norway	

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## FACILITIES:

### Center for Biofilm Engineering Facilities Overview

The CBE moved into the MSU's Engineering/Physical Sciences (EPS) Building when it was built in 1997. The >20,000 ft<sup>2</sup> facility includes offices and conference rooms for faculty, staff, and students; two computer laboratories; and thirteen fully equipped research laboratories. The full-time CBE Technical Operations Manager oversees the research laboratories, provides one-on-one training for students, ensures safe laboratory practices, and maintains equipment. State-of-the-art instruments and equipment are available for use by all CBE faculty, staff, and students. General use areas include a microbiology lab, a media kitchen, an instrument lab, and an isolated radioactive isotope lab. Facilities of particular note are described below.

## EQUIPMENT

### H1 Hybrid Multi-mode Plate Reader

CBE associated faculty **Brent Peyton** (professor, chemical and biological engineering) generously added the Synergy™ H1 Hybrid Multi-mode Plate Reader to the CBE instrument room. The reader, provided by BioTek® Instruments, Inc., is a flexible monochromator-based multi-mode instrument and will enhance the Center's analytical capabilities. The system supports top and bottom fluorescence intensity, UV-visible absorbance, and high performance luminescence detection. It is the ideal system for all the standard microplate applications found in life science research laboratories and will greatly benefit CBE researchers. The instrument features Gen5™ software. BioTek® is a family-run company based in Winooski, Vermont. The Synergy™ H1 is made in the USA.

### Mass spectrometry facility

In 2005 an equipment grant was awarded for an Environmental and Biofilm Mass Spectrometry Facility through the Department of Defense University Research Instrumentation Program (DURIP). The grant funded the acquisition of an Agilent 1100 series high performance liquid chromatography system with autosampler and fraction collector, an Agilent SL ion trap mass spectrometer, and an Agilent 6890 gas chromatograph with electron capture detector, flame ionization detector, and 5973 inert mass spectrometer. Since then, an Agilent 7500ce inductively coupled plasma mass spectrometer with autosampler, liquid, and gas chromatographic capabilities has also been added. Mass spectrometers are very well suited for unknown compound identification and high sensitivity speciation measurements of organic and inorganic compounds; this equipment enhances the CBE's research capabilities significantly. The Environmental and Biofilm Mass Spectrometry Facility is operated as a user facility and allows access for academic and non-academic researchers.

### Microscope Facilities

The microscopy facilities are coordinated by the Microscopy Facilities Manager who maintains the equipment and trains and assists research staff and students in capturing images of in situ biofilms via optical microscopy and fluorescent confocal microscopy. The microscopy facilities include three separate laboratories—the Optical Microscopy Lab, the Confocal Microscopy Lab, and the Microscope Resource Room and Digital Imaging Lab—which are detailed below.

The **Optical Microscopy Lab** houses two Nikon Eclipse E-800 research microscopes which are used for transmitted light and epi-fluorescent imaging. Both microscopes are equipped with cooled CCD cameras from Photometrics (we have a CoolSnapfx, and a CoolSnapEZ) and use Universal Imaging Corporation's MetaVue software (v 7.4.6) for digital image acquisition. We have a large collection of fluorescence filter cubes for the Nikons, including those optimized for the following fluorescent stains: FITC (gfp), TRITC (propidium iodide), DAPI, CTC, ELF-97, CY5, cfp, and we also have a B2E cube. Both Nikons are equipped with Nomarski/DIC. Other equipment in the Optical Microscopy Lab includes a Nikon SMZ-1500 barrel zoom stereomicroscope equipped with a color camera, a Leica CM1800 cryostat, a Zeiss Palm Laser Capture Dissection microscope and a dry ice maker.

The **Confocal Microscopy Lab** contains two brand-new (2011) Leica SP5 Confocal Scanning Laser Microscopes (CSLMs).

One is an inverted confocal microscope with 405, 488, 561 and 633 nm laser excitation lines. It is equipped with a tandem scanner, so it can be switched from standard scanning mode to operate in Resonant Scanner mode, which

enables scanning at exceptionally high frequencies for fluorescent imaging. This faster scanning is necessary for most live cell imaging (note: “live cell imaging” doesn’t generally refer to imaging bacterial cells, but rather mammalian cells and processes). This inverted SP5 also includes a heated stage with an environmental control chamber (i.e. it can be used to provide an enclosed CO<sub>2</sub> atmosphere), and a motorized stage with Mark-and-Find and image tiling capabilities.

The second new SP5 is an upright confocal microscope, also with 405, 488, 561 and 633 nm lasers, a motorized stage, Mark-and-Find, and tiling capabilities. This upright has a removable heated chamber that encloses the entire microscope, so that larger, incubated flow cell systems can be accommodated over long periods of time. This enables high-resolution time-lapse monitoring of biofilm development, treatment and detachment phenomena. Additionally, this microscope is equipped with Fluorescence Lifetime Imaging (FLIM) capability, which is also referred to as Single Molecule Detection.

The CSLM is capable of imaging biofilms on opaque surfaces, so a wide variety of materials can be used in the experimental flow cells. As biofilm formation proceeds in an experiment, representative areas of the colonized surface are scanned with the use of the automatic stage. Digital data is collected from sequential scans, and stored data can be viewed in the x, y, z coordinates to yield a 3-dimensional image of the biofilm architecture. Quantitative and qualitative information about biofilm architecture can be retrieved easily from examination of CSLM data, in both the x-y and x-z planes, and the existence or absence of structural features, such as microcolonies and water channels, can be determined.

The **Microscope Resource Room / Digital Imaging Lab** is where CBE researchers examine and reconstruct the stacks of image data they have collected using our image analysis software. For quantitative analysis, such as intensity or particle-size measurements, we use Universal Imaging Corporation’s MetaMorph software. We use Bitplane’s *Imaris* software for qualitative analysis—for example, putting together a stack of 200 red and green flat images, to get a 3-dimensional image of a biofilm microcolony that can be rotated in space and examined from every angle. The lab consists of three dedicated computers, SCSI drives for storing large files, CD and DVD burners and readers, and a color printer. In addition to providing CBE students, staff, and researchers with an imaging workplace, the resource room gives us a place to hold group tutorials and WebEx group software training sessions.

## Computer Facilities

CBE staff and students have access to workstations connected to the MSU College of Engineering computer network. A student computer laboratory offers ten state-of-the-art PCs along with scanning and printing services. In addition, the COE maintains computational PCs and a computational cluster for data manipulation, mathematical modeling, and graphic image analysis.

## SPECIALIZED CBE LABORATORIES

### Biofilm Control Laboratory

The CBE has a long-standing interest in the control of unwanted biofilms. In the Biofilm Control Lab, experiments are conducted to find out how biofilm bacteria react to antimicrobial agents (e.g., biocides or antibiotics) by working with sponsoring companies to develop techniques or applications to use chemicals more efficiently to control bacterial growth in their systems.

### Bioprocess Laboratory

The Bioprocess Lab accommodates the CBE’s “up-scale” research projects. Many of the experiments conducted here simulate large scale environmental systems. For example, activities in this lab include drinking water system experiments, large bioreactors that simulate microbial bioremediation processes in soils, and microbial biodegradation of environmental contaminants.



## Ecology/Physiology Laboratory

The Ecology/Physiology Laboratory, headed by Dr. Matthew Fields, has general microbiology equipment, anaerobic gassing stations, Shimadzu UV-VIS spectrophotometer, biofilm reactors, protein and DNA electrophoresis, Qbit fluorometer, 2 PCR machines (96-well), incubators, laminar/fume hoods, microcentrifuges, table-top centrifuges, and a microcapillary gas chromatograph with dual TCDs. The lab also has a light-cycle controlled photo-incubator as well as photo-bioreactors for the cultivation of algae and diatoms, and the lab maintains one -20°C freezer and a -70°C freezer for sample storage.

This laboratory also houses a 454 GS-Jr. pyrosequencer. The GS-Jr. uses 454 technology at an intermediate scale (100,000 reads with up to 40-50 Mb of sequence). The GS Jr. offered by Roche is a high-throughput, multi-parallel sequencing instrument that is capable of delivering the information of approximately 100,000 different DNA molecules of approximate 450 nucleotides long within 48 hours. We have been using the Gs-Jr. for approximately 1 year, and have developed an in-house Python script that deals with filtering raw sequences based upon quality scores (Bowen De León et al., in revision). We have also modified the protocols for the GS-Jr. in consultation with Roche to improve quality scores (Ramsay et al., manuscript in preparation).

## Environmental Biofilms Laboratory

The task of researchers in the Environmental Biofilms Lab is to understand key microbial community structures and interactions in environmental biofilms, with emphasis on aquatic systems. They also study water quality conditions that contribute to biofilm formation in different environments and how these conditions may influence the persistence and detection of pathogens in biofilms. Examples of areas of study include drinking water distribution systems, constructed wetlands, soils, arctic cores and membrane filtration.

## Medical Biofilm Laboratory

The Medical Biofilm Laboratory (MBL) has earned a reputation for being a university lab that responds quickly to real world needs in the area of health care as it relates to biofilms. Dr. Garth James (PhD, microbiology), Randy Hiebert (MS, chemical engineering), and Dr. Elinor Pulcini (PhD, microbiology) have been the innovative leaders and managers of this respected, flexible, and adaptable lab group. The MBL team also includes three full-time research scientists, two technicians, one graduate student, and two undergraduate research assistants.

Currently, fifteen companies, including CBE Industrial Associates, sponsor MBL projects. The MBL is also collaborating with small businesses on two Phase I Small Business Innovation Research (SBIR) grants. In addition, MBL principal investigator Kelly Kirker recently received an R03 research grant from the National Institutes of Health (NIH) to investigate staphylococcal biofilm induction of apoptosis in human epithelial cells. Other MBL projects include evaluating treatments for oral biofilms, testing needle-free connectors, catheters, and other medical devices, as well as evaluating novel treatments for medically related biofilms. The MBL is a prime example of integration at the CBE, bringing together applied biomedical science, industrial interaction, and student educational opportunities.

## Microbial Ecology and Biogeochemistry Laboratory

Research in the Microbial Ecology and Biogeochemistry Laboratory lies at the intersection of microbial and ecosystem ecology and uses a combination of field and laboratory studies, as well as approaches ranging from the single-cell to the community level. Staff in this lab are interested in understanding how the environment controls the composition of microbial communities and how, in turn, those microbes regulate whole ecosystem processes such as nutrient and organic matter cycling. Ongoing research examines carbon flux through microbial communities, with the long-term goal of improving predictions of carbon fate (metabolism to CO<sub>2</sub>, sequestration into biomass, long-term storage in ice) in the context of a changing environment. Additionally, they are interested in physiological adaptations to life in icy environments. Regardless of the environment, the group employs microbiological, limnological, biochemical and molecular biology approaches to investigate fundamental processes carried out by microbes.

## Standardized Biofilm Methods Laboratory

The Standardized Biofilm Methods Laboratory (SBML) was designed to meet research and industry needs for standard analytical methods to evaluate innovative biofilm control technologies. SBML staff and students develop, refine, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBML members work with

international standard setting organizations on the approval of biofilm methods by the standard setting community. Under a contract with the U.S. Environmental Protection Agency (EPA), the SBML conducts laboratory research to support the development and standardization of test methods for measuring the performance of antimicrobial products—including those for biofilm bacteria—and provide statistical services related to EPA's Office of Pesticide Programs Antimicrobial Testing Program. In addition, they conduct applied and fundamental research experiments and develop testing protocols. Methods include: design of reactor systems to simulate industrial/medical systems; growing biofilm and quantifying cell numbers and activity; testing the efficacy of chemical constituents against biofilms; and microscopy and image analysis of biofilms. SBML staff offer customized biofilm methods training workshops for CBE students, collaborators, and industry clients.

## OTHER FACILITIES

Montana State University facilities available for collaborative research

### MSU Nuclear Magnetic Resonance (NMR) Facility

A state-of-the-art NMR facility is available on campus on a recharge basis for research projects. This facility is a 5-minute walk from the College of Engineering and CBE laboratories. All the instruments in the facility are Bruker Avance instruments. The facility houses 300, 500 and 600 MHz NMR instruments for high resolution spectroscopy analysis.

### MSU Magnetic Resonance Microscopy (MRM) Facility

A state-of-the-art MRM facility is available on a recharge basis for research projects. This facility is located in the College of Engineering in the same building as the Center for Biofilm Engineering. Both instruments in the facility are Bruker Avance instruments. The facility houses 250 MHz standard/wide bore and a 300 MHz wide/super-wide bore instruments for imaging and fluid dynamics applications. The imaging systems are capable of generating NMR image and transport data with spatial resolution on the order of 10  $\mu\text{m}$  in a sample space up to 6 cm diameter.

### Flow Cytometry Facility

A flow cytometry facility is available, at the Department of Immunology and Infectious Diseases, for research staff to investigate physical and/or chemical properties of disaggregated biofilm cells in suspension. This facility is an excellent complement to the microscope facility in that biofilms may be examined in situ under the microscope and then later disaggregated for single-cell examination in the flow cytometer. This instrument has a wide variety of uses from examining heterogeneous populations, to counting cells, to sorting specific populations within a sample.

The facility is equipped with a Becton Dickinson FACSAria flow cytometer. Housed with three lasers, a 405 nm, 488 nm and a 633 nm, the FACSAria is able to detect up to seven different fluorochromes, plus forward and side scatter simultaneously. High-speed sorting is also a feature of the FACSAria. Two- and four-way sorting can be performed as well as sorting into 96-well plates.

### MSU ICAL Laboratory

The Image and Chemical Analysis Laboratory (ICAL) in the Physics Department at Montana State University is located on the 3rd floor of the EPS Building, adjacent to the Center for Biofilm Engineering. ICAL is a user oriented facility that supports basic and applied research and education in all science and engineering disciplines at MSU. The laboratory provides access to state of the art equipment, professional expertise, and individual training to government and academic institutions and the private sector. Laboratory instrumentation is dedicated to the characterization of materials through high resolution imaging and spectroscopy. ICAL promotes interdisciplinary collaboration between the research, educational and industrial fields.

#### Current Instrumentation

- \* Atomic Force Microscope (AFM)
- \* Field Emission Scanning Electron Microscope (FE SEM)
- \* Scanning Electron Microscope (SEM)

- \* Small-Spot X-ray Photoelectron Spectrometer (XPS)
- \* Time-of-Flight Secondary Ion Mass Spectrometer (ToF-SIMS)
- \* X-Ray Powder Diffraction Spectrometer (XRD)
- \* Scanning Auger Electron Microprobe (AUGER)
- \* Epifluorescence Optical Microscope
- \* Microplotting System
- \* Critical Point Drying
- \* Video Contact Angle System

For more information on each system, see the ICAL web site at: <http://www.physics.montana.edu/ical/home/index.asp>

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