2016
APPENDIX

Center for Biofilm Engineering

Montana State University Bozeman

Reporting period:
June 1, 2015–May 31, 2016
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RESEARCH:

CBE RESEARCH AREAS

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.

APPLIED RESEARCH AREAS & PROJECTS

Biofilm control strategies  antimicrobial efficacy | biocides | bioelectric effect | disinfectants | inhibitory coatings | bioactive compounds

Energy solutions  biofuels | product souring | coal bed methane production | microbial fuel cells

Environmental technologies  bioremediation | wetlands | CO₂ sequestration | biobarriers | biomineralization | microbes & mining issues

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

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

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 hot & cold environments | role of biofilms in natural processes | biomimetics | biogeochmistry

Cellular/intracellular  phenotype | genetics | metabolic pathways | proteomics

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

Ecology/physiology  population characterization | spatial and temporal population dynamics

ANALYTICAL TOOLS & TECHNIQUES

Instrumentation  microscopy | nuclear magnetic resonance imaging | gas chromatography | microfluidics

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

Modeling  cellular automata modeling | mathematics | hydrodynamics | cohesive strength

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

Molecular biology techniques  DNA extraction | PCR | DGGE | microarrays | sequencing
## 2015–2016 CBE GRANT-FUNDED RESEARCH ACTIVITY

### Current CBE Research Grants for Fiscal Year 2016 (July 1, 2015 to June 30, 2016)

<table>
<thead>
<tr>
<th>Research Area</th>
<th>Title</th>
<th>Principal Investigator</th>
<th>Funding Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biofilm Mechanics</td>
<td>Characterizing microbial biofilms in water recovery systems using micromechanical tools³</td>
<td>Wilking</td>
<td>NASA</td>
</tr>
<tr>
<td>Biofilm Mechanics</td>
<td>Exploring Biofilm Material Properties with Micromechanical Tools</td>
<td>Wilking</td>
<td>NSF</td>
</tr>
<tr>
<td>Biofilm Mechanics</td>
<td>Resuscitation of <em>P. aeruginosa</em> biofilm cells from dormancy¹</td>
<td>Franklin</td>
<td>NIH</td>
</tr>
<tr>
<td>Biofilms in Nature</td>
<td>Clark Fork River Biofilms</td>
<td>Fields</td>
<td>USGS</td>
</tr>
<tr>
<td>Biofilms in Nature</td>
<td>USGS-Big Horn</td>
<td>Fields</td>
<td>USGS</td>
</tr>
<tr>
<td>Biofilms in Nature</td>
<td>Riverine Carbon Cycling as a Function of Seasonality</td>
<td>Foreman</td>
<td>MONACA</td>
</tr>
<tr>
<td>Biofilms in Nature</td>
<td>Continued Monitoring of the Bridger Bowl Wetland System</td>
<td>Stein</td>
<td>BRIBOW</td>
</tr>
<tr>
<td>Education</td>
<td>Improving Montana Community Health through Graduate Education</td>
<td>Camper</td>
<td>NIH</td>
</tr>
<tr>
<td>Energy Solutions</td>
<td>SEP Collaborative Research: Alkaliphilic Microalgae-Based Sustainable &amp; Scalable Processes for Renewable Fuels and Products</td>
<td>Gerlach</td>
<td>NSF</td>
</tr>
<tr>
<td>Energy Solutions</td>
<td>Lipid Derived Biofuels: Bicarbonate Induced Triacylglycerol Accumulation in Microalgae</td>
<td>Peyton</td>
<td>Church &amp; Dwight</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Nutrient and Water Integration and Recycling for Sustainable Algal Biorefineries</td>
<td>Gerlach</td>
<td>U of Toledo-DOE</td>
</tr>
<tr>
<td>Technologies</td>
<td>Cooperative Research Program on Constructed Wetland Design and Implementation</td>
<td>Stein</td>
<td>USFWS</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Design and Implementation of Pilot Vertical Flow Treatment Wetland Systems at Bridger Bowl</td>
<td>Stein</td>
<td>MT DEQ</td>
</tr>
<tr>
<td>Technologies</td>
<td>Using Biomineralization Sealing for Leakage Mitigation in Shale during CO₂ Sequestration</td>
<td>Gerlach</td>
<td>MT Emerging Technologies-DOE</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Selenium Bioremediation</td>
<td>Peyton</td>
<td>Teck Coal Ltd</td>
</tr>
<tr>
<td>Technologies</td>
<td>Use of Saturated/Submerged Rock Fills for Water Quality Management</td>
<td>Peyton</td>
<td>SRK Consulting</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Nitrifying Wastewater Biofilms and the Influence of Emerging Contaminants *⁴</td>
<td>Lauchnor</td>
<td>USGS</td>
</tr>
<tr>
<td>Technologies</td>
<td>Saturated Rock Fill Research Program</td>
<td>Peyton</td>
<td>Teck Coal Ltd</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Collaborative Research: Connecting Omics to Physical Environment in Community Microbial Ecology</td>
<td>Zhang</td>
<td>NSF</td>
</tr>
<tr>
<td>Technologies</td>
<td>Proposal to Analyze Microbial Community Change with Depth in Samples from EV-F2-15-01</td>
<td>Peyton</td>
<td>Teck Coal</td>
</tr>
<tr>
<td>Environmental Substance</td>
<td>Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment</td>
<td>Stewart</td>
<td>U of Maryland-DOD</td>
</tr>
<tr>
<td>Technologies</td>
<td>Saturated Rock Fill Phase 3 Laboratory Column Testing</td>
<td>Peyton</td>
<td>SRK Consulting</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>New Frontiers in Nanoscience and Nanotechnology⁵</td>
<td>Stewart</td>
<td>NSF</td>
</tr>
<tr>
<td>Medical Biofilms</td>
<td><em>Staphylococcus aureus</em> Biofilms Mediate Keratinocytes Apoptosis</td>
<td>Kirker</td>
<td>NIH</td>
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<tr>
<td>Medical Biofilms</td>
<td>Spatiotemporal Distribution of Oxygen in Biofilm Infections</td>
<td>Stewart</td>
<td>NIH</td>
</tr>
<tr>
<td>Medical Biofilms</td>
<td>Resensitization of Bacteria in Biofilms to Antibiotics</td>
<td>Stewart</td>
<td>DOD (USAMRAA)</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------</td>
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</tr>
<tr>
<td>Methods Development</td>
<td>Development and Use of Standard Methods for the Growth, Treatment, Sampling and Analysis of Biofilm Bacteria</td>
<td>Goeres</td>
<td>EPA</td>
</tr>
<tr>
<td>Methods Development</td>
<td>Methods to Assess Biofilm Prevention on Medical Devices</td>
<td>Goeres</td>
<td>Burroughs Wellcome Fund</td>
</tr>
<tr>
<td>Methods Development</td>
<td>Anti-Biofilm Technologies: Pathways to Product Development</td>
<td>Goeres</td>
<td>Burroughs Wellcome Fund</td>
</tr>
<tr>
<td>Modeling</td>
<td>Predictive Multiscale Modeling of Microbial Consortia Biofilms</td>
<td>Carlson</td>
<td>NIH</td>
</tr>
<tr>
<td>Physiology &amp; Ecology</td>
<td>Virtual Institute for Microbial Stress &amp; Survival</td>
<td>Fields</td>
<td>DOE/LBNL</td>
</tr>
<tr>
<td>Physiology &amp; Ecology</td>
<td>Molecular Level Characterization of Dissolved Organic Carbon and Microbial Diversity in the WAIS Divide Replicate Core</td>
<td>Foreman</td>
<td>NSF</td>
</tr>
<tr>
<td>Physiology &amp; Ecology</td>
<td>Collaborative Research: Hydrodynamic Controls on Microbial Community Dynamics</td>
<td>Cunningham &amp; Fields</td>
<td>NSF</td>
</tr>
<tr>
<td>Physiology &amp; Ecology</td>
<td>Investigating How Microorganisms Thrive in the Hostile Conditions of Yellowstone’s Hot Springs¹</td>
<td>Peyton</td>
<td>W.M. Keck Foundation</td>
</tr>
<tr>
<td>Water Systems</td>
<td>Water, our Voice to the Future: Climate Change Adaptation and Waterborne Disease Prevention on the Crow Reservation</td>
<td>Camper</td>
<td>Little Big Horn College</td>
</tr>
</tbody>
</table>

¹Denotes a project running through a different MSU department, but involving collaboration with CBE researchers and/or use of CBE facilities.

¹MSU Department of Microbiology & Immunology
²Montana Water Center
³NASA EPSCOR
⁴MSU Thermal Biology Institute
⁵Montana Nanotechnology Facility (MONT)

List of Acronyms
ARRA American Recovery and Reinvestment Act
DOD U.S. Department of Defense
DOE U.S. Department of Energy
EPA U.S. Environmental Protection Agency
EPSCoR Experimental Program to Stimulate Competitive Research
LBNL Lawrence Berkeley National Lab
MT DEQ Montana Department of Environmental Quality
NASA National Aeronautics and Space Administration
NIH National Institutes of Health
NSF National Science Foundation
USAMRAA U.S.A. Medical Research Acquisition Activity
USDA U.S. Department of Agriculture
USFWS U.S. Fish and Wildlife Service
USGS U.S. Geological Survey
ZERT Zero Emissions Research and Technology

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## FY16 New CBE Research Grants (July 1, 2015 to June 30, 2016)

<table>
<thead>
<tr>
<th>Sponsor</th>
<th>Title</th>
<th>PI</th>
<th>Period</th>
<th>Award Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lawrence Berkeley Natl Lab</td>
<td>Virtual Institute for Microbial Stress and Survival/Environmental Stress Pathways*</td>
<td>Fields</td>
<td>1 yr</td>
<td>$537,000</td>
</tr>
<tr>
<td>US Geological Survey</td>
<td>USGS-Big Horn</td>
<td>Fields</td>
<td>2 yrs</td>
<td>$7,000</td>
</tr>
<tr>
<td>Montana Academy of Science</td>
<td>Riverine Carbon Cycling as a Function of Seasonality</td>
<td>Foreman</td>
<td>1 yr</td>
<td>$750</td>
</tr>
<tr>
<td>University of Toledo</td>
<td>Nutrient and Water Integration and Recycling for Sustainable and Algal Biorefineries*</td>
<td>Gerlach</td>
<td>1 yr</td>
<td>$405,519</td>
</tr>
<tr>
<td>MT Emergent Technologies</td>
<td>Using Biomineralization Sealing for Leakage Mitigation in Shale during CO₂ Sequestration*</td>
<td>Gerlach</td>
<td>1 yr</td>
<td>$221,062</td>
</tr>
<tr>
<td>US EPA</td>
<td>Development and Use of Standard Methods for the Growth, Treatment, Sampling and Analysis of Biofilm Bacteria*</td>
<td>Goeres</td>
<td>1 yr</td>
<td>$35,000</td>
</tr>
<tr>
<td>Burroughs Wellcome Fund</td>
<td>Methods to Assess Biofilm Prevention on Medical Devices</td>
<td>Goeres</td>
<td>5 yrs</td>
<td>$500,000</td>
</tr>
<tr>
<td>Burroughs Wellcome Fund</td>
<td>Anti-Biofilm Technologies: Pathways to Product Development</td>
<td>Goeres</td>
<td>1 yr</td>
<td>$5,000</td>
</tr>
<tr>
<td>Office of the Commissioner of Higher Education</td>
<td>One Medicine: Reducing the Impacts of Inflammatory and Infectious Diseases on Animal and Human Health</td>
<td>James</td>
<td>2 yrs</td>
<td>$18,750</td>
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<tr>
<td>Church &amp; Dwight Inc.</td>
<td>Lipid-Derived biofuels: Bicarbonate-Induced Microalgae for Biofuel and Specialty Chemicals*</td>
<td>Peyton</td>
<td>1 yr</td>
<td>$160,000</td>
</tr>
<tr>
<td>Teck Coal</td>
<td>Proposal to Analyze Microbial Community Change with Depth in Samples from EV-F2-15-01</td>
<td>Peyton</td>
<td>1 yr</td>
<td>$9,788</td>
</tr>
<tr>
<td>SRK Consulting</td>
<td>Saturated Rock Fill Phase 3 Laboratory Column Testing</td>
<td>Peyton</td>
<td>1 yr</td>
<td>$142,421</td>
</tr>
<tr>
<td>US Fish and Wildlife</td>
<td>Cooperative Research Program on Constructed Wetland Design and Implementation*</td>
<td>Stein</td>
<td>1 yr</td>
<td>$170,000</td>
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<tr>
<td>MT Dept of Env. Quality</td>
<td>Design and Construction of Pilot Vertical Flow Treatment Wetland System at Bridger Bowl*</td>
<td>Stein</td>
<td>1 yr</td>
<td>$15,000</td>
</tr>
<tr>
<td>Bridger Bowl Inc.</td>
<td>Continued Monitoring of the Bridger Bowl Wetland System</td>
<td>Stein</td>
<td>1 yr</td>
<td>$10,000</td>
</tr>
<tr>
<td>University of Maryland</td>
<td>Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment</td>
<td>Stewart</td>
<td>4.5 yrs</td>
<td>$7,488</td>
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<td>NSF</td>
<td>Connecting Omics to Physical Environment in Community Microbial Ecology</td>
<td>Zhang</td>
<td>3 yrs</td>
<td>$99,999</td>
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<tr>
<td><strong>Total Grant Awards to CBE in Fiscal Year 2016</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>$2,344,777</strong></td>
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</table>

*Additional funding awarded to existing grants in FY16 (budget increased by the amount listed)*
RESEARCH:
PUBLICATIONS
June 2015–May 2016

2015 Publications

NOTE:
2015-001 through 2015-017 are listed in 2015 Appendix


Ziganshin AM, Ziganshina EE, Byrne J, Gerlach R, Struve E, Biktagirov T, Rodionov A, Kappler A “Fe(III) mineral reduction followed by partial dissolution and reactive oxygen species generation during 2,4,6-trinitrotoluene transformation by the aerobic yeast *Yarrowia lipolytica,*” *AMB Express.*, 2015 Feb 1; 5:8. 2015-041

**2016 Publications**


Smith HJ, Foreman CM, Akiyama T, Franklin MJ, Devitt NP, Ramaraj T “Genome sequence of *Janthinobacterium* sp. CG23_2, a violacein-producing isolate from an Antarctic supraglacial stream,” *Genome Announc.*, 2016 Jan-Feb; 4(1). 2016-009


± Industrial or Federal Agency co-author
^ Undergraduate Student
* Previous Visiting Researcher
# Previous Staff/Faculty
#: 49
RESEARCH:
PRESENTATIONS
June 2015–May 2016

The following CBE researchers presented research at the American Society for Microbiology (ASM) 2015 general meeting, New Orleans, LA, May 30–June 2, 2015:

Invited talks:
Laura Camilleri, PhD student, microbiology & immunology as an invited speaker presented “Altered gene expression in a methanogenic, symbiotic biofilm.”

Greg Krantz, PhD student, microbiology & immunology, as an invited speaker presented “Electron donor limitation promotes metal corrosion by Desulfovibrio alaskensis G20 biofilms.”

Student travel award:
Tatsuya Akiyama, PhD student, microbiology & immunology, won a student travel award to present the poster “Regulation of hibernation promoting factor (hpf) and ribosome modulation factor (rmf) of Pseudomonas aeruginosa includes transcriptional and post-transcriptional mechanisms.”

Poster presentations:
Tisza Bell, PhD student, microbiology & immunology, presented “Monitoring community ecology in wastewater treatment lagoons for the production of algal biodiesel.”

Luisa Corredor-Arias, PhD student, microbiology & immunology, presented “Nutrient and temperature stress for lipid accumulation in a novel environmental green microalga.”

Lakota Doig, master’s student, microbiology & immunology, presented “Lipid accumulation with mixed photoautotrophic cultures from municipal wastewater.”

Lauren Franco, PhD student, microbiology & immunology, presented “Effects of nutrient limitation on Desulfovibrio vulgaris biofilm composition, structure, and metal deposition.”

Logan Hodgskiss, CBE research assistant, presented “Growth of a native algal species in coal bed methane water for biofuel and biomass accumulation.”

Anna Zelaya, PhD student, microbiology & immunology, presented “‘Species filter’ effects on sediment biofilms and groundwater source diversity.”

The following CBE PhD students presented research at the Biochemical Society’s Metabolic Pathways Analysis 2015 meeting, Braga, Portugal, June 8–12, 2015:

Kris Hunt, PhD student, chemical & biological engineering, as an invited speaker presented “Stoichiometric analysis of primary autotrophy and biomass turnover in a thermoacidophilic iron oxidizing archaeal community.”

Ashley Beck, PhD student, microbiology & immunology, presented the poster “Elementary flux mode analysis of irradiance-induced stress acclimation strategies in the thermophilic cyanobacterium Thermosynechococcus elongatus BP-1.”

Phil Stewart, professor, chemical & biological engineering, as invited speaker presented the following research:


Diane Walker, CBE research engineer, as an invited speaker presented “Laboratory techniques for studying biofilm,” International Association for Food Protection (IAFP), Portland, OR, July 25–28, 2015.

The following CBE researchers presented research at The International Workshop on Organic Matter Spectroscopy (WOMS), Sopot, Poland, September 22–25, 2015:

Heidi Smith, PhD student, land resources & environmental sciences, as a speaker presented “Transformations in autochthonous DOM: An Antarctic supraglacial case study.”

Juliana D’Andrilli, assistant research professor, chemical & biological engineering, presented the poster “Bulk and molecular level characterization of organic matter in glacial ice.”
Garth James, associate research professor, chemical & biological engineering, as an invited speaker presented “Biofilms and chronic wounds,” at the following meetings:
Why Wounds Won’t Heal Conference, Bozeman Deaconess Wound Clinic, Bozeman, MT, September 25, 2015.

Why Won’t this Wound Heal? workshop at the Fall 2015 Symposium on Advanced Wound Care (SAWC), Las Vegas, NV, September 28, 2015.
The workshop was made possible by an educational grant from Convatec.

Phil Stewart, professor, chemical & biological engineering, as an invited speaker presented “Antimicrobial tolerance in biofilms: Physics, chemistry, biology,” Department of Biological Sciences, University of Calgary, Canada, September 28, 2015.

The following CBE graduate students presented research at the Algal Biomass Summit in Washington D.C., September 29–October 2, 2015:

Tisza Bell, PhD student, microbiology & immunology, as a track panel speaker presented “Can ecology provide insight for algal lipid accumulation strategies in open systems?”

Matthew Jackson, PhD student, chemical & biological engineering, presented the poster “Promoting lipid accumulation in Chlorella vulgaris UTEX395 using nitrogen limitation and bicarbonate amendment.” Jackson won first place in the Young Researcher Poster Competition (biology track); as well as a student travel grant from The Algae Foundation to attend the conference.

Todd Pederson, master’s student, chemical & biological engineering, presented the poster “An enhanced culturing strategy for Nannochloropsis gaditana stimulating high lipid accumulation through the use of nitrogen depletion and bicarbonate amendment.” Pederson won third place in the Young Researcher Poster Competition (biology track).


Darla Goeres, associate research professor, chemical & biological engineering, presented the poster “Data from a recent inter-laboratory study and methods to efficacy test treated surfaces,” at the International Biodeterioration Research Group (IBRG) Methods Meeting, Prague, Czech Republic, October 18–23, 2015.

The following CBE faculty and staff presented research at the 7th ASM Conference on Biofilms, Chicago, IL, October 24–29, 2015:

Pre-meeting workshop:
Darla Goeres, Al Parker, CBE biostatistician, Kelli Buckingham-Meyer, research scientist, and Diane Walker, research engineer, facilitated a pre-meeting workshop “Standardized biofilm methods: Development and application of biofilm methods.”

Poster presentations:
Garth James, associate research professor, chemical & biological engineering: “Shockwave disruption of biofilms.”

Elinor Pulcini, assistant research professor, chemical & biological engineering: “In vitro analysis of Clostridium difficile biofilms: Imaging and antimicrobial treatment.”

Phil Stewart, professor, chemical & biological engineering: “Spatial patterns in biofilm infections.”

Robin Gerlach, professor, chemical & biological engineering: “Biofilm-mediated mineral precipitation technology: From the microscale to the field-scale.”

Mike Franklin, professor, microbiology: “Characterization of the Pseudomonas aeruginosa PAO1 biofilm matrix by fluorescence-based imaging.”
Darla Goeres, associate research professor, chemical & biological engineering, attended the ASTM subcommittee E35.15 meeting, Tampa, FL, October 28–30, 2015. Goeres was there to discuss various microbial methods under development. ASTM subcommittee E35.15 studies antimicrobial agents and ASTM main committee E35 studies pesticides, antimicrobials, and alternative control agents.


Karen Moll, PhD student, microbiology & immunology, presented the poster “Scaffolding 3rd generation sequence contigs using dovetail and bionano technologies,” at Plant and Animal Genome Conference (PAG XXIV), San Diego, CA January 9–13, 2016.

John Doyle, Mari Eggers, K Brame, and Anne Camper as invited speakers delivered an online presentation “2016. Water, our voice to the future: Climate change adaptation and waterborne disease prevention on the Crow Reservation,” as part of the EPA NCER (National Center for Environmental Research) Tribal Science Webinar Series, Durham, NC, Jan. 12, 2016.

Michael Vigers, undergraduate student, chemical & biological engineering, presented his research “Characterizing biofilm extracellular matrices with mechanical measurement techniques,” and was one of the recipients awarded the 2016 Education Committee Travel Award at Biophysical Society’s 60th Annual Meeting in Los Angeles, California, February 27–March 2, 2016.

Phil Stewart, professor, chemical & biological engineering, as an invited session moderator and speaker presented the following research:


“Biofilms in wounds... what we know and don’t know,” at the jointly held Society for Advanced Wound Care meeting in Atlanta, GA, April 14, 2016.

Joe Seymour, professor, chemical and biological engineering, as an invited platform speaker presented “Hydrodynamics mediates structure during abiotic growth of a calcite precipitate barrier: a combined MRI/CT study,” at Interpore: 8th International Conference on Porous Media & annual meeting in Cincinnati, OH, May 9–12, 2016

Phil Stewart, professor, chemical & biological engineering, presented “The biofilm defense: Physics, chemistry, biology,” at University of Minnesota, Minneapolis, MN, May 20, 2016.


*Zambare’s presentation was selected as one of the two best presentations in the Carbonate and Sulfate Minerals Symposium (out of 8 presenters) and she received an ACS Student Travel Award to present her research.
RESEARCH:
NEWS HIGHLIGHTS

Darla Goeres awarded Burroughs Wellcome Innovation in Regulatory Science Award

MSU-CBE faculty member Darla Goeres, associate research professor of chemical and biological engineering, received a Burroughs Wellcome Innovation in Regulatory Science Award. Goeres will receive $500,000 over five years to develop new methodology to assess the prevention of biofilm formation on medical devices. She is one of five recipients of the award.

Read more about Goeres and her Burroughs Wellcome award at MSU News: “MSU faculty member earns grant award for biofilm methodology research”

CBE faculty member Co-PI on recent NSF $3 million award to MSU

The National Science Foundation awarded $3 million to MSU for the creation of a new nanotechnology center. Phil Stewart, CBE-affiliated faculty member in chemical and biological engineering, is a Co-PI on the grant, which is part of an $81 million, national effort to boost American research and development in a fast-growing and promising field that requires very specialized equipment and expertise. Nanoscience and nanotechnology—the study and application of extremely small things—are pushing the envelope in the full array of science and engineering fields.

Read more about the award and the anticipated nanotechnology center at MSU News: “NSF awards $3 million to MSU to expand nanotechnology”

Publication Spotlight

Feature article: Nature Publication Journals (npj) Biofilms and Microbiomes

Congratulations to MSU-CBE graduate and first author James Connolly, students, and faculty on their recent feature article “Estimation of a biofilm-specific reaction rate: Kinetics of bacterial urea hydrolysis in a biofilm,” in npj Biofilms and Microbiomes. Urea-hydrolysing biofilms are of interest to the medical community when treating urinary tract infections and scientists and engineers when studying microbially-induced carbonate precipitation. In order to appropriately model these systems, biofilm-specific reaction rates need to be measured. In this article, researchers at Montana State University and Temple University developed a simple method for determining biofilm-specific reaction rates using biofilms of E. coli bacteria.

npj Biofilms and Microbiomes is an open access, online multi- and interdisciplinary journal dedicated to publishing the finest research on microbial biofilms and microbiomes. The journal hosts cross-disciplinary discussions and allows for our understanding of mechanisms governing the social behavior of microbial biofilm populations and communities, and their impact on life, human health, and the environment, both natural and engineered. npj Biofilms and Microbiomes is part of the Nature Publishing Group which publishes Nature, a leading weekly, international scientific journal founded in 1869.


First author: James Connolly, PhD graduate, March 2015, chemical & biological engineering, MSU, CBE
Co-authors:
Ben Jackson, PhD graduate, August 2015, mathematics, MSU, CBE
Adam Rothman, bachelor’s degree, 2012, chemical & biological engineering, MSU, CBE
Isaac Klappler, professor, mathematics, Temple University (formerly professor in mathematics at MSU and CBE)
Robin Gerlach, professor, chemical & biological engineering, MSU, CBE

Link to article: http://www.nature.com/articles/npjbiofilms201514 Back to Table of Contents
CBE bio-statistician earns top EPA award

Al Parker, CBE bio-statistician, was awarded an EPA 2015 Scientific and Technological Achievement Award, Level 1. This award is given to top contributors to the advancement of science and technology through their publications in peer-reviewed articles and books. Parker was part of a research team that included Steve Tomasino, EPA senior scientist, Martin Hamilton, MSU-CBE professor emeritus in statistics, and Gordon Hamilton, statistical analyst with Big Sky Statistical Analysts. The authors submitted two papers that focused on using statistical tools to evaluate test methods for killing bacteria on surfaces. Their work was published in the Journal of AOAC International. AOAC INTERNATIONAL is a globally recognized agency in standards development.

To read about Parker’s research and his EPA award click here

MSU team awarded Keck Foundation grant to study extreme Yellowstone microbes

Brent Peyton, a professor in MSU’s Department of Chemical and Biological Engineering, was awarded a prestigious $1 million grant from the W.M. Keck Foundation. Peyton and other MSU researchers will be expanding their research into how microorganisms thrive in the hostile conditions of Yellowstone’s hot springs. Their work has the opportunity to lead new discoveries in medicine, energy, materials and other fields.

In addition to his affiliation with the Center for Biofilm Engineering (CBE), Peyton is the director of MSU’s Thermal Biology Institute (TBI). Established in 1999, TBI is recognized internationally for its work on organisms living in extreme high temperature environments. On this Keck-funded project, Peyton will be working with several faculty from across MSU’s campus including: Brian Bothner, chemistry and biochemistry; Eric Boyd, microbiology and immunology; Ross Carlson, chemical and biological engineering; Valerie Copie, chemistry and biochemistry; Matthew Fields, director of MSU’s Center for Biofilm Engineering; Robin Gerlach, chemical and biological engineering; and Bill Inskeep, land resources and environmental sciences. Carlson and Gerlach are also affiliated faculty of the Center for Biofilm Engineering.

The W.M. Keck Foundation is one of the largest private foundations in the US, supporting fundamental and applied research in science, engineering and medicine as well as educational initiatives. Peyton and his team will be using the Keck grant to learn more about the heat-loving Archaea found in some of Yellowstone’s hot springs. Microbes that survive in extreme conditions have potential for applications in science, medicine, and crime forensics but require a great amount of fundamental research. The group plans to launch a multidisciplinary lab-based honors course called “Extreme Microbiology of Yellowstone.” Twelve undergraduate students—six microbiology students and six bioengineering students—will participate annually to study the genetic material that comprise these durable microorganisms common to Yellowstone’s hot springs.

Read more about the potential of Yellowstone’s extreme microbes at MSU News: “MSU team awarded Keck Foundation grant to study extreme Yellowstone microbes”
## RESEARCH:
### CBE Affiliated Faculty and Their Specialties, 2015–2016

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<tr>
<th>NAME</th>
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<th>SPECIALTY</th>
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<td>Anne Camper</td>
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CBE Affiliated Faculty Awards & News

New CBE Director

In July 2015, CBE welcomed Matthew Fields, professor of microbiology and immunology at Montana State University, as its new director. Dr. Fields previously served as interim head of MSU’s Department of Microbiology (now Microbiology and Immunology). He heads CBE’s Physiology and Ecology Lab, where his research is focused on metabolic and genetic processes of microbes and biofilms.

Dr. Fields has won numerous awards and journal editorships, including the MSU Award for Excellence and the Wiley Award for Meritorious Research. He currently serves as specialty editor for the journal Frontiers in Microbiology and Academic Editor for PLoS One, and he is a Research Fellow at the National Center for Genome Resources in Santa Fe, NM.

Dr. Fields succeeds Phil Stewart, professor of chemical and biological engineering, who spent much of his career at MSU conducting research with the CBE before stepping in as director in 2005.

Read the full article about Fields, his research, and his appointment at MSU News Service: MSU's Center for Biofilm Engineering names Matthew Fields as new director

Sarah Codd receives national recognition as an inspiring woman in STEM

MSU-CBE faculty member, Sarah Codd, professor of mechanical and industrial engineering, was selected by a national magazine as one of its 100 Inspiring Women in STEM Award.

Read more about Sarah and her award at MSU News Service: MSU professors receive national recognition as inspiring women in STEM

Engineering a perfect fit

MSU-CBE faculty member, Abigail Richards, associate professor of chemical and biological engineering, was featured in the spring 2016 edition of Montana State University’s Mountains & Minds magazine. The article “Engineering a perfect fit,” highlights Richards’ climb through the ranks of the chemical and biological engineering department, starting as a visiting scholar to now, where she is a driving force behind the department’s increased student enrollment.

It was 2002 when Richards landed at the Center for Biofilm Engineering in Montana State University’s College of Engineering. It was a move that she assumed would be temporary. Though she was a visiting scholar working with another outsider, Richards said she felt right at home from the beginning. “It was exciting to be at MSU because I wanted to expand my horizons, and I got to meet a whole new group of fabulous scientists and interdisciplinary thinkers in my field,” said Richards, who grew up in Washington. “The whole community here, made it a great place for me.”

The College of Engineering responded in kind, bringing her on as a tenure-track faculty member in 2007 and tapping the then 31-year-old Richards to teach the rigorous program’s entry-level courses and introduce students to the world of chemical engineering. She helped transform a freshman-level course typically enrolled by 40-some students into a class of more than 170 students.

Read more about Richards in MSU’s Mountain & Minds: “Engineering a perfect fit”
CBE faculty earn MSU 2016 awards

Two CBE-affiliated faculty members—Sarah Codd and Anne Camper—were among the recipients of Montana State University’s 2016 faculty awards. The annual award ceremony honors achievement in faculty research, teaching, outreach, and creative projects. This year’s awards were presented at the 5th annual MSU Spring Convocation on January 12th on the MSU campus.

In keeping with the CBE’s goal to provide high quality interdisciplinary research and education, it is of particular value to the CBE that the two affiliated faculty member awardees represent different disciplines.

Women in Science Distinguished Professor Award

Sarah Codd, professor in the Department of Mechanical and Industrial Engineering, received the Women in Science Distinguished Professor award to support and recognize outstanding women faculty in the fields of science, technology, engineering and mathematics (STEM), and the social and behavioral sciences. Codd will receive an annual award of $4,000 for two years.

Codd, who is co-director of MSU’s Magnetic Resonance Laboratory, studies a variety of complex fluid systems, including colonies of bacteria known as biofilms and supercritical carbon dioxide. Through the use of magnetic resonance imaging (MRI) microscopy, Codd works to discover answers to vital questions about the function of biofilms, which are the cause of oral plaque and many persistent medical infections, and how biofilms can be used beneficially to remove or contain contaminants in the subsurface. She is also using MRI to understand how carbon dioxide will behave when it is stored at high pressures and temperatures in reservoirs underground to try to prevent climate change.

Codd has had more than 60 papers published in peer-reviewed journals, and she is frequently invited to present at a prominent meeting in her field, the International Conference of Magnetic Resonance Microscopy conference series. She has also won several National Science Foundation awards, including a $400,000 NSF Career Award in 2007. The award is given to support the early career development of teacher-scholars, and it is considered one of NSF’s most prestigious distinctions.

In fall 2015, Codd served as a Gledden Fellow at the University of Western Australia, where she worked with a group that uses low-field portable MRI to study engineering in oil fields. She also has been previously recognized at MSU with the Provost’s Award for Undergraduate Research/Creativity Mentoring and the Women’s Faculty Caucus Distinguished Mentor Award.

President’s Commission on the Status of University Women Award

Anne Camper, Regents Professor, MSU’s Department of Civil Engineering and associate dean for faculty and administration in the College of Engineering, received the President’s Commission on the Status of University Women Award given to a member of the faculty or staff who has established a record of working to improve issues related to gender, equity and diversity on any of MSU’s four campuses. The award includes a $2,000 honorarium.

Camper has a proven record of working to improve issues related to gender, equity and diversity. She was the first chair of the President’s Commission on the Status of University Women and helped develop the commission’s vision for a successful future. Camper is also known for achieving excellence in research, teaching and service while simultaneously breaking down gender barriers. An international expert on water and biofilms, in 2013 Camper was selected as a Montana University System Regents Professor, the most prestigious designation to be attained by a professor in the system. Camper is the first woman at MSU and the first faculty member in MSU’s College of Engineering to be selected for the honor. Also in 2013, she was selected as a fellow of the National Academy of Inventors, who are selected for their outstanding contributions to innovation in areas such as patents and licensing, innovative discovery and technology, significant impact on society and support and enhancement of innovation. She also served as MSU’s interim Vice President for Research, Creativity and Technology Transfer in 2013.
2016 College of Engineering Awards

Brent Peyton, a professor in MSU’s Department of Chemical and Biological Engineering, was honored with the College of Engineering’s Distinguished Professorship award at its annual awards ceremony on May 4, 2016.

In addition to Peyton’s duties as a professor in the chemical and biological engineering department, he is the director of MSU’s Thermal Biology Institute, and an affiliated faculty member of the Center for Biofilm Engineering. Peyton’s research focus is on extremophilic bioprocessing, in situ biocatalyzed heavy metal biotransformations (Se, Cr, U), and growth of algae and fungi for biodiesel production in natural and engineered biological systems.

As a COE Distinguished Professor, Peyton will receive an annual award of $5,000 per year for five years and will be expected to give an inaugural public lecture during the first year of the professorship. Awardees hold the title of Distinguished Professor and receive funding for a 5-year term. Peyton was recognized for his long-standing record of excellence in research, teaching and mentoring, professional outreach to the State of Montana and MSU, and integrating learning, discovery and engagement.

Peyton was awarded a prestigious $1 million grant from the W.M. Keck Foundation. Peyton and other MSU researchers will use the money to expand their research into how microorganisms thrive in the hostile conditions of Yellowstone’s hot springs. Their work has the opportunity to lead new discoveries in medicine, energy, materials and other fields.

Read the related article on Peyton’s prestigious $1 million grant from the W.M. Keck Foundation at MSU News: http://www.montana.edu/news/15946/msu-team-awarded-keck-foundation-grant-to-study-extreme-yellowstone-microbes

2016 CBE Outstanding Faculty Award

Adrienne “Adie” Phillips, assistant professor in civil engineering, received the CBE’s Outstanding Faculty Award. Adie was recognized for her high research activity in biomineralization technology, her dedication to laboratory-based teaching and mentoring to undergraduate and graduate students, and her active role in the wellbore sealing testing project, which has commercialization potential.

CBE Staff Awards & News

2016 Outstanding Staff Award

Kristen Griffin received the CBE Outstanding Staff Award. Kristen was recognized for her exemplary performance as the Technology Development Specialist. In addition to her regular duties, Kristen takes care of many CBE needs, thereby ensuring overall efficient function and communication. Kristen continuously serve as a model of professionalism and excellence that best represents the CBE in its mission of research, education, and outreach.

2015 Outstanding Researcher Award

Diane Walker, CBE research engineer, received the CBE Outstanding Researcher Award. Walker was recognized for her commitment to the CBE Industrial Associates Program, her dedication in organizing and presenting biofilm workshops, and for contributions to creating a quality Standardized Biofilm Methods research program. The Outstanding Researcher Award is open to any CBE researcher or faculty member. The criteria for selection include research quality, teamwork, willingness to mentor others and willingness to contribute to CBE outreach efforts through the Montana Biofilm Meetings and workshops.

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New Staff

CBE welcomed the following postdoctoral researchers to its staff:

Zack Jay received his PhD in ecology from Montana State University's Department of Land Resources and Environmental Sciences. His research focus was microbial ecology in Yellowstone National Park. Jay is currently working for Ross Carlson, associate professor in chemical and biological engineering, on metabolic modeling of electron fluxes for fundamental understanding and biofuels synthesis as part of the DOE Center for Biological Electron Transfer and Catalysis (BETCy) grant. Originally from Glenwood Springs, Colorado, Jay enjoys all of the outdoor activities of the Rocky Mountains—alpine and backcountry skiing, hiking and biking, camping, and fly fishing.

Shipeng Lu earned his PhD in 2012 from the Aquatic Geomicrobiology Group, Institute of Ecology, at Friedrich Schiller University in Jena, Germany. His research focus was microbial iron cycling in pelagic aggregates (iron snow) and sediments of an acidic mine lake. Lu is working for Robin Gerlach, professor in chemical and biological engineering, on algal biofuels. In addition to getting acclimated to Bozeman and the CBE, Lu and his wife are busy raising their 21-month-old twin sons. Lu is from Nanjing, China and both he and his wife speak Mandarin, Korean, English, and some German.

Luke McKay is originally from Birmingham, Alabama. He received his PhD from the Department of Marine Sciences at the University of North Carolina at Chapel Hill where he studied microbial ecology at hydrothermal seeps in Guaymas Basin, Gulf of California. McKay earned a NASA postdoctoral fellowship through the NASA Astrobiology Institute to study primitive microbial processes in Yellowstone National Park. He will use molecular analyses and cultivation techniques to examine the distribution, functional capacity, and potential biomarker formation of methanogens in the park. McKay is co-advised by Matthew Fields, professor in microbiology and immunology, and Bill Inskeep, professor in MSU’s Department of Land Resources and Environmental Sciences. McKay enjoys all-things-Bozeman: backpacking, climbing, mountain biking, and snowboarding; and, he thinks snakes are cool!

Marnie Feder is a new postdoctoral researcher in the lab of CBE faculty member Robin Gerlach, professor in chemical and biological engineering. Marnie will be working with Dr. Gerlach and Dr. Adie Phillips, assistant professor in civil engineering on developing advanced mineral precipitation technologies for sealing applications and stabilization of coal combustion residues. Marnie received her PhD in civil engineering from the University of Glasgow, Scotland, where her research focused on determining biogeochemical mechanisms responsible for heavy metal immobilization in sustainable drainage systems. Marnie is originally from Chicago but has lived in Denver for many years. She enjoys traveling and getting up in the mountains to snowboard or to take her dog swimming.

The CBE welcomed Erika Espinoza-Ortiz as a postdoctoral researcher working for Robin Gerlach, professor in chemical and biological engineering. Erika received her PhD in Environmental Technologies for Contaminated Solids, Soils and Sediments as part of an Erasmus Mundus Joint Doctorate Program at UNESCO-IHE in Delft, Netherlands in December 2015. Her research focused on the mycogenic production of selenium and tellurium nanoparticles. Currently, Erika is working on biomineralization projects as well as fungal and algal biofilm projects in the Gerlach lab.

CBE welcomed Kristen Brileya as its new technical operations manager in June 2015. Brileya received her PhD from MSU’s Department of Microbiology and Immunology. She was an IGERT fellow studying anaerobic community ecophysiology. Upon graduation, Brileya spent two years as a postdoc at Portland State University working with Anna-Louise Reysenbach before returning to MSU to work with Matthew Fields. She hails from Fort Ann, New York where she grew up working on her family’s vegetable farm. Brileya is excited to be working at the CBE because she is a problem solver and enjoys helping others with their research challenges. She looks forward to the opportunity to facilitate research and keep things running smoothly and safely at CBE. Personally, Brileya is active in Montana outdoor activities—skiing, hiking, hunting, and biking. She also enjoys playing hockey and working around her homestead where she gardens, raises a variety of animals, and experiments with home fermentation.

The CBE welcomed new staff member Joseph Parchen in May 2016. Joey replaces Peg Dirckx as the CBE’s visual communications specialist and serves as the CBE’s go-to person for graphics and communication needs. His role provides leadership and expertise in visual and multimedia communications and editing to extend the CBE’s standing as a world-
leading institution for biofilm research, education, methods development, and industrial partnership. Joey has over 10 years of experience designing print and digital media. He looks forward to the opportunity to apply his graphics experience to the disciplines of science and engineering.

**Faculty and staff retirements**

In June 2015 the following CBE faculty and staff retirements were celebrated:

- Al Cunningham, professor, civil engineering, 35 years of service
- Peg Dirckx, director of visual communications, 36 years of service
- Rocky Ross, professor, computer science, 30 years of service
# EDUCATION:

**Undergraduate Students: Summer 2015, Fall 2015, Spring 2016**

*Graduating ‡ Native American

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<th>#</th>
<th>Last Name</th>
<th>First Name</th>
<th>Major</th>
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<td>*Keepseagle</td>
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<td>41.</td>
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<td>42.</td>
<td>*McFarland</td>
<td>Colleen</td>
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<td>43.</td>
<td>Meagher</td>
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<td>Miller</td>
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<td>45.</td>
<td>Moeun</td>
<td>Yora</td>
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<td>47.</td>
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<td>Kevin</td>
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<td>Oeschger</td>
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<td>F</td>
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<tr>
<td>49.</td>
<td>Oloff</td>
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<tr>
<td>50.</td>
<td>Olson</td>
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</table>

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Undergraduates Summary: 2015–2016

<table>
<thead>
<tr>
<th>Department (Program)</th>
<th>Male</th>
<th>Female</th>
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<tbody>
<tr>
<td>Chemical &amp; Biological Engineering</td>
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<td>Civil/Environmental Eng</td>
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<tr>
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<tr>
<td>Land Resources &amp; Environ Sci (LRES)</td>
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<td>2</td>
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<tr>
<td>Microbiology &amp; Immunology</td>
<td>2M</td>
<td>7F</td>
<td>9</td>
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<tr>
<td>Modern Languages &amp; Literature</td>
<td>1M</td>
<td></td>
<td>1</td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>27 M</strong></td>
<td><strong>49 F</strong></td>
<td><strong>76</strong></td>
</tr>
</tbody>
</table>

Back to Table of Contents
### Masters Candidates

1. Akyel, Arda (Gerlach)  
   - Gender: M  
   - Program: Chem & Bio Eng  
   - Country: Turkey  
2. Berglund, Emily (Wilking)  
   - Gender: F  
   - Program: Chem & Bio Eng  
   - Country: Helena, MT  
3. *Bodie, Kylie (Lauchnor)  
   - Gender: F  
   - Program: Civil/Environmental Eng  
   - Country: Camano Island, WA  
4. *Doig, Lakotah (Fields)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Gypsum, CO  
5. Ertuna, Cagan (Peyton)  
   - Gender: M  
   - Program: Chem & Bio Eng  
   - Country: Cyprus  
6. Hill, Morgan (Brown)  
   - Gender: F  
   - Program: Chem & Bio Eng  
   - Country: Turner, ME  
7. *Martin, Christine (Camper/Eggers)  
   - Gender: F  
   - Program: Health & Human Dev  
   - Country: Hardin, MT  
8. *‡Doig, Lakotah (Fields)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Gypsum, CO  
9. *‡Doig, Lakotah (Fields)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Gypsum, CO  
10. Ertuna, Cagan (Peyton)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: Cyprus  
11. Hill, Morgan (Brown)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Turner, ME  
12. *‡Doig, Lakotah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
13. *‡Doig, Lakotah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
14. Ertuna, Cagan (Peyton)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: Cyprus  
15. Hill, Morgan (Brown)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Turner, ME  
16. *‡Doig, Lakotah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
17. *‡Doig, Lakotah (Fields)  
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    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
18. *‡Doig, Lakotah (Fields)  
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    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
19. *‡Doig, Lakotah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Gypsum, CO  
20. *‡Doig, Lakotah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Gypsum, CO  

### PhD Candidates

1. Akiyama, Tatsuya (Franklin)  
   - Gender: M  
   - Program: Micro & Immunology  
   - Country: Japan  
2. *Allen, Chris (Stein)  
   - Gender: M  
   - Program: Civil/Environmental Eng  
   - Country: Bozeman, MT  
3. Anjum, Sobia (Wilking)  
   - Gender: F  
   - Program: Chem & Bio Eng  
   - Country: Pakistan  
4. Corredor Arias, Luisa (Fields)  
   - Gender: F  
   - Program: Micro & Immunology (Fulbright)  
   - Country: Colombia  
5. Beck, Ashley (Carlson)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Corning, IA  
6. Bell, Tisza (Fields/Peyton)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Littleton, CO  
7. Bernard, Garrett (Chang)  
   - Gender: M  
   - Program: Materials Science  
   - Country: Louisville, KY  
8. Brame, Keenan (Camper)  
   - Gender: M  
   - Program: LRES  
   - Country: Livingston, MT  
9. Camilleri, Laura (Fields)  
   - Gender: F  
   - Program: Micro & Immunology  
   - Country: Ukhia, CA  
10. Davis, Katie (Gerlach/Fields)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Green Creek, NC  
11. Franco, Lauren (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Moorpark, CA  
12. *Gordon, Melissa (Camper)  
    - Gender: F  
    - Program: Nursing  
    - Country: Heart Butte, MT  
13. Hunt, Kristopher (Carlson)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: Thorp, WI  
14. *Jackson, Benjamin (Klapper)  
    - Gender: M  
    - Program: Mathematics  
    - Country: Sheridan, OR  
15. Jackson, Matthew (Gerlach)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: Naples, FL  
16. *Jennings, Ryan (Carlson)  
    - Gender: M  
    - Program: LRES  
    - Country: Lexington, SC  
17. Kirkland, Catherine (Codd/Seymour)  
    - Gender: F  
    - Program: Civil/Environmental Eng  
    - Country: Bozeman, MT  
18. Koepnick, Hannah (Peyton)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Sherman, TX  
19. Krantz, Gregory (Fields)  
    - Gender: M  
    - Program: Micro & Immunology  
    - Country: Tinmouth, VT  
20. *Mailhiot, Sarah (Brown)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Oak Forest, IL  
21. Mery, Stephen (Lauchnor)  
    - Gender: M  
    - Program: Civil/Environmental Eng  
    - Country: Danielsville, MS  
22. McGill, Stacy (Carlson)  
    - Gender: M  
    - Program: Micro & Immunology  
    - Country: Minor Hill, TN  
23. Moll, Karen (Peyton)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Fairport, NY  
24. Pellizzaro, Aline (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Brazil  
25. Rathore, Muneeb (Peyton)  
    - Gender: M  
    - Program: Chem & Bio Eng (Fulbright)  
    - Country: Pakistan  
26. Schoen, Heidi (Carlson/Peyton)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: Geneva, IL  
27. Schweitzer, Hannah (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Chester, MT  
28. *‡Show, Jennifer (Camper)  
    - Gender: F  
    - Program: Nursing  
    - Country: Harlem, MT  
29. Sidar, Barkan (Wilking)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: Istanbul, Turkey  
30. Simkins, Jeffrey (Stewart)  
    - Gender: M  
    - Program: Chem & Bio Eng  
    - Country: The Netherlands  
31. *Smith, Heidi (Foreman)  
    - Gender: F  
    - Program: LRES  
    - Country: Westford, VT  
32. Zambare, Neerja (Gerlach)  
    - Gender: F  
    - Program: Chem & Bio Eng  
    - Country: India  
33. Zelaya, Anna (Fields)  
    - Gender: F  
    - Program: Micro & Immunology  
    - Country: Russellville, AR
**EDUCATION:**

**Graduate Students, 2015–2016**

**20: Chemical & Biological Engineering**

**MS: 9**
- 6 M Akyel, Arda: MS, Gerlach
- Ertuna, Cagan: MS, Peyton
- Pederson, Todd: MS, Peyton
- Schaefer, Robert: MS, Chang
- Spengler, Justin: MS, Carlson/Camper
- Zath, Geoffrey: MS, Chang

**PhD: 11**
- 5 M Hunt, Kristopher: PhD, Carlson
- Sidar, Barkan: PhD, Wilking
- Simkins, Jeffrey: PhD, Stewart
- Jackson, Matthew: PhD, Gerlach
- Rathore, Muneeb: PhD, Peyton

- 6 F Anjum, Sobia: PhD, Wilking
- Davis, Katie: PhD, Gerlach
- Koepnick, Hannah: PhD, Peyton
- Mailhiot, Sarah: PhD, Brown
- Schoen, Heidi: PhD, Peyton/Carlson
- Zambare, Neerja: PhD, Gerlach

**10: Civil / Environmental Engineering**

**MS: 7**
- 3 M Moss, Jefferson: MS, Stein
- Norton, Drew: MS, Lauchnor
- Wallis, Jack: MS, Stein

- 4 F Bodle, Kylie: MS, Lauchnor
- Stoick, Emily: MS, Lauchnor
- Thane, Abby: MS, Phillips
- Woodhouse, Shayla: MS, Lauchnor

**PhD: 3**
- 2 M Allen, Chris: PhD, Stein
- Mery, Stephen: PhD, Lauchnor

- 1 F Kirkland, Catherine: PhD, Codd

**3: Land Resources & Environmental Sciences**

**PhD: 3**
- 2 M Brame, Keenan: PhD, Camper
- Jennings, Ryan: PhD, Carlson
- Smith, Heidi: PhD, Foreman

**1: Mathematics**

**PhD: 1**
- 1 M Jackson, Benjamin: PhD, Klapper

**1: Materials Science**

**PhD: 1**
- 1 M Bernard, Garrett: PhD, Chang

**14: Microbiology & Immunology**

**MS: 2**
- 1 M White, Benjamin: MS, Franklin/James
- 1 F Doig, Lakotah: MS, Fields

**PhD: 12**
- 3 M Akiyama, Tatsuya: PhD, Franklin
- Krantz, Gregory: PhD, Fields
- McGill, Stacy: PhD, Carlson

- 9 F Corredor Arias, Luisa: PhD, Fields
- Beck, Ashley: PhD, Carlson
- Bell, Tiszka: PhD, Fields/Peyton
- Camilleri, Laura: PhD, Fields
- Franco, Lauren: PhD, Fields
- Moll, Karen: PhD, Peyton
- Schweitzer, Hannah: PhD, Fields
- Zelaya, Anna: PhD, Fields

**2: Nursing**

**PhD: 2**
- 2 F Gordon, Melissa: PhD, Camper
- Show, Jennifer: PhD, Camper

**TOTALS**

**Total Graduate Students: 53**
- Total MS: 20 10 M / 10 F
- Total PhD: 33 14 M / 19 F

**2: Health & Human Development**

**MS: 2**
- 2 F Martin, Christine: MS, Camper
- Nitzinger, Violeta: MS, Camper

**Total Male: 24**
**Total Female: 29**
EDUCATION:

Graduating with advanced degrees: June 2015–May 2016

Ryan deMontmollin Jennings, PhD, Land Resources and Environmental Sciences, May 2015
Inorganic carbon fixation and trophic interactions in high-temperature geothermal springs of Yellowstone National Park, WY, USA

Justin Spengler, MS, Civil Engineering, August 2015
Denitrification at the microscale in treatment wetlands

Benjamin Jackson, PhD, Mathematics, August 2015
Transport of dissolved and particulate material in biofilm-lined tubes and channels

Jeff Moss, MS, Civil Engineering, November 2015
Operation and optimization of a two-stage, vertical-flow treatment wetland in an alpine environment

Heidi Smith, PhD, Land Resources and Environmental Sciences, March 2016
Microbial community composition and the transformation of dissolved organic matter in supraglacial environments

Lakotah Doig, MS, Microbiology and Immunology, April 2016
Lipid accumulation in mixed photoautotrophic cultures from municipal wastewater

Geoffrey Zath, MS, Chemical Engineering, April 2016
A high-throughput, multiplexed microfluidic method utilizing an optically barcoded drop library

Chris Allen, PhD, Civil Engineering, May 2016
Nitrogen removal and associated greenhouse gas production from carbon limited synthetic wastewater in lab scale treatment wetlands
EDUCATION:

2016 MSU Student Research Celebration: CBE Participants

MSU’s undergraduate and graduate students shared their research at the annual Student Research Celebration Friday, April 15, 2016. Among the more than 200 students presenting their research, numerous students were connected with the Center for Biofilm Engineering.

TOPICAL SESSION
McNair Scholars Program
12:15 p.m.  SUB 233

Amanda Parsons – Chemical Engineering
Faculty Mentor – Joseph Seymour
“Formation and magnetic resonance imaging of alginate gels”

POSTERS

Graduate Students
Barkan Sidar: Chemical & Biological Engineering
Mentor: James Wilking, Seth Walk, Diane Bimczok --
Chemical & Biological Engineering, Microbiology & Immunology “Human intestinal organoids on a millifluidic chip”

Undergraduate Students
Stephanie Conrad: Chemical & Biological Engineering
Mentor: Ellen Lauchnor -- Civil Engineering
“Cultivation and kinetic analysis of Anammox bacteria grown in a sequencing batch reactor”

James Crawford: Chemical & Biological Engineering
Mentor: Brent Peyton -- Chemical & Biological Engineering “Culturing high value Astaxanthin as a biofuel co-product of Haematococcus Pluvialis”

Thayne Ekness: Chemical & Biological Engineering
Mentor: Seth Walk -- Microbiology & Immunology “Identification of nosocomial outbreaks of Clostridium difficile by isolate genotyping and antibiotic resistance profiling”

Brooke Filanoski: Chemical & Biological Engineering
Mentor: Adrienne Phillips -- Civil Engineering “Microbial induced calcium carbonate precipitation of coal combustion residuals”

Amy Fox: Chemical & Biological Engineering

Danielle Hanger: Psychology
Mentor: Keith Hutchison – Psychology “The Role of Working Memory Capacity and Cognitive Load in Producing and Detecting Deception”

Trace Hobbs: Chemistry & Biochemistry
Mentor: Robin Gerlach -- Chemical & Biological Engineering “Comparison of struvite precipitation under biotic and abiotic conditions”

Reece Hoskins: Civil Engineering
Mentor: Ellen Lauchnor, Christopher Allen -- Civil Engineering “Ennis treatment wetlands: A baseline study of organic pollution in the Blaine Spring Creek ecosystem”

Kayla Keepseagle: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering “Spatiotemporal distribution of oxygen in biofilms measured by MR”

Michelle Meagher: Chemical & Biological Engineering
Mentor: Brent Peyton -- Chemical & Biological Engineering “Cultivation and isolation of novel thermophilic archaea from Alkaline Springs in Yellowstone National Park”

Esther Oloff: Chemical & Biological Engineering
Mentor: Connie Chang -- Chemical & Biological Engineering “Manipulating the growth of organoids using microfluidic techniques”

Amanda Parsons: Chemical & Biological Engineering
Mentor: Joseph Seymour -- Chemical & Biological Engineering “Pressure driven flow through alginate gels”

Miguel Strunk: Chemical & Biological Engineering
Mentor: James Wilking -- Chemical & Biological Engineering “3D printing of biofilm scaffolds”

Shu Ying Wee: Chemical & Biological Engineering
Mentor: Christine Foreman -- Chemical & Biological Engineering “Role of pigments in Antarctic bacteria stress response”

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EDUCATION:

News Highlights

**National Science Foundation-Graduate Research Fellowship (NSF-GRFP)**

Eric Troyer, research technician for Robin Gerlach, professor of chemical and biological engineering, was awarded a National Science Foundation-Graduate Research Fellowship (NSF-GRFP). This NSF program recognizes outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based masters and doctoral degrees. Fellows benefit from a three-year annual stipend, a cost of education allowance for tuition and fees, the opportunity for international research and professional development, and the freedom to conduct their own research. Eric will be attending graduate school at the University of California at Berkeley. He graduated from MSU in December 2015 with a dual degree in chemical engineering and biological engineering.

**Two CBE doctoral candidates awarded NSF-EAPSI Fellowships**

Jeff Simkins and Sarah Mailhiot were awarded an 8-week fellowship in the National Science Foundation’s East Asia and Pacific Summer Institutes Program (EAPSI). The program is designed to introduce U.S. graduate students to East Asia and Pacific science and engineering in a research setting, and to help students initiate scientific relationships that will better enable future collaboration with foreign counterparts.

Simkins is a PhD candidate in chemical engineering and will be traveling to Australia to work with Drs. Michael Johns and Einar Fridjonsson at the University of Western Australia in Perth. Simkins is pioneering a novel, non-invasive magnetic resonance method for measuring oxygen distribution in a biofilm. In Perth, he will repurpose this technique for the early, non-invasive detection of biofouling (microbial degradation) in reverse osmosis membranes. Reverse osmosis membranes have become the gold standard for water desalination, but are very susceptible to microbial degradation. The hope of this project is that, if biofouling can be identified in the early stages, damage to the membrane can be prevented. Simkins works for CBE affiliated faculty members Joseph Seymour and Philip Stewart, both professors of chemical and biological engineering.

Mailhiot is a PhD candidate in mechanical engineering and she will travel to New Zealand to work with Dr. Petrik Galvosas at the Victoria University of Wellington. Mailhiot currently works in MSU’s Magnetic Resonance Lab where she studies how the lining of the human joint, known as cartilage, changes during arthritis. In Wellington, she will study how one protein in cartilage—collagen—affects the fluid-solid interactions in human cartilage using collagen hydrogels as a model system. This project will show how damage to collagen is related to arthritis in human cartilage. Mailhiot’s advisors are Ron June, assistant professor in mechanical and industrial engineering, Joseph Seymour, and CBE affiliated faculty member Jennifer Brown, associate professor of chemical and biological engineering.

**CBE PhD student takes first place at Three-Minute Thesis competition**

For a second straight year a group of graduate students from Montana State University gave the public a chance to hear an 80,000-word thesis distilled into 180 seconds. MSU hosted the Three-Minute Thesis event on March 3rd at the Procrastinator Theater in the Strand Union Building.

The seven finalists chosen for the 3-Minute Thesis competition are from disciplines across MSU’s College of Engineering. The finalists explained, very concisely, how their research might affect the public. Presenters were required to condense their research into a brief, engaging presentation for a non-specialist audience, using a single presentation slide.

Finalist Jeff Simkins took first place in the competition with his presentation “MRI: A new tool in the fight to end infectious disease.” For a list of the finalists go to MSU News Service: “Three-Minute Thesis event set for March 3 at MSU”
2016 MSU Awards for Excellence

Forty of Montana State University’s top seniors and their faculty and staff mentors were recognized Tuesday, February 16th at the 34th annual Awards for Excellence banquet held on the MSU campus.

The event is co-hosted by the MSU Alumni Association and the Bozeman Chamber of Commerce. 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. CBE undergraduate student Kathryn Pintar, chemical and biological engineering, was honored at the ceremony.

The award-winning students each selected a mentor who was recognized with them at the event. Pintar selected mentor Ross Carlson, associate professor of chemical and biological engineering and CBE-affiliated faculty member.

At the same ceremony, Pintar was one of eight MSU seniors to receive the 2016 Torlief Aasheim Community Involvement Award, the university’s top award for student service. Pintar was again recognized for her academic achievements as well as her volunteer service on campus and in the community.

To read more about Pintar’s community involvement go to MSU News: http://www.montana.edu/news/15980/eight-msu-students-win-torley-awards-for-community-involvement


MSU-CBE undergraduate wins regional Montana Mathematics Modeling Challenge

Miguel Strunk, MSU-CBE undergraduate student in bioengineering, was featured by Montana State University for his work on a team that took first place in an essay competition at the Montana Mathematics Modeling Challenge. Fifteen teams from five colleges participated in the competition, which took place October 24–25 at Carroll College in Helena, Montana. Strunk and his teammates—Kelsey Philipsek (civil engineering) and Sarah Juedeman (electrical engineering)—took top honors in the regional contest that challenged competitors to develop a mathematical model to solve real-world problems in just 24 hours. To read about their quick-thinking assignment, go to MSU News Service: “MSU team wins regional Montana Mathematics Modeling Challenge”

2016 W.G. Characklis Outstanding Graduate Student Award

The CBE is proud to announce the 2016 W.G. Characklis Outstanding Graduate Student Award recipient—Katherine “Katie” Davis. Katie was recognized for her exceptional management of her PhD project in the face of significant research challenges, her role as a valuable resource for colleagues and industrial collaborators on coal bed methane research, and her ability to work successfully with students, staff, and faculty across disciplines. The W.G. Characklis Award is presented annually to 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

Catherine (Cat) Kirkland, PhD student in civil engineering, received CBE’s Student Lab Citizen Award. Kirkland was recognized for strong work ethic, productivity, and excellence in research; as well as for taking initiative in establishing the Graduate Seminar Series, organizing the Three Minute Thesis Competition, supporting Engineers Without Borders, and mentoring students through College of Engineering programs. The Student Lab Citizen Award is open to any CBE student and recognizes a student’s exceptional responsibility and good citizenship in his or her work at the CBE. Attributes that are considered in selecting awardees include: attention to laboratory safety and cleanliness, considerate use of shared spaces, respect for equipment and proper protocols, willingness to help fellow students and staff, strong work ethic, and commitment to CBE goals. The award is presented in honor of John Neuman, the CBE’s Technical Operations Manager from 1994–2008 and was established by John’s family after his death in 2011.

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## EDUCATION:

### CBE Seminar Series: Fall 2015

Montana State University, Roberts Hall 321, 4:10pm

<table>
<thead>
<tr>
<th>Date</th>
<th>Speaker</th>
<th>Affiliation</th>
<th>Title/Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug 27</td>
<td>No Seminar—First Week of Classes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept 3</td>
<td>Ashley Beck</td>
<td>PhD Student, Microbiology &amp; Immunology, MSU, CBE</td>
<td>Metabolic pathway analysis of light acclimation in a thermophilic cyanobacterium</td>
</tr>
<tr>
<td>Sept 10</td>
<td>No Seminar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sept 17</td>
<td>Dr. Anne Camper</td>
<td>Regents Professor, Civil Engineering; Associate Dean, College of Engineering, MSU, CBE</td>
<td>Navigating the application and interview process for a faculty position</td>
</tr>
<tr>
<td>Sept 24</td>
<td>Dr. Vernita Gordon</td>
<td>Assistant Professor, Physics, University of Texas at Austin</td>
<td>Mechanical initiation and robustness of <em>Pseudomonas aeruginosa</em> biofilms</td>
</tr>
<tr>
<td>Oct 1</td>
<td>No Seminar</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct 8</td>
<td>Laura Camilleri</td>
<td>PhD Student, Microbiology &amp; Immunology, MSU, CBE</td>
<td>Dynamics of a methanogenic, symbiotic biofilm</td>
</tr>
<tr>
<td>Oct 15</td>
<td>Dr. Lynette Cegelski</td>
<td>Asst. Professor, Chemistry, Stanford University, Palo Alto, California</td>
<td><em>E. coli</em> biofilms: Lessons from small molecules and a big magnet</td>
</tr>
<tr>
<td>Oct 22</td>
<td>Luisa Corredor-Arias, Karen Moll</td>
<td>PhD Students, Microbiology &amp; Immunology, MSU, CBE</td>
<td>The truth about genome assembly: Distilling our data</td>
</tr>
<tr>
<td>Oct 29</td>
<td>Tatsuya Akiyama</td>
<td>PhD Student, Microbiology &amp; Immunology, MSU, CBE</td>
<td>Mechanism for maintaining cell viability during bacterial dormancy</td>
</tr>
<tr>
<td>Nov 5</td>
<td>Dr. Zack Jay</td>
<td>Postdoctoral Researcher, CBE</td>
<td><em>In silico</em> analysis of electron partitioning and energy conservation in <em>Clostridium thermocellum</em> str. DSM 1313</td>
</tr>
<tr>
<td>Nov 12</td>
<td>Dr. Robin Gerlach</td>
<td>Professor, Chemical &amp; Biological Engineering, MSU, CBE</td>
<td>Establishing bioinformatics and reactive transport modeling expertise in bio(film) engineering at MSU— A sabbatical leave review</td>
</tr>
<tr>
<td>Nov 19</td>
<td>No Seminar— CBE Meeting</td>
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</tr>
<tr>
<td>Nov 26</td>
<td>No Seminar— Thanksgiving</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec 3</td>
<td>Dr. Robert Kokoska</td>
<td>Program Manager, Microbiology Life Sciences Division, U.S. Army Research Office</td>
<td>Basic Research Priorities— Army Research Office Microbiology Program and Life Sciences</td>
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</tbody>
</table>

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## EDUCATION:
### CBE Seminar Series: Spring 2016
Montana State University, Roberts Hall 321, 4:10pm

<table>
<thead>
<tr>
<th>Date</th>
<th>Speaker</th>
<th>Affiliation</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 14</td>
<td></td>
<td>No seminar—First week of classes</td>
<td></td>
</tr>
<tr>
<td>Jan 21</td>
<td>Logan Hodgskiss</td>
<td>Research Scientist, CBE</td>
<td>Cultivating microalgae in coal bed methane production water</td>
</tr>
<tr>
<td>Jan 28</td>
<td></td>
<td>No Seminar – CBE semi-annual rally</td>
<td></td>
</tr>
<tr>
<td>Feb 4</td>
<td>Dr. Jennifer DuBois</td>
<td>Assistant Professor, Chemistry &amp; Biochemistry, MSU</td>
<td>The tale of the tetrapyrrole: Making, breaking, and using heme in Gram positive bacteria</td>
</tr>
<tr>
<td>Feb 11</td>
<td>Dr. Jennifer Brown</td>
<td>Associate Professor, Chemical &amp; Biological Engineering, MSU, CBE</td>
<td>Using magnetic resonance to observe recrystallization inhibition in polycrystalline ice due to ice binding protein activity</td>
</tr>
<tr>
<td>Feb 18</td>
<td>Garrett Moraski</td>
<td>Research Scientist, Chemistry &amp; Biochemistry, MSU</td>
<td>Cats versus Grizzlies: Small molecules and their potential to inhibit biofilms</td>
</tr>
<tr>
<td>Feb 25</td>
<td>Dr. Paul Sturman Dr. Matthew Fields</td>
<td>Industrial Coordinator, CBE Director, CBE</td>
<td>Report on the CBE regulatory meeting in Washington D.C.</td>
</tr>
<tr>
<td>Mar 3</td>
<td>Robert Schaefer</td>
<td>Masters Student, Chemical &amp; Biological Engineering, MSU, CBE</td>
<td>Fluorescence detection and sorting for biological assays in droplet microfluidics</td>
</tr>
<tr>
<td>Mar 10</td>
<td>Dr. Margaux Meslé</td>
<td>Postdoctoral Researcher, CBE</td>
<td>Coal-dependent methanogenesis in a high-pressure, flow-through reactor</td>
</tr>
<tr>
<td>Mar 17</td>
<td></td>
<td>No seminar—Spring break</td>
<td></td>
</tr>
<tr>
<td>Mar 24</td>
<td>Dr. Maria Hadjifrangiskou</td>
<td>Asst. Professor, Pathology, Microbiology, &amp; Immunology, School of Medicine, Vanderbilt Univ., Nashville, Tennessee</td>
<td>Identifying mechanisms of heterogeneity within UPEC biofilms</td>
</tr>
<tr>
<td>Mar 28</td>
<td>Dr. Forest Rohwer</td>
<td>Professor, Biology, San Diego State University, San Diego, California</td>
<td>The cystic fibrosis lung: Ecology to personalized medicine</td>
</tr>
<tr>
<td>Mar 31</td>
<td>Dr. Joann Mudge</td>
<td>Senior Research Scientist, National Center for Genome Resources, Santa Fe, New Mexico</td>
<td>Enabling biology with next generation sequencing technologies</td>
</tr>
<tr>
<td>Apr 7</td>
<td>Undergraduate Research Day</td>
<td>Erika Avera, Cell Biology and Neuroscience, MSU, CBE</td>
<td><em>Propionibacterium acnes</em> biofilms grown in a drip-flow reactor system</td>
</tr>
<tr>
<td>Apr 7</td>
<td></td>
<td>Trace Hobbs, Chemistry, MSU, CBE</td>
<td>Laboratory urinary tract model to investigate infectious kidney stone development</td>
</tr>
<tr>
<td>Apr 14</td>
<td>Dr. Shawn Starkenburg</td>
<td>Scientist 3, Los Alamos National Lab, Los Alamos, New Mexico</td>
<td>Advances in algal genomics</td>
</tr>
<tr>
<td>Apr 21</td>
<td>Dr. Luke McKay</td>
<td>NASA Astrobiology Institute Postdoctoral Fellow, MSU, CBE</td>
<td>Microbial ecology of the sedimentary subsurface of two thermal areas in Yellowstone National Park</td>
</tr>
<tr>
<td>Apr 28</td>
<td></td>
<td>No Seminar – Last week of classes</td>
<td></td>
</tr>
</tbody>
</table>

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TECHNOLOGY TRANSFER:

**Industrial Associates, 2015–16**

Bold, new  *Small business member

3M
Accuratus Lab Services*
American Chemet*
BASF
Baxter Healthcare
BP
Church & Dwight Company
Colgate-Palmolive
Dow Corning Corporation
Dow Microbial Control
Ecolab
ICU Medical, Inc.
KCI, An Acelity Company
Lonza
Masco Corporation
NASA
NCH Corporation
Next Science
Novozymes

PPG Industries
Procter & Gamble Company
Sani-Marc, Inc.
SANUWAVE Health*
Sealed Air Corporation
Sterilex*
STERIS
The Clorox Company
The Sherwin-Williams Company
W.L. Gore & Associates
Zimmer Biomet
TECHNOLOGY TRANSFER:
Montana Biofilm Meeting
July 13–16, 2015

Monday, July 13
6:00–8:30 p.m.
Pre-registration and welcome reception
Larkspur Foyer, Hilton Garden Inn, Bozeman

Tuesday, July 14
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
Chuck Pettigrew, Chair, CBE Industrial Program; Principal Scientist, Procter & Gamble
Matthew Fields, CBE Director

SESSION 1:
Oilfield Biofilms
8:10-8:15
Session Introduction
Paul Sturman

8:15–8:45
Visualization and quantification of biofilm removal
TJ Tidwell, Principal Microbiologist, Nalco Champion Company, Sugar Land, TX

8:45-9:20
Mechanisms and mitigation of severe microbial corrosion by sulfate-reducing bacteria
Dennis Enning, Senior Research Engineer, ExxonMobil Upstream Research Company, Houston, TX

9:20-9:50
Modeling the growth and chemistry of sulfate-reducing biofilms
Robin Gerlach, Professor, Chemical & Biological Engineering, MSU-CBE

9:50–10:20
Networking Break

10:20-10:50
Thiosulfate-reducing microbes in oil field systems: Too often overlooked
Kathleen Duncan, Research Associate Professor, Microbiology & Plant Sciences, University of Oklahoma, Norman, OK

10:50-11:20
Transformation of hydraulic fracturing chemicals underground—Focus on glutaraldehyde
Genevieve Kahrilas, PhD Candidate, Chemistry, Colorado State University, Fort Collins, CO

11:20-11:50
Enhancement of biogenic coalbed methane production
Katie Davis, PhD student, Chemical & Biological Engineering, MSU-CBE

12:00–1:00
Catered lunch, Hilton Garden Inn

SESSION 2:
Regulatory Agency Update
1:00-1:30
Meeting Highlights: Anti-biofilm Technologies—Pathways to Product Development, Feb 2015
Paul Sturman

1:30-1:55
Biofilm claims for antimicrobial products: U.S. EPA regulatory perspective
Steve Tomasinio, Senior Scientist, U.S. EPA Office of Pesticide Programs, Fort Meade, MD

1:55-2:20
Results from continued optimization of the Single Tube Method
Darla Goeres, Associate Research Professor, Chemical & Biological Engineering, MSU-CBE

CBE Open House: Lab demonstrations and poster session
3:00–5:00
3rd Floor EPS Building, MSU

Wednesday, July 15
7:30–8:00 a.m.
Registration and continental breakfast
Larkspur Foyer, Hilton Garden Inn

SESSION 3:
Medical Biofilms
8:00–8:05
Session introduction
Garth James, Associate Research Professor, Chemical & Biological Engineering, MSU-CBE

8:05-8:30
3D imaging of oral biofilms
Garth James

8:30–9:00
Clostridium difficile and health care-associated infection
Seth Walk, Assistant Professor, Microbiology & Immunology, MSU

9:00-9:30
In vitro analysis of Clostridium difficile biofilms: Imaging and antimicrobial treatment
Elinor deLancey Pulcini, Assistant Research Professor, Chemical & Biological Engineering, MSU-CBE

9:30-10:00
Networking Break

10:00–10:30
Antimicrobial and anticancer β2, 2-amino acid derivatives: Peptide mimetics with potential for oral administration
Dominik Ausbacher, CBE visiting Postdoctoral Researcher, Department of Pharmacy, UiT—The Arctic University of Norway, Tromsø, Norway
10:30–11:00  
**Staphylococcus aureus** biofilms and keratinocyte apoptosis  
*Kelly Kirker*, Assistant Research Professor, Chemical & Biological Engineering, MSU-CBE

**YOUNG INVESTIGATORS**  
11:00–11:30  
Phenazine antibiotic inspired discovery of biofilm-eradicating small molecules  
*Robert Huigens III*, Assistant Professor, Medicinal Chemistry, University of Florida, Gainesville, FL

11:30–12:00  
Coupling multi-scale in situ determination of biofilm mechanical properties to mathematical modeling of biofilm fluid-structure interaction  
*Juan Pavissich*, Postdoctoral Researcher, Department of Biotechnology, Delft University of Technology, The Netherlands

12:00–12:10  
Presentation of CBE awards  
*Phil Stewart*, Professor, Chemical & Biological Engineering, MSU-CBE

12:10–1:10  
Catered lunch, Hilton Garden Inn

**SESSION 4:**  
**Biofilm Mineral Interactions**  
1:10–1:15  
Session introduction  
*Robin Gerlach*

1:15–1:35  
From speleogenesis to sewer corrosion  
*Phil Stewart*

1:35–2:15  
Subaerial biofilms: New horizons in stone biodeterioration research  
*Federica Villa*, CBE Visiting Postdoctoral Researcher, University of Milan, Italy

2:15–2:45  
Biomineralization of kidney stones  
*Logan Schultz*, Postdoctoral Researcher, MSU-CBE

2:45–3:15  
Overview of biofilm mediated mineralization and engineering applications  
*Adie Phillips*, Assistant Professor, Civil Engineering, MSU-CBE

3:30–5:00 Business Meeting  
Hilton Garden Inn

6:00 Dinner/Banquet  
Rockin’ TJ Ranch, Bozeman

**Thursday, July 16**  
7:30–8:00 a.m.  
Registration & continental breakfast  
Larkspur Foyer, Hilton Garden Inn

**SESSION 5:**  
**Biofilm Fundamentals**  
8:05–8:10  
Session introduction  
*Matthew Fields*

8:10–8:35  
Novel extracellular membrane structures in a sulfate-reducing biofilm  
*Lauren Franco*, PhD student, Microbiology & Immunology, MSU-CBE

8:35–9:00  
Antimicrobial tolerance in biofilms  
*Phil Stewart*

9:25–9:50  
Biofilm formation mechanisms of *Pseudomonas aeruginosa* predicted via metabolic models  
*Francisco Vital-Lopez*, Research Scientist, DoD Biotechnology High-Performance Computing Software Applications Institute (BHSAI), Frederick, MD

**SESSION 6:**  
**New Tools & Methods**  
10:20–10:25  
Session introduction  
*Jim Wilking*, Assistant Professor, Chemical & Biological Engineering, MSU-CBE

10:25–10:50  
Quantifying biofilm characteristics over time from 3-D confocal microscope movies  
*Al Parker*, Assistant Research Professor, Mathematical Sciences; Bio-statistician, MSU-CBE

10:50–11:15  
Drop-based microfluidics for high-throughput biological assaying  
*Connie Chang*, Assistant Professor, Chemical & Biological Engineering, MSU-CBE

11:15–11:40  
Developing materials-based understanding of biofilm mechanics  
*Jim Wilking*

11:40–12:05  
Applications of microelectrodes for biofilm kinetics and inhibition studies  
*Ellen Lauchnor*, Assistant Professor, Civil Engineering, MSU-CBE
## WORKSHOP:
### Biofilm Methods for Your Lab
#### July 13, 2015

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
</tr>
</thead>
</table>
| 9:00–9:15 | **Welcome** — *CBE Director*  
- Group introductions                                                  | EPS 323        |
| 9:15–9:30 | **An Introduction to Biofilms** — *Paul Sturman*                                                | EPS 323        |
| 9:30–10:15 | **Adapting Standardized Biofilm Growth Methods for Other Bacteria** — *Darla Goeres*           | EPS 323        |
| 10:15–10:30 | **Morning Refreshments**                                                                         | EPS 323        |
| 10:30–11:15 | **Adapting Biofilm Growth Methods around the CBE** —  
- Medical Biofilms  
  - *Garth James, Medical Biofilms Lab*  
- Biofilms in Cold Environments  
  - *Emily Bermel, Microbial Ecology & Biogeochemistry Lab*  
- Anaerobic Biofilms  
  - *Sara Altenburg, Physiology & Ecology Lab* | EPS 316/334/336 |
| 11:15–11:45 | **Keepin’ it Real: The R’s of Statistical Methods** — *Al Parker*                               | EPS 323        |
| 11:45–1:00 | **LUNCH** — Computer Science Conference Room                                                      | EPS 347        |
| 1:00–2:15 | **Adapting & Optimizing Biofilm Growth Methods in the Standardized Biofilm Methods Laboratory** —  
  - *Lindsey Lorenz, Kelli Buckingham-Meyer, Diane Walker, Jennifer Summers, Stephen Pedersen, Grace Dickerman* | EPS 301        |
| 2:15–2:30 | **Afternoon Refreshments**                                                                       | EPS 323        |
| 2:30–3:00 | **Microscopy: Overview of the Treatment Flow Cell with CSLM & Imaging Reactor Coupons** — *Lindsey Lorenz* | EPS 326/7 |
| 3:00–3:15 | **Treatment Flow Cell Movies** — *Kelli Buckingham-Meyer*                                        | EPS 323        |
| 3:15–3:45 | **Quantitation via Image Analysis** — *Al Parker*                                                 | EPS 323        |
| 3:45–4:00 | **Wrap-Up/Discussion**                                                                           | EPS 323        |
## TECHNOLOGY TRANSFER:
### Anti-Biofilm Technologies: Pathways to Product Development
**February 10, 2016      Arlington, VA**

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
</table>
| 7:15 a.m.–8:00 a.m. | Registration and continental breakfast, Salon foyer, Studio B       | Matthew Fields, CBE Director; Professor, Microbiology & immunology, MSU  
Paul Sturman, CBE Industrial Coordinator; Chuck Pettigrew, Chair, CBE Industrial Associates Program; Principal Scientist, Procter & Gamble |
| 8:00 a.m.–8:10 a.m. | Welcome and opening remarks, Salons 1–3                              | K. Scott Phillips, Reg. Research Scientist, Center for Devices & Radiological Health, FDA  
Phil Stewart, Professor, Chemical & Biological Engineering, MSU, CBE  
Brittany Goldberg, MD, Medical Officer, CDRH/OIR Div. of Microbiology Devices, FDA |
| 8:10 a.m.–8:15 a.m. | SESSION 1: Medical Device Technologies  
Phil Stewart, Professor, Chemical & Biological Engineering, MSU, CBE  
Brittany Goldberg, MD, Medical Officer, CDRH/OIR Div. of Microbiology Devices, FDA |
| 8:15 a.m.–8:45 a.m. | The central role of biofilm in contamination and colonization of dermal fillers | Tom Schaer, VMD, Director, Preclinical Research Services, School of Veterinary Medicine, Univ. of Pennsylvania |
| 8:45 a.m.–9:15 a.m. | Biofilm initiation on medical devices                                | Brett Baker, Founder & CSO, Microbion  
Elaine Black, Principal Regulatory Specialist, Ecolab  
Al Parker, CBE Bio-statistician; Assistant Research Professor, Mathematics, MSU  
Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 9:15 a.m.–9:45 a.m. | Clinical perspectives on microbial biofilms and medical device infections | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 9:45 a.m.–10:15 a.m. | BREAK                                                                | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 10:15 a.m.–10:45 a.m. | Animal models and implant associated infection                      | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 10:45 a.m.–11:15 a.m. | Regulatory development of an anti-biofilm drug product               | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 11:15 a.m.–12:00 p.m. | Session 1 wrap up and panel discussion                               | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 12:00 p.m.–1:00 p.m. | Networking Lunch, Studio B                                           | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 1:00 p.m.–1:10 p.m. | SESSION 2: Surface Disinfection Technologies  
Session Introduction | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 1:10 p.m.–1:40 p.m. | Assessment of biofilm on dry hospital surfaces: How this informed development of model test systems | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 1:40 p.m.–2:05 p.m. | Biofilm: Real world problems, solutions and regulations—An industry perspective | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 2:05 p.m.–2:30 p.m. | Use of the Single Tube Method to evaluate the efficacy of disinfectants against *Pseudomonas* biofilm: 2015 Collaborative study | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 2:30 p.m.–2:55 p.m. | BREAK                                                                | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 2:55 p.m.–3:20 p.m. | Using statistical confidence and power to assess performance standards of antimicrobial test methods | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 3:20 p.m.–3:45 p.m. | A regulatory model harmonized with the product development pathway   | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 3:45 p.m.–4:10 p.m. | Lighting the way to long-lasting biofilm remediation—Photochemistry meets biology | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 4:10 p.m.–5:00 p.m. | Session 2 wrap up and panel discussion                               | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
| 5:30 p.m.–7:30 p.m. | Reception, Salon foyer                                               | Marc Rinaldi, Regulatory Microbiologist, Antimicrobials Division, Microbiology Laboratory Branch, OPP, EPA |
# TECHNOLOGY TRANSFER:
## Beneficial-Biofilms Workshop
### February 9, 2016      Arlington, VA

<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:30 a.m.–8:15 a.m.</td>
<td>Registration and continental breakfast, Studio E, Studio F</td>
<td>Matthew Fields, CBE Director; Professor, Microbiology &amp; immunology, MSU</td>
</tr>
<tr>
<td>8:15 a.m.–8:30 a.m.</td>
<td>Welcome and opening remarks, Studio E</td>
<td>Paul Sturman, CBE Industrial Coordinator; Chuck Pettigrew, Chair, CBE Industrial Associates Program; Principal Scientist, Procter &amp; Gamble</td>
</tr>
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</table>

### SESSION 1: Industry Perspectives
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<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>8:30 a.m.–9:00 a.m.</td>
<td>Beneficial biofilms in crop care and protection</td>
<td>Ted Deisenroth, Principal Scientist, BASF</td>
</tr>
<tr>
<td>9:00 a.m.–9:30 a.m.</td>
<td>Beneficial microbes in spaceflight or: How I learned to stop worrying and love the bugs</td>
<td>Leticia Vega, Scientist, Water Recovery Systems Group, NASA-Johnson Space Ctr.</td>
</tr>
<tr>
<td>9:30 a.m.–10:00 a.m.</td>
<td>BREAK</td>
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</table>

### Session 2: Regulatory Perspectives
<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 a.m.–10:30 a.m.</td>
<td>Beneficial colonization: A researcher’s perspective on medical devices</td>
<td>Eva Wang, ORISE Research Fellow, Center for Devices &amp; Radiological Health, FDA</td>
</tr>
<tr>
<td>10:30 a.m.–11:00 a.m.</td>
<td>Microbial pesticide ecological risk assessment</td>
<td>Mike Mendelsohn, Senior Regulatory Specialist, Biopesticides and Pollution Prevention Division, Office of Pesticide Programs, EPA</td>
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</tbody>
</table>

### Session 3: Academic Perspectives
<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00 a.m.–11:30 a.m.</td>
<td>Beneficial bacteria associated with the human body</td>
<td>Garth James, Manager, Medical Biofilms Laboratory, CBE; Assistant Research Professor, Chemical &amp; Biological Engineering, MSU</td>
</tr>
<tr>
<td>11:30 a.m.–12:00 p.m.</td>
<td>Altering oral biofilm communities to maintain dental health</td>
<td>Alexander H. Rickard, Assistant Professor, Epidemiology, School of Public Health, University of Michigan</td>
</tr>
<tr>
<td>12:00 p.m.–1:00 p.m.</td>
<td>Catered Lunch, Studio F</td>
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</table>

### Academic Perspectives continued
<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:00 p.m.–1:30 p.m.</td>
<td>Energy-related biofilms</td>
<td>Matthew Fields</td>
</tr>
<tr>
<td>1:30 p.m.–2:00 p.m.</td>
<td>Biofilms in biomineralization, bioremediation, and biocorrosion</td>
<td>Brent Peyton, Professor, Chemical &amp; Biological Engineering, MSU, CBE</td>
</tr>
<tr>
<td>2:00 p.m.–2:30 p.m.</td>
<td>Energy recovery in wastewater using electrogenic biofilms in microbial fuel cells</td>
<td>Birthe Venø Kjellerup, Assistant Professor, Civil &amp; Environmental Engineering, University of Maryland</td>
</tr>
<tr>
<td>2:30 p.m.–3:00 p.m.</td>
<td>BREAK</td>
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<tr>
<td>3:00 p.m.–4:00 p.m.</td>
<td>Discussion &amp; Brainstorming Session</td>
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</tbody>
</table>
TECHNOLOGY TRANSFER:
NEWS HIGHLIGHTS

CBE welcomed new members to its Industrial Associates Program:

Lonza Specialty Products

Lonza is one of the world’s leading suppliers to the pharma, biotech, and specialty ingredient markets. Their products and services range from active pharmaceutical ingredients and stem-cell therapies to drinking water sanitizers; industrial preservatives to microbial control solutions that combat dangerous viruses, bacteria and other pathogens; and manufacturing of vitamin B compounds and organic personal care ingredients to agricultural services and products. Denise Taylor is the CBE designated representative. Read more about Lonza at: http://www.lonza.com

PPG Industries

PPG Industries was founded in 1883 when Capt. John B. Ford and John Pitcairn started the first commercially successful plate glass factory in the US at Creighton, Pennsylvania. Known as the Pittsburgh Plate Glass Co., the enterprise focused on innovation and quality. After 130 years, PPG is a global supplier of paints, coatings, optical products, specialty materials, glass and fiber glass. Steve Zawacky is the CBE designated representative. For more information about the company go to: http://corporate.ppg.com/Home.aspx

View the list of CBE Industrial Associates

Read about CBE membership

Darla Goeres appointed to NASA’s Planetary Protection Subcommittee and elected chair of ASTM Committee E35

In 2015, CBE affiliated faculty member Darla Goeres, associate research professor of chemical and biological engineering, elevated her outreach efforts within two professional organizations. Goeres was appointed to NASA’s Advisory Council Planetary Protection Subcommittee (PPS) and was also elected chairwomen of ASTM International Main Committee E35 for a two year term.

NASA’s planetary protection subcommittee is responsible for programs, policies, plans, hazard identification and risk assessment, and other matters pertinent to the Agency’s responsibilities for biological planetary protection. PPS supports the advisory needs of the NASA administrator and all mission directorates and protection officers.

Read more about the PPS at http://science.nasa.gov/science-committee/subcommittees/nac-planetary-protection-subcommittee/

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. Committee E35 is responsible for the development of standard definitions, classifications, appropriate test methods, and recommended practices relating to efficacy, safety, quality, and impact in appropriate environments of pesticides, antiseptic and antimicrobial agents, biological agents, devices, and equipment.
TECHNOLOGY TRANSFER:
Industry and Agency Interactions

CBE hosted Sandeep Tripathi from BD Medical, Franklin Lakes, NJ, on June 4, 2015.

CBE hosted two representatives from Lonza Specialty Products on September 1–2, 2015. Denise Taylor, Leader for the Center of Excellence in Microbiology, and Andreas Heyl, Chief Technology Officer, met with several CBE faculty and researchers to learn about CBE’s research areas and discuss potential collaborative projects. Lonza joined the CBE industrial associates program in June 2015.

Paul Sturman visited Kimberly-Clark to discuss membership. Neenah, WI, on September 14, 2015.

CBE hosted two representatives from American Chemet on October 13, 2015. Colin Anderson, R&D director, and Neal Blossom, director of global environmental and regulatory affairs, met with Paul Sturman and members of CBE’s standardized biofilm methods laboratory to discuss several testing projects.

CBE hosted Evgenya Shelobolina and Dorian Lust from NorthStar Medical Radioisotopes, Madison, WI, on October 14-16, 2015.

Matthew Fields, Darla Goeres, Al Parker, and Kelli Buckingham-Meyer visited Baxter Healthcare on October 27, 2015. Baxter, a CBE industrial member, invited the group to present their research on biofilms to the entire company. Presentations included: “What is a biofilm?” M. Fields

The value of CBE’s industrial membership, M. Fields

Standard methods and disinfectant efficacy testing, D. Goeres

Microscopy and treatment flow cell, A. Parker & K. Buckingham-Meyer

Phil Stewart visited Lonza Specialty Products on November 10, 2015. Stewart was invited to present “The science of biofilm control with antimicrobial agents,” to about twenty-five employees as well as others who connected remotely from Lonza’s offices in New Jersey, South Africa, and Switzerland. Stewart’s visit coincided with a twice-yearly meeting of the company’s Research & Technology Council so all of the technical leaders of Lonza (including Pharma), and the CEO were in the audience. During his visit, Stewart met with leadership from the water treatment group and other departments to discuss activity related to swimming pools, endoscope disinfection, paint preservation, cooling water systems, and anti-biofilm coatings.

Matthew Fields hosted Angela McLean, State of Montana Lieutenant Governor on November 16, 2015.

On January 28, 2016 representatives from PPG visited the CBE. Peter Votruba-Drzal, Steve Zawacky, and Tom Kelly toured the CBE, met with several faculty and researchers, and discussed membership with Paul Sturman.


Paul Sturman visited PPG in Cleveland, OH, on April 4, 2016.

Garth James presented the seminar, “Beneficial biofilm and the human body,” at Johnson & Johnson Advanced Sterilization Products in Irvine, California, April 4, 2016 and BASF in Tarrytown, NY, on April 6, 2016.

Diane Walker, CBE research engineer, hosted Dr. Fernanda Martins, Development Engineer, 3M Infection Prevention Division, Sumaré, Brazil, April 20–21, 2016.

Paul Sturman hosted Mike Healey, Dave McDonald, and Tim Schroeder from Kohler April 27, 2016.


Paul Sturman hosted Jean-Yves Delannoy and Ahmed Alsayed from Solvay, Bristol, PA, on May 9, 2016.

Matthew Fields hosted Steven Markovich, Arun Bose, and Djuna Gulliver from US Department of Energy (DOE) National Energy Technology Lab, South Park Township, PA, on May 11, 2016.

Diane Walker, CBE research engineer made two visits in Missoula, MT, on May 18, 2016:

Follow-up visit to Cliff Bradley, President, Montana BioAgriculture, Inc.

Meet with fungal researcher Andrea Stierle at University of Montana.


Back to Table of Contents
Garth James hosted Dr. Ondrej Slaby of Masaryk University Central European Institute of Technology, Brno, Czech Republic, and Dr. Manu N. Capoor of Rockefeller University Lab of Bacterial Pathogenesis and Immunology, New York, NY on May 19, 2016.

OUTREACH:

News Highlights

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Cover image: *Proceedings of National Academy of Sciences, August 2015*

Researchers at the University of Montana earned the cover image of the August 2015 issue of *Proceedings of The National Academy of Sciences (PNAS)* with images collected at the CBE microscopy facility. Assistant professor John McCutcheon and PhD student James Van Leuven from the University of Montana’s Division of Biological Sciences worked with Betsey Pitts, CBE microscope facilities manager, to obtain the cover images using the confocal scanning laser microscope at MSU’s Center for Biofilm Engineering. McCutcheon has also collaborated with CBE affiliated faculty member Phil Stewart, professor of chemical and biological engineering.

“This collaboration reiterates the CBE’s commitment to interdisciplinary research, not only across MSU’s campus. The CBE supports an exceptional state-of-the-art microscope facility and we are happy to share our resources with collaborators from other Montana universities to advance research,” Pitts said.

*Proceedings of National Academy of Sciences*
August 2015; 112(33): 10101–10103.

To view the cover image and the entire PNAS issue go to: “[CBE collaboration earns PNAS cover image](http://bit.ly/1L6QBRz)

**CBE’s Standardized Biofilm Methods Laboratory hosted workshop at ASM Biofilms Conference**

CBE’s Standardized Biofilm Methods Laboratory hosted a workshop “Standardized Biofilm Methods: Development and Application,” at the ASM Biofilms conference in Chicago, Illinois, October 24–29, 2015. The workshop was one of three pre-meeting workshops offered by the ASM Biofilms conference, which is the premier science-oriented international biofilm meeting planned for the next two years.

To view the workshop agenda, go to: [http://bit.ly/1L6QBRz](http://bit.ly/1L6QBRz)


**MSU’s NanoDays Event**

CBE faculty and researchers participated in MSU’s 2016 NanoDays on February 29, 2016. Connie Chang, assistant research professor in chemical and biological engineering, presented “Tiny test tubes created using the magic of microfluidics,” to fifth graders from local elementary schools. Chang was assisted by Amy Fox, MSU-CBE undergraduate student in chemical and biological engineering, and Robert Schaefer, MSU-CBE master’s student in chemical and biological engineering.
Nanoscience is the study of extremely small particles. Nanoscientists work with particles and devices between one and 100 nanometers in size (the head of a pin is 1,000,000 nanometers across). Through nanoscience, scientists have developed disease-fighting drugs, computer components, transparent sunscreen, ultra-strong sports equipment and many other applications.

For more information about NanoDays go to: http://eu.montana.edu/nanodays/

**Phil Stewart explains biofilm on radio show**

**Phil Stewart**, professor of chemical and biological engineering, conducted an interview on biofilms for *Radio Health Journal*. The 12-minute segment aired on March 27, 2016 and featured Stewart, Dr. Randy Wolcott, and Bill Soukup. Wolcott is the medical director of the Southwest Regional Wound Care Center in Lubbock, Texas and a long-standing CBE collaborator. Bill Soukup is the president of Scientific Biofilm Solutions. Stewart presented an overview of biofilms including where they grow and how they impact public health.

*Radio Health Journal* is a weekly radio magazine that features interviews with guests that have expertise and real-world experience with current issues in health and medicine. The program is aired on close to 500 radio stations throughout the country.

To listen to Stewart’s RHJ interview, go to: http://mediatracks.com/shows/RHJ_16-13.mp3

**OUTREACH:**

**Visiting Researchers**

**Visiting Student Researchers**

The CBE welcomed the following visiting students conducting research with faculty during the 2015–2016 academic year:

**Adam Hise**, PhD student, environmental sciences & engineering, University of North Carolina at Chapel Hill
Area of study: Algal biofuels
CBE host: **Robin Gerlach**, professor, chemical & biological engineering
Adam successfully defended his PhD thesis, “Interdependence of financing parameters and processing improvements in the design of economically competitive algal biofuel production pathways” while working at the CBE (July 30, 2016).

**Johannes Hommel**, PhD student, environmental engineering, University of Stuttgart, Stuttgart, Germany
Area of study: Biomineralization barriers in porous media
CBE host: **Al Cunningham**, professor emeritus, civil engineering

**Jordan Martin**, undergraduate, New Mexico State University, Las Cruces, New Mexico
Area of study: Genetics and biotechnology. Montana INBRE Summer Research Internship Fellowship
CBE host: **Connie Chang**, assistant professor, chemical & biological engineering

**Mario Perez**, masters candidate, Universidad Autonoma de San Luis Potosi, San Luis Potosi, Mexico
Area of study: Antibiofilm evaluation of chitosan gel
CBE host: **Garth James**, associate research professor, chemical & biological engineering

**Yeni Yung**, PhD student, University of Illinois at Chicago, Illinois
Area of study: Mass spectroscopy imaging of biofilm proteome and metabolome for analysis of the CBE chronic wound model system
CBE host: **Ross Carlson**, associate professor, chemical & biological engineering

**Suvi Manner**, PhD student from the Pharmaceutical Sciences Laboratory at Åbo Akademi University in Turku, Finland
Area of study: Identifying and characterizing potent biofilm inhibitors from natural and naturally-derived compound libraries utilizing diverse biomolecular screening approaches.
CBE Host: **Darla Goeres**, associate research professor, chemical & biological engineering

**Lea Tan**, PhD student from UNESCO-IHE in Delft, Netherlands.
Area of study: Selenium reduction in biofilms.
CBE Host: **Robin Gerlach**, professor, chemical & biological engineering
Visiting Research Faculty

The CBE hosted the following visiting faculty during academic summer 2015:

Luigi Frunzo, Assistant Professor, Mathematics, University of Naples, Italy
Research area: Mathematical modelling
CBE host: Isaac Klapper, professor, mathematics

Greg Characklis, Professor, Environmental Sciences and Engineering, School of Global Public Health, University of North Carolina at Chapel Hill
Research area: Algal biofuels
CBE host: Robin Gerlach, professor, chemical and biological engineering

CBE Tours

September 1, 2015: CBE hosted a tour for a group of undergraduate students from Kumamoto University in Kumamoto, Japan. Kumamoto is a sister university to Montana State University. The visit was sponsored by MSU’s Office of International Programs. CBE tour leader: Kristen Brileya, technical operations manager.

November 24, 2015: CBE hosted “Talks and Tours” for middle school students who were on MSU’s campus participating in the Montana Science Olympiad competition. CBE graduate students Ashley Beck, Lauren Franco, Laura Camilleri, and Katie Davis led the tours through the following CBE labs—soft materials, wound biofilms, and confocal microscopy. Volunteers Jim Wilking, Connie Chang, Michael Vigers, Neerja Zambare, Sarah Mailhiot, Makayla Eickelberg, Erika Avera, and Jonas David demonstrated their research to the students.

Science Olympiad is a national non-profit organization dedicated to improving the quality of K-12 science education, increasing interest in science, creating a technologically-literate workforce and providing recognition for outstanding achievement by both students and teachers. These goals are achieved by participating in Science Olympiad tournaments and non-competitive events, incorporating Science Olympiad into classroom curriculum and attending teacher training institutes. Locally, 1,031 Montana students from 71 different schools and 88 different teams competed for spots in the national competition held in spring 2016 in Orlando, Florida.
### OUTREACH:

#### Web image library use 2015–2016

Total image downloads: **321**

Requests for CBE graphics were submitted from **35** of the U.S. states and Puerto Rico:

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There were requests from an additional **36** countries:

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FACILITIES:

Center for Biofilm Engineering Facilities Overview

The CBE moved into MSU’s Engineering and Physical Sciences Building when it was built in 1997. The >20,000 ft² facility includes offices and conference rooms for faculty, staff, and students; a computer lab; 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 an analytical instrument lab, a microbiology lab with media preparation area and autoclaves, an incubator room, and a general molecular area with two thermocyclers, a gel running and imaging station, and NanoDrop for nucleic acid quantification, as well as an isolated radioactive isotope lab. Facilities of particular note are described below. In spring 2016 the Engineering and Physical Sciences Building was renamed Barnard Hall in honor of Tim and Mary Barnard, MSU-College of Engineering donors and founders of the Bozeman-based company Barnard Construction.

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 (GC) 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 have been added as well as an additional Agilent 1100 series high performance liquid chromatography system with autosampler and an Agilent 6890 GC with autosampler and flame ionization detector. The chromatographs and 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.

Microsensor Laboratory

A specialized Microsensor Laboratory provides the capability of measuring microscale chemical and physical parameters within biofilms. The Microsensor Laboratory has the capability to measure spatial concentration profiles using sensors for oxygen, pH, hydrogen sulfide, nitrous oxide and some custom-made electrodes. All electrodes are used in conjunction with computer-controlled micropositioners for depth profiling. The microsensor lab also has instrumentation for measuring corrosion and other electrochemical phenomena associated with biofilms.

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 that are used for transmitted light and epi-fluorescent imaging. Both microscopes are equipped with Photometrics MYO cooled CCD cameras 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, and we have a 100x oil phase contrast objective and condenser especially for use with imaging spores.
Our microscope collection has expanded with the acquisition of a new Leica M 205 FA computer-controlled stereomicroscope and a Leica DFC3000G fluorescence camera. This stereoscope can be used to image samples using fluorescence, brightfield with or without polarization or Rotterman contrast, and reflected white light. The software will also allow a z-stack of images to be collected and recombined using simple deconvolution. 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 fairly 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 CO2 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 computer-intensive data analysis like particle tracking and 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, a server 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**

The CBE maintains several dedicated computational and data storage computers including high performance data and image analysis computers and large storage servers. The CBE maintains a small to mid-scale computational cluster for modeling and analysis. The center provides personal workstations for staff and graduate students that are connected to the MSU computer network. A student computer laboratory offers eight state-of-the-art PCs along with scanning and printing services.

Additionally, CBE staff and students have access to the centrally maintained computational cluster for data manipulation, analysis, and mathematical modeling. This cluster consists of 44 nodes with a total of 1408 hyper-threaded cores and 12.29 teraflops of computing power.
SPECIALIZED CBE RESEARCH GROUPS

Ecology/Physiology Laboratory
The Ecology/Physiology Laboratory headed by Dr. Matthew Fields has general microbiology equipment, anaerobic gassing stations in two lab spaces, Shimadzu UV-VIS spectrophotometer, Ultra-Centrufuge, Anaerobic Chamber, biofilm reactors, protein and DNA electrophoresis, Qubit fluorometer, two Eppendorf Mastercylcers, incubators, laminar/fume hoods, microcentrifuges, table-top centrifuges, and a microcapillary gas chromatograph with dual TCDs. The lab has two light-cycle controlled photo-incubators as well as photo-bioreactors for the cultivation of algae and diatoms, and maintains two -20°C freezers and three -70°C freezers for sample storage.

This laboratory houses an Illumina MiSeq Sequencing System. The MiSeq desktop sequencer allows the user to access more focused applications such as targeted gene sequencing, metagenomics, small genome sequencing, targeted gene expression, amplicon sequencing, and HLA typing. This system enables up to 15 Gb of output with 25 M sequencing reads and 2x300 bp read lengths by utilizing Sequencing by Synthesis (SBS) Technology. A fluorescently labeled reversible terminator is imaged as each dNTP is added, and then cleaved to allow incorporation of the next base. Since all 4 reversible terminator-bound dNTPs are present during each sequencing cycle, natural competition minimizes incorporation bias. The end result is true base-by-base sequencing that enables the industry's most accurate data for a broad range of applications. The method virtually eliminates errors and missed calls associated with strings of repeated nucleotides (homopolymers).

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 a full-time research professor, two technicians, and three undergraduate research assistants.

Currently, ten companies, including CBE Industrial Associates, sponsor MBL projects. The MBL is also collaborating with a small business on a Phase II Small Business Innovation Research (SBIR) grant. In addition, MBL principal investigator, Assistant Research Professor Dr. Kelly Kirker, is investigating staphylococcal biofilm induction of apoptosis in human epidermal cells, with funding from the National Institutes of Health (NIH). Other MBL projects include evaluating antimicrobial wound dressings, biofilm formation on biomedical polymers, testing novel toothpaste ingredients, and testing biofilm prevention and removal agents. The MBL is a prime example of integration at the CBE, bringing together applied biomedical science, industrial interaction, and student educational opportunities.

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 (AOAC International, ASTM International, IBRG, and OECD) on the approval of biofilm methods by the standard setting community. Under a contract with the U.S. Environmental Protection Agency (EPA), the SBML provides statistical services related to the EPA’s Office of Pesticide Programs Antimicrobial Testing Program to assess the performance of antimicrobial test methods—including those for biofilm bacteria. Most recently, the SBML received funding from the Burroughs Wellcome Foundation to develop a method for assessing the prevention of biofilm on surface modified urinary catheters. In addition, they conduct applied and fundamental research experiments and develop testing protocols for product specific applications. Methods include: design of reactor systems to simulate industrial/medical systems; growing biofilm and quantifying microbial abundances 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.
**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 CO₂, 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.

**Microfluidics Laboratory**
Dr. Connie Chang runs a soft matter and microfluidics laboratory that focuses on drop-based microfluidics, the creation and manipulation of picoliter-sized drops of fluid for ultra high-throughput screening and assaying. The Chang lab is interested in 1.) developing new experimental methods for the screening and analysis of large numbers of cells or microorganisms and 2.) the creation of colloidal particles for applications in medicine, pharmaceuticals, oil recovery, catalysis, and encapsulation technology in food and cosmetics.

The photolithography portion of the lab houses a spin-coater, plasma cleaner, UV light source, and two hot plates for post-baking. The glass capillary microfluidics portion of the lab houses a pipette puller and microforge. The PDMS microfluidics portion of the lab contains a droplet sorting and detection stand composed of an inverted light microscope mounted on an optical table, syringe pumps, a fast camera, lasers, high voltage amplifier, photomultiplier tubes, and all of the necessary data acquisition components to interface with LabVIEW control software for droplet sorting and detection.

**OTHER Montana State University facilities available for collaborative research**

**Montana Nanotechnology (MONT) Facility**
The MONT facility was formed from a $3 million NSF grant awarded to MSU in September of 2015. This collaborative facility includes the Montana Microfabrication Facility (MMF), the Imaging and Chemical Analysis Lab (ICAL), the CBE, the MSU Mass Spectrometry facility, and the Center for Bio-Inspired Nanomaterials. MONT provides researchers from academia, government and companies large and small with access to university facilities with leading-edge fabrication and characterization tools, instrumentation and expertise within all disciplines of nanoscale science, engineering and technology.

**Montana Microfabrication Facility (MMF)**
The Montana Microfabrication Facility is a cleanroom user facility located at MSU-Bozeman. As part of the NSF NNCI consortium MMF is a user facility open to university students and faculty as well as extramural users from industry and academia. The MMF facility comprises three separate areas: the Barnard Hall cleanroom, the Cobleigh process cleanroom and the Cobleigh packaging room. The Barnard Hall facility is a 1500 sq. ft. lab consisting of a class 1000 lithography area and a class 1000 general processing area. The Cobleigh process facility is a 500 sq. ft. class 10,000 lab that is home to MMF’s PVD deposition tools and the packaging room is a 200 sq. ft., class 10,000 softwall cleanroom. The labs are located in adjacent, connected buildings. MMF supports education, research, and development work in nano and microfabrication areas.

**Photolithography**
- ABM- contact aligner
- EVG 620 contact aligner
- Brewer Cee100 spin coater
- Headway PMW32 spin coater
Etching
- Oxford ICP Plasmalab 100
- March 1703 RIE
- PVA Tepla Ion 10 asher

Deposition
- Amod 4-pocket e-beam evaporation system
- Angstrom Engineering RF and DC sputtering system
- Modulab thermal evaporator

Metrology
- Ambios XP2 profilometer
- Gaertner L116 ellipsometer
- Filmetrics F3 reflectance spectrometer
- Jandel 4-point probe
- Nikon Eclipse L150 inspection microscope
- Wild stereo microscope

Packaging
- K&S 4523 wedge bonder
- K&S 4124 ball bonder

Furnaces
- MRL oxidation
- MRL solid source diffusion furnaces: boron and phosphorus
- ATV PEO603

MSU ICAL Laboratory
The Image and Chemical Analysis Laboratory (ICAL) at Montana State University is located on the 3rd floor of Barnard Hall, adjacent to the Center for Biofilm Engineering. ICAL is a core user facility that fosters interdisciplinary collaboration and supports basic and applied research and education in all science and engineering disciplines at MSU and in the surrounding area. The laboratory provides users from academic and government institutions and the private sector with access to state-of-the-art equipment, professional expertise, and individual training. ICAL instrumentation is dedicated to the characterization of materials through high-resolution imaging and spectroscopy. The recent addition of a state-of-the-art Auger nanoprobe with EBSD and EDX opens up unique and transformative material characterization capabilities. This system will enable the simultaneous submicron analysis of surface and bulk composition, identification of crystal phase and crystallographic orientation, and measurement of strain on precisely the same spot at nearly the same time, which will elevate the capabilities of the research groups in the region to the next level.

Current Instrumentation
- Atomic force microscopes (AFMs)
- Field emission scanning electron microscope with EDX and EBSD (FE SEM/EDX/EBSD)
- Scanning electron microscope with EDX (SEM/EDX)
- X-ray photoelectron spectrometer with cryo-stage (XPS)
- Time-of-flight secondary ion mass spectrometer (ToF-SIMS)
- X-ray powder diffraction spectrometer (XRD)
- X-ray fluorescence spectrometer (XRF) (will be available in June 2016)
- Field emission scanning Auger nanoprobe (FE AUGER/EDX/EBSD) (will be available in June 2016)
- Epifluorescence optical microscope
- Microplotting system
- Critical point drying
- Contact angle sysyte
- Zeta Potential system

For more information on each system, see the ICAL web site at: http://www.physics.montana.edu/ical/
**MSU Proteomics, Metabolomics, Mass Spectrometry Facility**

The mission of the Proteomics, Metabolomics, Mass Spectrometry Facility is to seed methods, technology, and applications to research labs at Montana State University and the Great Northern Rockies. This facility offers a full range of services from single samples to complete proteomics and metabolomics projects. Currently there are 9 instruments including GCMS, MALDI-TOF, ESI-QTOF, and ESI-IonTrap configurations. Periodic hands-on training sessions are offered by the facility staff. The goal of the training modules is to expand facility access to researchers with little or no previous training in proteomics, metabolomics, or mass spectrometry. Individual training can also be arranged. Please contact the facility personnel listed below if you wish to discuss training or submit samples for analysis.

Facility Coordinator: Dr. Jonathan Hilmer  jkhilmer@montana.edu
Facility Director:   Dr. Brian Bothner   bbothner@montana.edu

**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 μm in a sample space up to 6 cm diameter.

**MSU High Field Nuclear Magnetic Resonance (NMR) Facility**

A state-of-the-art NMR facility is available on campus a short 5-minute walk from the College of Engineering and CBE laboratories. The Department of Chemistry and Biochemistry currently houses three (and soon, four) NMR spectrometers, including an older DRX 500 MHz NMR, and an upgraded 600 MHz (1H Larmor Frequency) NMR spectrometer, both located in a specifically designed instrumentation room in the basement of the Chemistry and Biochemistry Building. Both 500 and 600 NMR instruments are equipped with four RF channels, deuterium decoupling capabilities, and 5 mm triple (1H, 15N, 13C) resonance room temperature probes with triple axis gradients.

The 600 MHz NMR was upgraded in 2011 from a DRX to an AVANCE III spectrometer, and is equipped with a helium-cooled 1H-optimized, inverse detection, (1H, 15N, 13C) TCI cryoprobe, and a SampleJet™ automatic sample loading system. The 600 MHz NMR is dedicated to protein structure determination, characterization of macromolecular complexes (protein-protein or protein-nucleic acid interactions), protein dynamics studies (using 15N and 13C NMR relaxation approaches) and, more, is being used for broadly based untargeted NMR metabolomic analyses.

The TCI cryoprobe installed on MSU’s 600 MHz NMR provides a significant increase in sensitivity for the NMR experiments (> 4 fold, amounting to a > 16 time saving in data acquisition time requirements for mM concentration samples). It also allows for detection of low abundance metabolites in sub-micromolar concentrations.

Acquisition of the cryoprobe has opened new research opportunities for identification of small molecules such as metabolites that may be present in low concentrations, and together with the 600 MHz automatic sample loading system (SampleJet™), opens new avenues for automated high-throughput profiling of metabolites (for example the SampleJet has five positions for 96 well-plate sized NMR tube racks. This allows the handling of batches with up to 480 sample tubes. It also accommodates and provides 96 positions for standard 3 mm and 5 mm NMR tubes). A multi-user license (> 5) to operate the Chenomx™ metabolite profiler software required to process and analyze NMR metabolomics data has been purchased.

In addition to the DRX 500 MHz NMR and the AVANCE III 600 MHz NMR, the NMR facility of the Department of Chemistry and Biochemistry houses an old two-channel Bruker DPX 300 MHz NMR spectrometer, which is used for the most routine organic and bioinorganic work, and occasionally for characterization of metal clusters.

For more information, contact Dr. Valérie Copié, Professor of Chemistry and Biochemistry, and Director of MSU’s High Field NMR Center at vcopie@montana.edu

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