
2018 APPENDIX

Center for Biofilm
Engineering

Montana State University
Bozeman

Reporting Period:
June 1, 2017–May 31, 2018

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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 | biogeochemistry

Cellular/intracellular phenotype | genetics | metabolic pathways | proteomics

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

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

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RESEARCH:

2017–2018 CBE GRANT-FUNDED RESEARCH ACTIVITY

Current CBE Research Grants for Fiscal Year 2018 (July 1, 2017 to June 30, 2018)			
Research Area	Title	PI	Funding Agency
Biofilm Mechanics	Exploring Biofilm Material Properties with Micromechanical Tools	Wilking	NSF
Biofilm Mechanics	VIPER: Viral Interdiction through Population Engineering and Restructuring	Chang	NCSU
Biofilm Mechanics	CAREER: Understanding Spatial Heterogeneity in Biofilms Using Colloidal Engineering	Chang	NSF
Biofilm Mechanics	MRI: Acquisition of a Confocal Raman Microscope with Cell-Sorting Capability at Montana State University ²	Hatzenpichler	NSF
Biofilm Mechanics	Spatial organization of microbial activity from nanometer to centimeter scale ²	Hatzenpichler	Gordon and Betty Moore Foundation
Biofilms in Nature	USGS - Bighorn	Fields	US Geological Survey
Biofilms in Nature	Cooperative Ecosystem Studies Unit, Rocky Mountain CESU	Fields	US Geological Survey
Biofilms in Nature	SLICE: Spectral Signs of Life in Ice	Foreman	NASA
Biofilms in Nature	Continued Monitoring of the Bridger Bowl Wetland System	Stein	Bridger Bowl
Energy Solutions	SEP Collaborative Research: Alkaliphilic microalgae-based sustainable & scalable processes for renewable fuels and products	Gerlach	NSF
Energy Solutions	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	Church & Dwight
Energy Solutions	Innovative Subsurface Sampling Technology for Energy Production and Environmental Applications	Fields	Montana Emergent Technologies Inc
Environmental Substance Technologies	Nutrient and Water Integration and recycling for sustainable algal biorefineries	Gerlach	U of Toledo-DOE
Environmental Substance Technologies	Cooperative research program on constructed wetland design and implementation	Stein	USFWS
Environmental Substance Technologies	Use of Saturated/Submerged Rock Fills for Water Quality Management	Peyton	SRK Consulting
Environmental Substance Technologies	Collaborative Research: Connecting omics to physical environment in community microbial ecology	Zhang	NSF
Environmental Substance Technologies	Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep & Extreme Environments	Gerlach	South Dakota School of Mines
Environmental Substance Technologies	Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment*	Stewart	University of Maryland
Environmental Substance Technologies	Sulfate reducer biofilm transcriptomics and thermodynamics under transient conditions	Fields	EXXMOB002

Environmental Substance Technologies	Developing Biomineralization Technology for Ensuring Wellbore Integrity	Gerlach	Montana Emergent Technologies Inc
Environmental Substance Technologies	Bio-cement Coating of Waste Ores and Tailings	Lauchnor	Pegasus Technical Services
Medical Biofilms	Spatiotemporal distribution of oxygen in biofilm infections	Stewart	NIH
Medical Biofilms	Resensitization of Bacteria in Biofilms to Antibiotics	Stewart	DOD (USAMRAA)
Medical Biofilms	Designing Immunomodulatory Antibiofilm Biomaterials	Stewart	University of Copenhagen
Methods Development	Methods to assess biofilm prevention on medical devices	Goeres	Burroughs Wellcome Fund
Methods Development	Antimicrobial Test Method - Statistical Support & Consultation	Goeres	EPA
Methods Development	Research Support for Design and Fabrication of an Aerated Partially Hydrated Low Shear Biofilm Reactor	Goeres	Montana Board of Research and Commercialization Technology
Methods Development	Biofilm and Biomineralization Methods Development in Support of CRC 1313 Projects C04 and C05	Cunningham	Deutsche Forschungsgemeinschaft
Methods Development	Biofilm Test and Analysis for Hydration Units	Byrd/Sturman	Wright Patterson Airforce Base
Modeling	Predictive Multiscale Modeling of Microbial Consortia Biofilms	Carlson	NIH
Modeling	Development of Robust Microbial Communities through Engineered Biofilms	Carlson	ARREOF
	Engineering systems for the eradication of biofilms in metal working and machining fluids	Foreman	NSF
Physiology & Ecology	Virtual institute for microbial stress & survival	Fields	DOE/LBNL
Physiology & Ecology	Collaborative Research: Hydrodynamic controls on microbial community dynamics	Cunningham & Fields	NSF
Physiology & Ecology	Linking engineering and urology towards a better understanding and improved treatment of urinary stones	Gerlach	Burroughs Wellcome
Physiology & Ecology	Environmental Networks Integrated with Genomes and Molecular Assemblies	Fields	Lawrence Berkley National Laboratory
Physiology & Ecology	Mineral Recovery from Urine - An Alternative Approach for Providing Nutrient for Primary Production in a Controlled Ecological Life Support System for Long-Term Space Missions ¹	Gerlach	NASA
Water Systems	Water, Our Voice to the Future: Climate change adaptation and waterborne disease prevention on the Crow Reservation	Camper	Little Big Horn College
Water Systems	Strengthening Little Big Horn College Research Capacity through Improving Rural Families' Access to Safe Drinking Water, Crow Reservation, Montana	Eggers	Little Bighorn College

FY18 New CBE Research Grants (July 1, 2017 to June 30, 2018)

Sponsor	Title	PI	Period	Award Amount
Bridger Bowl	Continued Monitoring of the Bridger Bowl Wetland System*	Otto Stein	2 yr	\$30,000
Burroughs Wellcome	Linking Engineering and Urology Towards a Better Understanding and Improved Treatment of Urinary Stones	Robin Gerlach	1 Yr	\$10,667
Deutsche Forschungsgemeinschaft	Biofilm and Biomineralization Methods Development in Support of CRC 1313 Projects C04 and C05	Al Cunningham	3 Yr	\$132,000
Gordon and Betty Moore Foundation	Spatial Organization of Microbial Activity from Nanometer to Centimeter Scale**	Roland Hatzenpichler	2 Yr	\$892,544
Lawrence Berkley National Laboratory	Environmental Networks Integrated with Genomes and Molecular Assemblies	Matthew Fields	5 Yr	\$2,250,000
Little Bighorn College	Strengthening Little Big Horn College Research Capacity through Improving Rural Families' Access to Safe Drinking Water, Crow Reservation, Montana	Mari Eggers	2 Yr	\$60,000
Montana Board of Research and Commercialization Technology	Research Support for Design and Fabrication of an Aerated Partially Hydrated Low Shear Biofilm Reactor	Darla Goeres	1 Yr	\$55,451
Montana Emergent Technologies Inc	Developing Biomineralization Technology for Ensuring Wellbore Integrity	Robin Gerlach	2 Yr	\$300,700
Montana Emergent Technologies Inc	Innovative Subsurface Sampling Technology for Energy Production and Environmental Applications	Matthew Fields	1 Yr	\$10,000
NASA	Mineral Recovery from Urine - An Alternative Approach for Providing Nutrient for Primary Production in a Controlled Ecological Life Support System for Long-Term Space Missions**	Robin Gerlach	9 mo	\$40,435
NASA	SLICE: Spectral Signs of Life in Ice	Christine Foreman	3 Yr	\$488,250
National Science Foundation	MRI: Acquisition of a Confocal Raman Microscope with Cell-Sorting Capability at Montana State University**	Roland Hatzenpichler	3 Yr	\$354,758
National Science Foundation	CAREER: Understanding Spatial Heterogeneity in Biofilms Using Colloidal Engineering	Connie Chang	5 Yr	\$500,000
Pegasus Technical Services	Bio-cement Coating of Waste Ores and Tailings	Ellen Lauchnor	6 mo	\$19,000
South Dakota School of Mines	Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep & Extreme Environments	Robin Gerlach	4 Yr	\$1,819,134
University of Copenhagen	Designing Immunomodulatory Antibiofilm Biomaterials	Phil Stewart	7 mo	\$18,586

University of Florida	Biobehavioral Mechanisms Underlying Symptoms and Healing Outcomes in Older Individuals with CVLU	Phil Stewart	5 Yr	\$735,068
University of Maryland	Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment*	Phil Stewart	1 yr	\$7,488
US Geological Survey	USGS - Bighorn*	Matthew Fields	1 yr	\$7,000
US Geological Survey	Cooperative Ecosystem Studies Unit, Rocky Mountain CESU	Matthew Fields	1 Yr	\$10,000
Wright Patterson Airforce Base	Biofilm Test and Analysis for Hydration Units**	Alix Byrd/Paul Sturman	6 mo	\$58,500
Total New Grant Awards to CBE in Fiscal Year 2018				\$7,799,581
<i>*Additional funding awarded to existing grants in FY18 (budget increased by the amount listed)</i>				
<i>**Denotes a project running through a different MSU department but involving collaboration with CBE researchers and/or use of CBE facilities.</i>				

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RESEARCH:

PUBLICATIONS

June 2017–May 2018

2017 Publications

NOTE:

2017-001 through 2017-030 are listed in 2017 Appendix

McKay LJ, Hatzenpichler R, Inskip WP, Fields MW, “Occurrence and expression of novel methyl-coenzyme M reductase gene (*mcrA*) variants in hot spring sediments,” *Sci Rep.* 2017 Aug 3;7(1):7252. 2017-031

Seymour JD, Codd SL, Kimmich R, “Pecllet number dependent superdiffusive hydrodynamic dispersion in a site percolation porous media measured by NMR,” *Mesoporous Mat.* 2017 April;1–4. 2017-032

SanClements M, **Smith H, Foreman C,** Tedesco M, Chin Y, Jaros C, McKnight D, “Biogeophysical properties of an expansive Antarctic supraglacial stream,” *Antarctic Science* 2017; 29(1), 33–44. 2017-033

D'Andrilli J, Foreman CM, Sigl M, Priscu JC, McConnell JR, “A 21 000-year record of fluorescent organic matter markers in the WAIS Divide ice core,” *Clim. Past.* 2017; 13, 533–544. 2017-034

Schoen HR, Hunt KA, Strobel GA, **Peyton BM, Carlson RP,** “Carbon chain length of biofuel- and flavor-relevant volatile organic compounds produced by lignocellulolytic fungal endophytes changes with culture temperature,” *Mycoscience* 2017 September; 58(5), 338-343. 2017-035

Arbogast J, Quinn J, Clark T, Moore L, Thompson M, Wagner P, Young B, **Parker A,** “Who Goes in and Out of the Hospital Patient Room?” *Am J Infection Control,* 2017 June, 45(6): S29. 2017-036

Beckstead AA, Zhang Y, Hilmer JK, **Smith HJ, Bermel E, Foreman CM,** Kohler B, “Ultrafast Excited-State Deactivation of the Bacterial Pigment Violacein,” *J Phys Chem B.*, 2017 Aug 24;121(33):7855–7861. 2017-037

Ledbetter RN, Garcia Costas AM, Lubner CE, Mulder DW, Tokmina-Lukaszewska M, Artz JH, Patterson AP, Magnuson TS, Jay ZJ, Dissel Duan H, Miller J, Plunkett MH, Hoben JP, Barney BM, **Carlson RP,** Miller A-F, Bothner B, King PW, Peters JW, Seefeldt LC, “Electron Bifurcating FixABCX Protein Complex from *Azotobacter vinelandii*: Generation of Low-Potential Reducing Equivalents for Nitrogenase Catalysis,” *Biochemistry,* 2017; 56 (32), 4177–4190. 2017-038

Herrling MP, Weisbrodt J, **Kirkland CM,** Williamson NH, Lackner S, **Codd SL, Seymour JD,** Guthausen G, Horn H, “NMR Investigation of Water Diffusion in different Biofilm Structures,” *Biotechnol Bioeng.*, 2017 Dec; 114(12):2857–2867. 2017-039

De León KB, Zane GM, Trotter VV, **Krantz GP,** Arkin AP, Butland GP, Walian PJ, **Fields MW,** Wall JD, “Unintended Laboratory-Driven Evolution Reveals Genetic Requirements for Biofilm Formation by *Desulfovibrio vulgaris* Hildenborough,” *MBio,* 2017 Oct 17;8(5). 2017-040

Romero CM, Engel RE, **D'Andrilli J,** Chen C, Zabinski C, Miller PR, Wallander R, “Bulk optical characterization of dissolved organic matter from semiarid wheat-based cropping systems,” *Geoderma,* 2017 November; 306, 40–49. 2017-041

Gomes IB, Meireles A, Gonçalves AL, **Goeres DM,** Sjollema J, Simões LC, Simões M, “Standardized reactors for the study of medical biofilms: a review of the principles and latest modifications,” *Crit Rev Biotechnol.*, 2017 September; 1–14. 2017-042

Brown JR, Trudnowski J, Nybo E, Kent KE, **Lund T, Parsons A,** “Quantification of non-Newtonian fluid dynamics of a wormlike micelle solution in porous media with magnetic resonance,” *Chem Eng Sci.*, 2017 December; (173):145–152. 2017-043

Xu B, Wei Q, Mettetal R, Han J, Rau L, Tie J, May RM, Pathe ET, Reddy ST, Sullivan L, **Parker AE,** Maul DH, Brennan AB, Mann EE, “Surface micropattern reduces colonization and medical device-associated infections,” *J Medical Microbiol.*, November 2017; (66): 1692–1698. 2017-044

Schultz G, Bjarnsholt T, **James GA,** Leaper DJ, McBain AJ, Malone M, Stoodley P, Swanson T, Tachi M, Wolcott RD, “Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds,” *Wound Repair Regen.*, September 2017; 25(5):744–757. 2017-045

2018 Publications

Hobbs T[‡], Schultz LN, Lauchnor EG, Gerlach R, Lange D, “Evaluation of Biofilm Induced Urinary Infection Stone Formation in a Novel Laboratory Model System,” *The Journal of Urology*, January 2018; 199(1): 178–185. 2017-046

Davis, KJ, Lu S, Barnhart EP, Parker AE, Fields MW, Gerlach R, “Type and amount of organic amendments affect enhanced biogenic methane production from coal and microbial community structure,” *Fuel*, January 2018; 211: 600–608. 2018-001

Davis, KJ, Gerlach R, “Transition of biogenic coal-to-methane conversion from the laboratory to the field: a review of important parameters and studies,” *Int J Coal Geol.*, 2018; 185:33–43. 2018-002

Eggers MJ, Doyle JT, Lefthand MJ, Young SL, Moore-Nail AL, Kindness L, Other Medicine R, Ford TE, Dietrich E, Parker AE, Hoover JH, Camper AK, “Community Engaged Cumulative Risk Assessment of Exposure to Inorganic Well Water Contaminants, Crow Reservation, Montana,” *Int J Environ Res Public Health.*, January 2018; 15(1): E76. 2018-003

James GA, Chesnel L, Boegli L, Pulcini ED, Fisher S, Stewart PS, “Analysis of *Clostridium difficile* biofilms: imaging and antimicrobial treatment,” *J Antimicrob Chemother.*, January 2018;73(1):102–108. 2018-004

Hamerly T, Everett JA, Paris N, **Fisher ST,** Karunamurthy A, **James GA,** Rumbaugh KP, Rhoads DD, Bothner B, “Detection of *Pseudomonas aeruginosa* biomarkers from thermally injured mice in situ using imaging mass spectrometry,” *Anal Biochem.*, December 2017; 539:144–148. 2018-005

Ausbacher D*, Lorenz L, Pitts B, Stewart PS, Goeres DM, “Paired methods to measure biofilm killing and removal: a case study with Penicillin G treatment of *Staphylococcus aureus* biofilm,” *Lett Appl Microbiol.*, March 2018; 66(3): 231–237. 2018-006

Mailhiot SE, Zong F, Maneval JE, June RK, Galvosas P, Seymour JD, “Quantifying NMR relaxation correlation and exchange in articular cartilage with time domain analysis,” *J Magn Reson.*, February 2018; 287:82–90. 2018-007

Sebrell TA, **Sidar B,** Bruns R, Wilkinson RA, Wiedenheft B, Taylor PJ, Perrino BA, Samuelson LC, **Wilking JN,** Bimczok D, “Live imaging analysis of human gastric epithelial spheroids reveals spontaneous rupture, rotation and fusion events,” *Cell Tissue Res.* February 2018; 371(2):293–307. 2018-008

Franco LC, Steinbeisser S, Zane GM, Wall JD, **Fields MW,** “Cr(VI) reduction and physiological toxicity are impacted by resource ratio in *Desulfovibrio vulgaris*,” *Appl Microbiol Biotechnol.* March 2018; 102(6):2839–2850. 2018-009

He Z, Zhang P, Wu L, Rocha AM, Tu Q, Shi Z, Wu B, Qin Y, Wang J, Yan Q, Curtis D, Ning D, Van Nostrand JD, Wu L, Yang Y, Elias DA, Watson DB, Adams MWW, **Fields MW,** Alm EJ, Hazen TC, Adams PD, Arkin AP, Zhou J, “Microbial Functional Gene Diversity Predicts Groundwater Contamination and Ecosystem Functioning,” *MBio*, February 2018; 9(1): e02435-17. 2018-010

Doyle JT, Kindness L, Realbird J, **Eggers MJ, Camper AK** “Challenges and opportunities for tribal waters: Addressing disparities in safe public drinking water on the Crow Reservation in Montana, US,” *Int J Environ Res Public Health.*, March 2018; 15(4): E567. 2018-011

Carlson RP, Beck AE, Phalak P, Fields MW, Gedeon T, Hanley L, Harcombe WR, Henson MA, **Heys JJ,** “Competitive resource allocation to metabolic pathways contributes to overflow metabolisms and emergent properties in cross-feeding microbial consortia,” *Biochem Soc Trans.*, April 2018; 46(2):269–284. 2018-012

Kirkland CM, Codd SL “Low-field borehole NMR applications in the near-surface environment,” *Vadose Zone J*, January 2018; 17(1): 1–11. 2018-013

Tan LC*, Espinosa-Ortiz EJ, Nancharaiyah YV, van Hullebusch ED, **Gerlach R, Lens PN** “Selenate removal in biofilm systems: Effect of nitrate and sulfate on selenium removal efficiency, biofilm structure and microbial community,” *J Chem Technol Biotechnol*, 2018; 93:2380–2389. 2018-014

Pedersen TC, Gardner RD, **Gerlach R, Peyton BM** “Assessment of *Nannochloropsis gaditana* growth and lipid accumulation with increased inorganic carbon delivery,” *J Appl Phycol.*, April 2018; 1–12. 2018-015

Smith HJ, Tigges M, D'Andrilli J, **Parker A,** Bothner B, **Foreman CM,** “Dynamic processing of DOM: Insight from exometabolomics, fluorescence spectroscopy, and mass spectrometry,” *Limnol. Oceanogr.* April 2018; 3(3): 225–235. 2018-016

Suchomel M, Leslie RA, **Parker AE,** Macinga DR, “How long is enough? Identification of product dry-time as a primary driver of alcohol-based hand rub efficacy,” *Antimicrob Resist Infect Control.*, May 2018; 7(65): 1–6. 2018-017

Coenye T, **Goeres D**, Van Bambeke F, Bjarnsholt T, “Should standardized susceptibility testing for microbial biofilms be introduced in clinical practice?” *Clin Microbiol Infect.*, Jun 2018; 24(6):570–572. 2018-018

Davis KJ, Barnhart EP, Fields MW, Gerlach R, “Biogenic coal-to-methane conversion efficiency decreases after repeated organic amendment stimulation,” *Energy Fuels*, January 2018; 32(3):2916–2925. 2018-024

Schoen HR, Knighton WB, **Peyton BM**, “Endophytic fungal production rates of volatile organic compounds are highest under microaerophilic conditions,” *Microbiology*, November 2017; 163(12):1767–1777. 2018-027

‡ Undergraduate student

* Visiting Researcher

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RESEARCH:
PRESENTATIONS
June 2017–May 2018

Matthew Fields, CBE director, professor, microbiology & immunology, presented “US perspectives on antimicrobial coatings,” 2nd AMICI Conference, Pori, Finland, June 4–8, 2017.

The following CBE researchers presented research at the University Council on Water Resources in Fort Collins, CO, June 13–15, 2017:

John Doyle, project coordinator, microbiology & immunology, presented “Taking back the responsibilities to protect our water.”

John Doyle, and **Mari Eggers**, CBE research scientist, presented “Water in a Changing Environment.”

Garth James, associate research professor, chemical & biological engineering, presented “Modern techniques to study biofilms and possible applications,” and “The future of antibiofilm strategies,” as an invited speaker at the Milan Biofilm Meeting in Milan, Italy, June 22–25, 2017.

Phil Stewart, professor, chemical & biological engineering, was invited to present “Controlling microbial biofilms,” at the annual American Dairy Science Association meeting in Pittsburgh, PA, June 26–27, 2017.

Roland Hatzenpichler, assistant professor, chemistry & biochemistry, as an invited speaker presented “Metabolic potential and in situ activity of thermophilic uncultured archaea at single cell resolution,” Gordon Research Conference on Archaea: Ecology, Metabolism & Molecular Biology, Waterville Valley, NH, July 23–28, 2017.

Diane Walker, CBE research engineer, presented “Biofilm studies of water systems including detection and testing for microbial control,” at the Society for Industrial Microbiology’s (SIMB) Annual Meeting in Denver, CO, July 30–August 2, 2017.

The following CBE researchers presented posters at the 2017 World Congress of Endourology (WCE) in Vancouver, BC, September 12–16, 2017:

Robin Gerlach, professor, chemical and biological engineering, presented “A novel laboratory model system for the evaluation of biofilm-induced urinary infection stone formation.”

Erika Espinosa-Ortiz, postdoctoral researcher, presented “Evaluating the role of urine chemistry on the formation of infection stones.”

The following CBE researchers presented research at STERIS in Columbus, OH, September 13–15, 2017:

Paul Sturman, CBE industrial coordinator, presented “Biofilm growth and response to antimicrobial treatment.”

Darla Goeres, associate research professor, chemical & biological engineering, presented “Standardized Biofilm Methods Development: Approach & Applications.”

John Doyle, **Mari Eggers**, and **Anne Camper**, professor, chemical & biological engineering, presented “Integrating TEK and Climate Science to Understand Changes in Water Resources and Resulting Tribal Health Impacts,” at the 2017 National Native Health Research Training Conference, September 17–21, 2017.

The following CBE researchers presented their work at the EuroBiofilm 2017 Congress in Amsterdam, The Netherlands, September 18–24, 2017:

Phil Stewart served as the chair at the EuroBiofilms 2017 Conference and also presented “Critical Parameters for Neutrophil Control of Nascent Biofilm,” and “Measuring Antimicrobial Efficacy Against Biofilms.”

Danica Walsh, PhD student, chemistry & biochemistry, presented the poster “The Design, Synthesis and Evaluation of Prodrugs to Control Biofilms.”

Diane Walker as an invited speaker presented “Controlling Microbial Biofilms,” at the 2017 North Central Cheese Industries Association (NCCIA) in Rochester, MN, October 10–12, 2017.

The following CBE researchers presented research at the International Society of Exposure Science in Durham, NC from October 15–20, 2017:

John Doyle presented “The European Human Biomonitoring Initiative-HBM4EU.”

John Doyle, **Mari Eggers**, and **Anne Camper** presented “Communicating Home Well Water Results to Families.”

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Brent Peyton, professor, chemical & biological engineering, presented “Unseen Yellowstone: Microbial Discoveries and Biotech Applications,” at the Museum of the Rockies Fall Science Inquiry Series, Bozeman, MT, October 18, 2017.

Ross Carlson, professor, chemical & biological engineering, presented “Bacteria Communities, the Whole is Greater than the Sum of its Parts,” at the MSU Innovation Road Show: From Solar Physics to Brains to Weeds in Bozeman, MT, October 26, 2017.

Phil Stewart presented “The Science of Biofilm Control with Antimicrobial Agents,” at the International Biofilm Summit, Lisbon, Portugal, October 21–28, 2017.

The following CBE researchers presented their work at the Algae Biomass Summit 2017 Conference in Salt Lake City, UT, October 29–November 1, 2017:

Luisa Corredor Arias, PhD student, microbiology & immunology, presented “Growth and Lipid Accumulation in a Native Alga from Energy Sector Production Water.”

Robin Gerlach presented “Leveraging -Omics Tools to Understand Metabolic Diversity in Algal Systems.”

Hannah Goemann, PhD student, microbiology & immunology, presented “Cyanobacteria Biofertilizer at the Frontier of Agricultural Sustainability.”

Matthew Jackson, PhD student, microbiology & immunology, presented “Alternative Culturing Strategies.”

Todd Pedersen, masters student, chemical & biological engineering, presented “Waste Not Want Not: Impacts of Nutrient Source on Algal Biology.”

The following CBE researchers presented their work at the International Society for Subsurface Microbiology (ISSM) 2017 Conference, Rotorua, New Zealand, November 6–10, 2017:

Robin Gerlach presented “Identifying the source, pathways, and rates of microbial coalbed methane production.”

Margaux Mesle, CBE postdoctoral researcher, presented “Design and Demonstration of Meso-Scale Coal-Dependent Methanogenesis Under Pressurized Flow Conditions.”

Hannah Schweitzer, PhD student, microbiology & immunology, presented “Aqueous Sulfate Levels Control Methanogen Diversity and Activity in Subsurface Coal Seams.”

Heidi Smith, CBE postdoctoral researcher, presented “Linking Organic Matter Degradation and

Microbial Assemblage Composition to Subsurface Methane Production in the Powder River Basin.”

Darla Goeres was invited to present “Understanding the importance of biofilm in recreational water” at the Nara Kasugano International Forum (NKIF), Nara, Japan, November 11–18, 2017.

Paul Sturman was invited to present “Biofilm Response to Fluid Shear in Water and Plumbing Systems,” at the 2017 PMI Conference, Sonoma, CA, November 13–15, 2017.

Elliott Barnhart, CBE assistant research professor, as an invited speaker presented “Moving Microbiology and DNA Analysis Out of the Lab and Into the Field with New Technology,” at the Public Lecture Series, Montana Technological University, January 11, 2018, Butte, MT.

Phil Stewart was invited to present “Biofilm Infections on Medical Devices,” at the Illinois Institute of Technology Seminar in Chicago, IL, January 25, 2018.

Diane Walker presented “Biofilms: From Formation to Elimination” at the 2nd Annual Food Safety and Microbiology Conference, Dallas, TX, February 25–28, 2018.

Heidi Smith was invited to present “Linking Activity to Phylogeny in Groundwater/Soil Ecosystems,” at the DOE Joint Genomics Conference, February 25–28, 2018, Washington, D.C.

Darla Goeres presented “Ethics in Biosciences,” and “Effective Technical Presentations,” at the PRINT-AID Training Network Workshop, Helsinki, Finland, March 2–7, 2018.

Two CBE faculty members were invited to present at the 255th American Chemistry Society (ACS) National Meeting and Exposition, March 18–22, 2018, New Orleans, LA:

Connie Chang, assistant professor, chemical & biological engineering, presented “Understanding heterogeneous populations of *P. aeruginosa* at the single cell level.”

Jim Wilking, assistant professor, chemical & biological engineering, presented “Structure and mechanics of microbial biofilms.”

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Phil Stewart was invited to present “Biofilms, Biomaterials, and Infection,” at the University of Illinois-UC, Champaign, IL, April 10, 2018.

Al Parker, CBE statistician, was invited to present “Fast Experimental Designs for LARGE Linear Processes, Conference on Uncertainty Quantification,” at the Society for Industrial and Applied Mathematics and American Statistical Association, Garden Grove, CA, April 19, 2018.

Phil Stewart was invited to present “Mathematics for Complex Microbial Systems,” at the Fields Institute Workshop, Toronto, Canada, May 7, 2018.

Diane Walker presented “Biofilm formation & evolution in food industries: A food safety concern,” Food Tech Barcelona 2018, Barcelona, Spain, May 9–10, 2018.

The following CBE researchers presented their work at the InterPore 2018 Conference, May 14-18, 2018, New Orleans, LA:

Sarah Codd, professor, mechanical & industrial engineering, delivered a keynote address “Magnetic resonance studies of transport in porous media.”

Catherine Kirkland, assistant research professor, civil & environmental engineering, presented “MICP in the Field: Enhancement of Wellbore Cement Integrity and Permeability Modification.”

Adrienne Phillips, assistant professor, civil & environmental engineering, presented the posters “Overview of Experimental Systems and Approaches Supporting In Situ Mineral Precipitation Research,” and “Visualizing and Quantifying Biomineralization in a Wellbore Analog Reactor.”

Jeffrey Simkins, PhD student, chemical & biological engineering, presented “Oxygen Profile Characterization in Packed Bed Biofilm Using 19F Nuclear Magnetic Resonance Oximetry.”

Neerja Zambare, PhD student, chemical & biological engineering, presented “Strontium co-precipitation in a porous media flow cell.”

Diane Walker presented “Standardized Test Methods for Growing Laboratory Biofilms to Test Cleaners and Sanitizers,” at the Annual Meeting of the Alliance for Advanced Sanitation, Lincoln, NE, May 22–24, 2018.

Kristen Brileya, CBE technical operations manager, was invited to present “*Desulfovibrio vulgaris* experiences transient sulfide-induced stasis during sulfate reduction with lactate,” at the Department Seminar, Section for Microbiology/Center for Geobiology, Aarhus University, Aarhus, Denmark, May 24, 2018.

The following CBE researchers presented their work at the Biofilm 8 Conference, Aarhus, Denmark, May 27–29, 2018:

Matthew Fields served on the scientific committee and also presented “Secreted, Large-Scale, Extracellular Membrane Systems in Microbial Biofilms.”

Ross Carlson was an invited plenary speaker presenting “Multiscale analysis of microbial cross-feeding in biofilms: from Yellowstone hot springs to chronic wounds.”

Kristen Brileya presented the poster “Nitrogen fixation in a syntrophic coculture alters biofilm structure and function.” *Kristen received an Outstanding Poster Presentation award. The award was sponsored by *microorganisms*, an open access journal published by MDPI.

Erika Espinosa Ortiz presented the course “Microsensor analysis in the environmental sciences,” Aalborg University, Aalborg, Denmark, May 27–June 10, 2018.

Al Parker presented “How to make accelerate Bayesian experimental design assessments for LARGE problems,” at the Uncertainty Quantification Conference, Center of Mathematical Investigations and University of Bath, Guanajuato, Mexico, May 29, 2018.

RESEARCH:

CBE Affiliated Faculty and Their Specialties, 2017–2018

NAME	DEPARTMENT	SPECIALTY
Elliott Barnhart	Center for Biofilm Engineering	Environmental biotechnology
Roberta Amendola	Mechanical & Industrial Engineering	Material science and technology
Jennifer Brown	Chemical & Biological Engineering	Rheology and biofilm mechanics
Anne Camper	Civil Engineering	Biofilms in environmental systems; water distribution
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic networks; chronic wounds
Connie Chang	Chemical & Biological Engineering	Microfluidics
Sarah Codd	Mechanical & Industrial Engineering	Magnetic resonance imaging
Kevin Cook	Mechanical & Industrial Engineering	Tool and machine design
Al Cunningham	Civil Engineering	Subsurface biotechnology and bioremediation
Markus Dieser	Chemical & Biological Engineering	Ecology
Erika Espinosa Ortiz	Chemical & Biological Engineering	Environmental technologies
Matthew Fields	Microbiology & Immunology	Environmental biofilms
Christine Foreman	Chemical & Biological Engineering	Microbial ecology in cold temperature environments
Michael Franklin	Microbiology & Immunology	Molecular genetics, gene expression, alginate biosynthesis; <i>Pseudomonas</i>
Robin Gerlach	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Darla Goeres	Chemical & Biological Engineering	Standardized biofilm methods
Martin Hamilton	Mathematical Sciences	Mathematics and statistics
Roland Hatzenpichler	Chemistry & Biochemistry	Microbial activity
Jeffrey Heys	Chemical & Biological Engineering	Fluid-structure interactions
Garth James	Chemical & Biological Engineering	Medical biofilms
Kelly Kirker	Chemical & Biological Engineering	Medical biofilms
Catherine Kirkland	Chemical & Biological Engineering	Environmental technologies
Ellen Lauchnor	Civil Engineering	Wastewater Systems
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
Luke McKay	Land Resources and Environmental Sciences	Biofilms in extreme environments, metagenomics
Albert Parker	Mathematical Sciences	Mathematics and statistics
Brent Peyton	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Adrienne Phillips	Civil Engineering	Environmental engineering
Elinor Pulcini	Chemical & Biological Engineering	Medical biofilms
Abbie Richards	Chemical & Biological Engineering	Environmental biotechnology

Cecily Ryan	Mechanical & Industrial Engineering	Polymers & composites
Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Dana Skorupa	Chemical & Biological Engineering	Carbon capture sequestration
Otto Stein	Civil Engineering	Engineered waste remediation
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Sturman	Civil Engineering	Biofilms in waste remediation, industrial systems
Stephan Warnat	Mechanical & Industrial Engineering	MEMS, sensors and actuators
James Wilking	Chemical & Biological Engineering	Physical and material biofilm properties
Tianyu Zhang	Mathematical Sciences	Mathematical modeling

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CBE Affiliated Faculty Awards & News

Hatzenpichler earns NASA Early Career Fellow Award

CBE affiliated faculty member, **Roland Hatzenpichler**, assistant professor in chemistry and biochemistry, was featured by *MSU News* for his receipt of a NASA Early Career Fellow Award. Hatzenpichler's research focuses on multicellular bacteria that live in salt marsh sediments. [Read the full article on Roland's work in MSU News.](#)

CBE team awarded \$1.8 million from the National Science Foundation

A team of CBE affiliated faculty members was awarded a \$1.8 million grant from the National Science Foundation to study methane-converting microbes. The team includes **Robin Gerlach**, professor in chemical and biological engineering and lead PI on the project; **Ross Carlson**, professor in chemical and biological engineering; **Connie Chang**, assistant professor in chemical and biological engineering; **Matthew Fields**, CBE director and professor in microbiology and immunology; **Roland Hatzenpichler**, assistant professor in chemistry and biochemistry; **Ellen Lauchnor**, assistant professor in civil engineering; **Brent Peyton**, professor in chemical and biological engineering; and **Jim Wilking**, assistant professor in chemical and biological engineering. [The collaborative project was featured by MSU News.](#)

Pulcini co-author on paper recognized by the leading professional association for infection preventionists

The Association for Professionals in Infection Control (APIC) announced their list of most impactful infection articles of 2016. CBE affiliated faculty member **Elinor Pulcini**, assistant research professor in chemical and biological engineering, was co-author on one of the association's top ten articles. The article "Surface-attached cells, biofilms and biocide susceptibility: Implications for hospital cleaning and disinfection," is published in the *Journal of Infection Control* and describes biofilms and biocide susceptibility and how that affects hospital cleaning. APIC noted important takeaways from the article including new approaches to hospital cleaning and disinfection and methods to augment the activity of biocides against surface-attached microbes; and the need for further research to clarify the nature of and physiology of microbes on dry hospital surfaces.

APIC is the leading professional association for infection preventionists (IPs) with more than 15,000 members. Their mission is to create safer environments through the prevention of infection.

Citation: Otter JA, Vickery K, Walker JT, **de Lancey Pulcini E**, Stoodley P, Goldenberg SD, Salkeld JA, Chewins J, Yezli S, Edgeworth JD, "Surface-attached cells, biofilms and biocide susceptibility: Implications for hospital cleaning and disinfection" *J Hosp Infect.*, Jan 2015; 89(1):16–27.

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CBE faculty member earns NASA award

Christine Foreman, associate professor in chemical and biological engineering, was awarded a grant from the NASA Research Opportunities in Space Science, Exobiology Program. Foreman and her team will study icy environments in Greenland and in the MSU SubZero labs, creating a spectral library of life in ice to compare to NASA's datasets, helping facilitate site selection for future missions in search of life on other planets. The project is called SLICE: Spectral Signatures of Life in Ice and the award provides \$600,000 over three years. For mor

MSU launches one-of-a-kind mobile field lab

CBE-affiliated researchers customized a 28-foot trailer with pumps, a generator, and specialized equipment that allows them to work much more efficiently by conducting experiments on-site. For its inaugural mission, the team towed the lab to Indiana for the first of three field tests to seal cracks in leaking oil and gas wells using rock-forming bacteria—an emerging technology currently being developed at the CBE. [Read the full article about the mobile field lab at MSU News.](#)

CBE faculty member earns NSF CAREER Award

MSU-CBE researcher **Connie Chang** won a [\\$500,000 CAREER award from the National Science Foundation](#). The prestigious award, the NSF's top honor for young scientists, will advance her research that could shed new light on how biofilms cause diseases and possibly generate biofuel. The research will draw heavily upon her work with microfluidics. Chang is an assistant professor of chemical and biological engineering at Montana State University.

2018 College of Engineering Awards

Christine Foreman and **Phil Stewart** were recognized by The Norm Asbjornson College of Engineering at Montana State University for their achievements in research and mentorship at its annual awards luncheon May 1.

NACOE Dean Brett Gunnink said he views the Distinguished Professorship award as a "lifetime achievement award" as he announced Phil Stewart, professor of chemical and biological engineering and biofilm researcher at the CBE as this year's recipient. Stewart is the most-cited researcher at MSU by a wide margin, having published 174 papers to date that have been cited more than 35,000 times, according to Google Scholar. His most-cited paper, "Bacterial biofilms: a common cause of persistent infections," has been cited nearly 10,000 times.

"I would argue that Dr. Stewart has potentially the most distinguished research record at Montana State University," wrote Jeffrey J. Heys, department head of chemical and biological engineering, in his letter nominating Stewart for the award. "The numbers are difficult for me to fathom."

Gunnink bestowed upon Christine Foreman, associate professor of chemical and biological engineering and associate dean of the NACOE, the Lloyd Berg Faculty Mentorship award for her work with undergraduate

students. This academic year, Foreman mentored eight undergraduate students in projects relating to her research into polar ice cores.

“She has also been a strong advocate for the success of women graduate students, having served as the primary advisor and committee chair for Heidi Smith and Safiya ‘Sophia’ Ozcan and the co-chair for Michelle Tigges,” wrote Anne Camper, associate dean at the NACOE, in her letter nominating Foreman for the honor. “This level of commitment is even more extraordinary because Dr. Foreman is on a 50 percent faculty appointment.”

Research Faculty Appointment

[Catherine “Cat” Kirkland](#) was appointed to an assistant research professor position in MSU’s Department of Civil Engineering. Cat earned her PhD in 2017 from MSU’s civil engineering department, studying magnetic resonance imaging (MRI) to probe the internal structure and mass transfer properties of aerobic granular sludge. Upon graduation she joined the lab of Adie Phillips, assistant professor in civil engineering at MSU, and began work on ureolysis-induced calcium carbonate precipitation for enhanced wellbore integrity. Cat is continuing this work as a research professor, in addition to working on MRI of granular sludge used in wastewater treatment.

CBE Staff Award

2018 Outstanding Researcher Award

Markus Dieser, assistant research professor in chemical and biological engineering, received the CBE Outstanding Researcher Award. Markus was recognized for his outstanding contributions to the CBE. Markus embodies the CBE mission of education, research, and technology transfer. He creates a safe lab environment, with consistently perfect laboratory inspections, and instills a culture of safety for every student that works within his group. Markus’ commitment to excellence enables his lab to be highly productive.

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EDUCATION:

Undergraduate Students: Summer 2017, Fall 2018, Spring 2018

*Graduating

*Native American

1. *Alagoz, Helin (Gerlach)	F	Chemical & Biological Engineering	Igdir, Turkey
2. Anderson, Rebekah (Foreman)	F	Chemical & Biological Engineering	Golden, CO
3. Avila, Nickolas (Gerlach)	M	Chemical & Biological Engineering	Richland, WA
4. Baker, Dave (Goeres)	M	Chemical & Biological Engineering	Henderson, KY
5. *Benjamin, Aaron (Wilking)	M	Chemical & Biological Engineering	New Rochelle, NY
6. Blossom, Taylor (Carlson)	M	Chemical & Biological Engineering	Helena, MT
7. Boise, Noelani (Peyton)	F	Land Resources & Environ. Sciences	Livingston, MT
8. *Bowditch, Mason (Lauchnor)	M	Civil & Environmental Engineering	Missoula, MT
9. *Boyl-Davis, Martin (Fields)	M	Chemical & Biological Engineering	Snohomish, WA
10. Brown, David (Wilking)	M	Chemical & Biological Engineering	Meridian, ID
11. Burr, Mary (Lauchnor)	F	Civil & Environmental Engineering	Anchorage, AK
12. Carmody, Caitlin (Wilking)	F	Mechanical & Industrial Engineering	Butte, MT
13. *Carter-Gibb, Jacob (Chang)	M	Civil & Environmental Engineering	Boulder, CO
14. Chase-Bayless, Yenny (Stewart)	F	Ecology	Coeur D'Alene, ID
15. Cummings, Kacie (Chang)	F	Ecology	Cascade, MT
16. Cuthbertson, Isabelle (Chang)	F	Chemical & Biological Engineering	Kalispell, MT
17. David, Jonas (James)	M	Modern Languages & Literature	Fort Collins, CO
18. Dorle, Michael (Hatzenpichler)	M	Microbiology & Immunology	Canon City, CO
19. Du, Martina (Carlson)	F	Chemical & Biological Engineering	Kent, WA
20. * [‡] Dupuis, Lauren (Chang)	F	Chemical & Biological Engineering	Polson, MT
21. *Ekness, Thayne (Peyton)	M	Chemical & Biological Engineering	Westby, MT
22. Forbes, Matthew (Fields)	M	Ecology	Boise, ID
23. *Grodner, Benjamin (Wilking)	M	Chemical & Biological Engineering	Mosier, OR
24. Haider, Olivia (Chang)	F	Chemical & Biological Engineering	Helena, MT
25. Haller, Gregory (Gerlach)	M	Chemical & Biological Engineering	Lakewood, CO
26. Hemmah, Ashlyn (Peyton)	F	Civil & Environmental Engineering	Lead, SD
27. * [‡] Keepseagle, Kayla (Codd/Seymour)	F	Chemical & Biological Engineering	Bismark, ND
28. Keskin, Yagmur (Peyton)	F	Chemical & Biological Engineering	Tire, Turkey
29. Kieffer, Whitney (Lauchnor)	F	Chemical & Biological Engineering	Richland, WA
30. *Kilic, Ayse Bengisu (Wilking)	F	Chemical & Biological Engineering	Istanbul, Turkey
31. Klingelsmith, Korinne (Fields)	F	Chemistry & Biochemistry	Fort Collins, CO
32. *Lee, Fei San (Goeres)	F	Chemical & Biological Engineering	Selangor, Malaysia
33. Lewis, Christian (Peyton)	M	Chemical & Biological Engineering	Gig Harbor, WA
34. Martinson, Anna (Gerlach/Phillips)	F	Chemical & Biological Engineering	Gig Harbor, WA
35. Massey, KaeLee (Fields)	F	Chemical & Biological Engineering	Billings, MT
36. Mettler, Madeleine (Goeres)	F	Chemical & Biological Engineering	Littleton, CO
37. *Moeun, Youra (Wilking)	F	Chemical & Biological Engineering	Kampong Chang, Cambodia
38. Naser, Nada (Chang/Gerlach)	F	Chemical & Biological Engineering	Assuit, Egypt
39. Olsen, Timothy R. (Wilking)	M	Chemical & Biological Engineering	Deer Lodge, MT
40. Ondin, Nilsu (Fields)	F	Chemical & Biological Engineering	Ankara, Turkey
41. Park, Rita (Phillips)	F	Microbiology & Immunology	Butte, MT
42. Parrett, Brian (James)	M	Microbiology & Immunology	Rochester, NY
43. Perez Orts, Mireira (Peyton)	F	Chemical & Biological Engineering	Alicante, Spain
44. *Peters, Daniel (Gerlach)	M	Chemical & Biological Engineering	Poulsbo, WA
45. *Polukoff, Natalya (Goeres)	F	Microbiology & Immunology	Park City, UT
46. Proudfoot, Dylan (Lauchnor)	M	Civil & Environmental Engineering	Fairmont, WV
47. Reed, McKay (Eggers)	M	Microbiology & Immunology	Reno, NV
48. Rotert, Jacob (Stewart)	M	Chemical & Biological Engineering	Everett, WA
49. *Stangeland, James (Stewart)	M	Chemical & Biological Engineering	Helena, MT
50. Steinberg, David (Gerlach)	M	Chemical & Biological Engineering	Tenafly, NJ
51. Stonebraker, Ali (Lauchnor)	F	Civil & Environmental Engineering	Red Lodge, MT
52. *Szafraniec, Hannah (Chang)	F	Chemical & Biological Engineering	Bloomington, MN
53. Thompson, Jared (Chang)	M	Chemical & Biological Engineering	Whitefish, MT
54. Totten, William (Fields)	M	Chemical & Biological Engineering	Bozeman, MT
55. Trudgeon, Benjamin (Foreman)	M	Chemical & Biological Engineering	Grand Rapids, MI
56. Tunby, Paige (Chang)	F	Chemical & Biological Engineering	Bozeman, MT
57. Udeck, Megan (Peyton)	F	Microbiology & Immunology	Missoula, MT

58. Vallie, James (Peyton)	M	Chemical & Biological Engineering	Crow Agency, MT
59. Wigle, Daniel (Chang)	M	Microbiology & Immunology	Kalispell, MT
60. *Worum, Bjorn (Gerlach/Phillips)	M	Chemical & Biological Engineering	Fairbanks, AK

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Undergraduates Summary: 2017–2018

<u>Department (Program)</u>	<u>Male</u>	<u>Female</u>	<u>Total</u>
Chemical & Biological Engineering	20M	20F	40
Chemistry & Biochemistry		1F	1
Civil Engineering	3M	3F	6
Ecology	1M	2F	3
Land Resources & Environ Sci (LRES)		1F	1
Mechanical & Industrial Engineering		1F	1
Microbiology & Immunology	4M	3F	7
Modern Languages & Literature	1M		1
Totals	29M	31F	60

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EDUCATION:

Graduate Students: Summer 2017, Fall 2018, Spring 2018

‡ Native American *Received degree

Masters Candidates

1. *Beser, Guneycon Dicle (Phillips)	F	Civil & Environ Engineering	Ankora, Turkey
2. Bowersock, Lisa (Goeres)	F	Mathematical Sciences	Rochester Hills, MI
3. Daily, RYanne (Phillips)	F	Civil & Environ Engineering	Great Falls, MT
4. *DeVerna, Kyle (Phillips)	M	Civil & Environ Engineering	Lynchburg, VA
5. Erturk, Berrak (Peyton)	F	Chemical & Biological Engineering	Istanbul, Turkey
6. Frieling, Zach (Gerlach/Phillips)	M	Chemical & Biological Engineering	Gallatin Gateway, MT
7. *Morasko, Vincent (Gerlach/Phillips)	M	Chemical & Biological Engineering	Glendive, MT
8. *Norton, Drew (Phillips)	M	Civil & Environ Engineering	Olympia, WA
9. *Ozcan, Safiye Selen (Foreman)	F	Chemical & Biological Engineering	Istanbul, Turkey
10. Panighetti, Robert (Stein)	M	Civil & Environ Engineering	Cedarburg, WI
11. Raeside, Emma (Stein/Lauchnor)	F	Civil & Environ Engineering	Rochester, NY
12. *Stoick, Emily (Stein)	F	Civil & Environ Engineering	Kalispell, MT
13. Summers, Jennifer (Goeres)	F	Chemical & Biological Engineering	Conowingo, MD
14. Sykes, Jordan (Lauchnor)	M	Civil & Environ Engineering	Brevard, NC
15. *Wallis, Jack (Stein)	M	Civil & Environ Engineering	Vancouver, WA
16. *Woodhouse, Shayla (Stein)	F	Civil & Environ Engineering	San Diego, CA

PhD Candidates

1. Abbasi, Reha (Wilking)	M	Chemical & Biological Engineering	Istanbul, Turkey
2. *Akiyama, Tatsuya (Franklin)	M	Microbiology & Immunology	Shimada, Japan
3. Akyel, Arda (Gerlach)	M	Chemical & Biological Engineering	Istanbul, Turkey
4. Albers, Dalton (Gerlach)	M	Chemical & Biological Engineering	Great Falls, MT
5. Anjum, Sobia (Gerlach)	F	Chemical & Biological Engineering	Lahore, Punjab, Pakistan
6. Corredor Arias, Luisa (Fields)	F	Microbiology & Immunology	Pereira, Columbia
7. *Beck, Ashley (Carlson)	F	Microbiology & Immunology	Corning, IA
8. Boyd-Davis, Martin (Fields)	M	Material Sciences	Snohomish, WA
9. Camilleri, Laura (Fields)	F	Microbiology & Immunology	Ukiah, CA
10. Cicha, Calvin (Gerlach)	M	Microbiology & Immunology	Post Falls, ID
11. *Davis, Katherine (Fields/Gerlach)	F	Microbiology & Immunology	Green Creek, CA
12. *Franco, Lauren (Fields)	F	Microbiology & Immunology	Moorpark, CA
13. Goemann, Hannah (Peyton)	F	Microbiology & Immunology	Wells, MN
14. Jackson, Matthew (Gerlach)	M	Chemical & Biological Engineering	Naples, FL
15. Keenan, Brame (Camper)	M	Land Resources & Environ. Sciences	Henderson, KY
16. Koepnick, Hannah (Peyton)	F	Chemical & Biological Engineering	Sherman, TX
17. Krantz, Gregory (Fields)	M	Microbiology & Immunology	Tinmouth, VT
18. LeFevre, Thomas (Wilking)	M	Chemical & Biological Engineering	Escanaba, MI
19. Lyles, Mackenzie (Hatzenpichler)	F	Chemistry & Biochemistry	Cleveland, OH
20. McGill, Stacy (Carlson)	M	Molecular Biosciences	Minor Hill, TN
21. Mery, Stephen (Lauchnor)	M	Civil & Environmental Engineering	Danielsville, PA
22. Miller, Isaac (Fields)	M	Microbiology & Immunology	East Helena, MT
23. Moll, Karen (Peyton)	F	Microbiology & Immunology	Fairport, NY
24. Pettygrove, Brian (Stewart)	M	Microbiology & Immunology	Leesburg, VA
25. Platt, George (Fields/Gerlach)	M	Chemical & Biological Engineering	Eagle River, AK
26. Pratt, Shawna (Chang)	F	Chemical & Biological Engineering	Miles City, MT
27. Rathore, Muneeb (Peyton)	M	Chemical & Biological Engineering	Punjab, Pakistan
28. Reichart, Nicholas (Hatzenpichler)	M	Chemistry & Biochemistry	Bel Air, MD
29. Sanchez, Humberto (Chang)	M	Chemical & Biological Engineering	Corona, CA
30. Schoen, Heidi (Peyton/Carlson)	F	Chemical & Biological Engineering	Geneva, IL
31. Schweitzer, Hannah (Fields)	F	Microbiology & Immunology	Chester, MT
32. Sidar, Barkan (Wilking)	M	Chemical & Biological Engineering	Istanbul, Turkey
33. Simkins, Jeffrey (Stewart)	M	Chemical & Biological Engineering	Bozeman, MT
34. Townsend, Alexandra (Chang)	F	Microbiology & Immunology	Vancouver, WA
35. Walsh, Danica (Stewart)	F	Chemistry & Biochemistry	Olympia, WA
36. Zambare, Neerja (Gerlach)	F	Chemical & Biological Engineering	Maharashtra, India
37. Zath, Geoffrey (Chang)	M	Chemical & Biological Engineering	Bend, OR
38. Zelaya, Anna (Fields)	F	Microbiology & Immunology	Russellville, AR

EDUCATION:

Graduate Students, 2017–2018

20: Chemical & Biological Engineering

MS: 5

- 2 M Frieling, Zach: MS, *Gerlach/Phillips*
- Morasko, Vinny: MS, *Gerlach/Phillips*
- 3 F Erturk, Berrak: MS, *Peyton*
- Ozcan, Safiye Selen: MS, *Foreman*
- Summers, Jennifer: MS, *Goeres*

PhD: 15

- 11 M Abbasi, Reha: PhD, *Wilking*
- Akyel, Arda: PhD, *Gerlach*
- Albers, Dalton: PhD, *Gerlach*
- Jackson, Matthew: PhD, *Gerlach*
- LeFevre, Thomas: PhD, *Wilking*
- Platt, George: PhD, *Fields/Gerlach*
- Rathore, Muneeb: PhD, *Peyton*
- Sanchez, Humberto: PhD, *Chang*
- Sidar, Barkan: PhD, *Wilking*
- Simkins, Jeffrey: PhD, *Stewart*
- Zath, Geoffrey: PhD, *Chang*
- 5 F Anjum, Sobia: PhD, *Gerlach*
- Koepnick, Hannah: PhD, *Peyton*
- Pratt, Shawna: PhD, *Chang*
- Schoen, Heidi: PhD, *Peyton/Carlson*
- Zambare, Neerja: PhD, *Gerlach*

3: Chemistry & Biochemistry

PhD: 3

- 2 F Lynes, Mackenzie: PhD, *Hatzenpichler*
- Walsh, Danica: PhD, *Stewart*
- 1 M Reichart, Nicholas: PhD, *Hatzenpichler*

11: Civil / Environmental Engineering

MS: 10

- 5 M DeVerna, Kyle: MS, *Phillips*
- Norton, Drew: MS, *Phillips*
- Pangihetti, Robert: MS, *Stein*
- Sykes, Jordan: MS, *Lauchnor*
- Wallis, Jack: MS, *Stein*
- 5 F Beser, Guneycon Dicle: MS, *Phillips*
- Daily, RYanne: MS, *Phillips*
- Raeside, Emma: MS, *Stein*
- Stoick, Emily: MS, *Stein/Lauchnor*
- Woodhouse, Shayla: MS, *Stein*

PhD: 1

- 1 M Mery, Stephen: PhD, *Lauchnor*

1: Land Resources & Environmental Sciences

PhD: 1

- 1 M Brame, Keenan: PhD, *Camper*

1: Material Sciences

PhD: 1

- 1 M Boyl-Davis, Martin: PhD, *Wilking*

1: Mathematical Sciences

MS: 1

- 1 F Bowersock, Lisa: MS, *Parker*

16: Microbiology

PhD: 16

- 6 M Akiyama, Tatsuya: PhD, *Franklin*
- Cicha, Calvin: PhD, *Gerlach*
- Krantz, Gregory: PhD, *Fields*
- McGill, Stacy: PhD, *Carlson*
- Miller, Isaac: PhD, *Fields*
- Pettygrove, Brian: PhD, *Stewart*
- 10 F Beck, Ashley: PhD, *Carlson*
- Camilleri, Laura: PhD, *Fields*
- Corredor Arias, Luisa: PhD, *Fields*
- Davis, Katherine: PhD, *Gerlach/Fields*
- Franco, Lauren: PhD, *Fields*
- Goemann, Hannah: PhD, *Peyton*
- Moll, Karen: PhD, *Peyton*
- Schweitzer, Hannah: PhD, *Fields*
- Townsend, Alexandria: PhD, *Chang*
- Zelaya, Anna: PhD, *Fields*

TOTALS

Total Grads: 54

Total MS: 16 7 M / 9 F
 Total PhD: 38 21 M / 17 F

Total Male: 28
 Total Female: 26

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EDUCATION:

Graduating with advanced degrees: June 2017–June 2018

Drew Norton, MS, Civil Engineering, July 2017

Visualizing and quantifying biomineralization in wellbore analog reactors

Jack Wallis, MS, Civil Engineering, July 2017

Selecting filter media for phosphorus removal at the Ennis National Fish Hatchery three-stage subsurface flow treatment wetland

Katherine Davis, PhD, Civil Engineering, July 2017

Organic amendments for enhancing microbial coalbed methane production

Lauren Franco, PhD, Microbiology & Immunology, November 2017

Nutrient limitation alters metabolism, Cr(VI) response, and biofilm matrix composition in *Desulfovibrio vulgaris* Hildenborough

Shayla Woodhouse, MS, Civil Engineering, December 2017

Optimization of a two stage, vertical flow treatment wetland for total nitrogen removal at Bridger Bowl Ski Area

Ashley Beck, PhD, Microbiology & Immunology, March 2018

Microbial interactions and the role of environmental stress in natural and synthetic consortia

Vincent Morasko, MS, Chemical & Biological Engineering, April 2018

Thermal inactivation kinetics of ureases and proppant sand immobilization using enzymatically induced calcium carbonate precipitation

Tatsuya Akiyama, PhD, Microbiology and Immunology, April 2018

The roles of hibernation promoting factor in resuscitation of *Pseudomonas aeruginosa* from dormancy

Dicle Beser, MS, Civil Engineering, April 2018

Ureolysis induced mineral precipitation material properties compared to oil and gas well cements

Safiye Selen Özcan, MS, Chemical & Biological Engineering, May 2018

Quorum quenching as a promising method to control biofilm growth in metalworking fluids

EDUCATION:

2018 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration Friday, April 13, 2018. Among the more than 200 students presenting their research, numerous students were connected with the Center for Biofilm Engineering.

POSTERS

Undergraduate Students

Rebekah Anderson: Chemical & Biological Engineering
 Mentors: Brent Peyton & Rebecca Mueller—Center for Biofilm Engineering, Chemical & Biological Engineering
 “Microbial characterization and biotechnological enzyme discovery in hot springs of Yellowstone National Park”

Taylor Blossom: Chemical & Biological Engineering
 Mentor: Ross Carlson—Center for Biofilm Engineering, Chemical & Biological Engineering
 “Medical microorganism robustness study”

Mason Bowditch: Civil Engineering
 Mentor: Ellen Lauchnor—Civil Engineering, Center for Biofilm Engineering
 “Plants ability to remove varying levels of nitrate”

Thayne Ekness: Chemical & Biological Engineering
 Mentor: Brent Peyton
 “Examining the response of diatomic algal species growth and development with supplemental iron concentrations”

Benjamin Grodner: Chemical & Biological Engineering
 Mentor: Jim Wilking – Center for Biofilm Engineering, Chemical & Biological Engineering
 “Chicken splash! Analysis of droplet distribution during splashing”

Timothy Johnson: Chemical & Biological Engineering
 Mentor: Jeff Heys—Center for Biofilm Engineering, Chemical & Biological Engineering
 “Mathematical model of microbial growth on various substrates”

Kayla Keepseagle: Chemical & Biological Engineering
 Mentor: Joseph Seymour—Center for Biofilm Engineering, Chemical & Biological Engineering
 “Measuring oxygen distribution in bacterial biofilms”

Whitney Kieffer: Chemical & Biological Engineering
 Mentor: Ellen Lauchnor—Civil Engineering, Center for Biofilm Engineering
 “Remediation of mine tailings using microbially induced calcite precipitation”

Fei San Lee: Chemical & Biological Engineering
 Mentors: Paul Sturman & Diane Walker—Center for Biofilm Engineering
 “Growing a mixed species biofilm with modification to an ASTM International Standard Test Method”

KaeLee Massey: Chemical & Biological Engineering
 Mentors: Matthew Fields, Heidi Smith, Anna Zelaya—Microbiology & Immunology, Center for Biofilm Engineering
 “The role of environmental isolates in cycling heavy metals in groundwater ecosystems”

Anna Martinson: Chemical & Biological Engineering
 Mentors: Adrienne Phillips & Guneycan Dicle—Civil Engineering, Center for Biofilm Engineering
 “Effect of MICP and EICP additives on the mechanical strength of concrete”

Youra Moeun: Chemical & Biological Engineering
 Mentor: Jim Wilking
 “Quantifying a drug composite breakup using a Hydrophone”

Timothy Olsen: Chemical & Biological Engineering
 Mentor: Jim Wilking
 “Developing a method for freeze drying microbial loaded hydrogels”

McKay Reed: Microbiology & Immunology
 Mentor: Brian Bothner—Chemistry & Biochemistry; Mari Eggers
 “Assessing correlation of coliform bacteria and biomarkers of human wastewater in home well water”

James Stangeland: Chemical & Biological Engineering
 Mentor: Phil Stewart—Chemical & Biological Engineering, Center for Biofilm Engineering
 “Measurement of bacterial growth rates using 13C incorporation”

Hannah Szafraniec: Chemical & Biological Engineering
 Mentor: Connie Chang, Center for Biofilm Engineering, Chemical & Biological Engineering
 “Characterization of Influenza A using microfluidics”

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EDUCATION:

News Highlights

CBE PhD student recognized by the International Conference on Magnetic Resonance Microscopy

Jeffrey Simkins, PhD student in chemical and biological engineering, received the Sir Paul Callaghan Young Investigator Award from the International Conference on Magnetic Resonance Microscopy for his research using nuclear magnetic resonance to non-invasively map oxygen gradients in bacterial biofilms. The award is the highest honor that ICMRM bestows on PhD or postdoctoral researchers that are making significant innovations or contributions to the field of magnetic microscopy. Simkins was invited to present his research “Oxygen profile characterization in biofilm systems using fluorine-19 nuclear magnetic resonance oximetry,” at the ICMRM conference in Halifax, Nova Scotia, in August and received a \$2,500 cash award.

CBE PhD student earned Judges Prize at Three-Minute Thesis event

Shawna Pratt, PhD student in chemical and biological engineering, earned the Judges Prize for her presentation “High resolution science: Life in a drop,” during the Three Minute Thesis competition on MSU's campus in March 2018.

For a fourth straight year, 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 1st at the Procrastinator Theater in the Strand Union Building.

The seven finalists chosen for the Three 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.

2018 MSU Student Awards for Excellence

An MSU-CBE engineering student and his mentor were among the 40 seniors and their faculty and staff mentors honored in February 2018 at the 36th annual Awards for Excellence event.

Benjamin Grodner, a biological engineering student from Salt Lake City, and **Jim Wilking**, assistant professor of chemical and biological engineering, were among the nine pairs of honorees from the Norm Asbjornson College of Engineering.

Faculty nominate top seniors from their college or department for the award, each of whom must have at least a 3.5 GPA, as well as a history of leadership on campus and community service. The students then select a faculty or staff member who has served as their mentor to be recognized with them at the event. The event was held on campus and is hosted by the MSU Alumni Foundation.

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2018 W.G. Characklis Outstanding Student Award

The CBE is proud to announce the 2018 W.G. Characklis Outstanding Student Award recipient—**Matthew Jackson**. Matt is a PhD candidate in civil engineering and he received this award in recognition of the quality and productivity of his research project; his leadership with training others; and his selflessness in helping colleagues trouble-shoot experiments in his own lab as well as other CBE labs. Matt consistently goes out of his way to help others.

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.

2018 CBE Student Citizen Award

Brian Parrett, undergraduate student in microbiology and immunology, received CBE's Student Lab Citizen Award. Brian was recognized for his outstanding work on the Lyme Disease project. His efforts working on the *in vitro* model are commendable. Brian was also recognized for his notable work extracting RNA from the cell cultures in order to examine gene expression in the presence of *Borrelia*. Brian has proven to be extremely capable in the lab and tenacious in completing difficult lab projects. This 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 2017

Montana State University, Roberts Hall 113, 4:10pm

Date	Speaker	Affiliation	Title/Topic
Aug 31	No Seminar—First Week of Classes		
Sept 7	Dr. Bryan White	Professor Emeritus, Animal Sciences and the Carl R. Woese Institute of Genomic Biology, University of Illinois at Urbana-Champaign	Next generation sequencing and analysis approaches for precision animal agriculture
Sept 14	Dr. Tibor Benedek	Research Associate, Regional University Centre of Excellence in Environmental Industry, Szent István University, Hungary	Selective enrichment and population dynamics of microaerobic and aerobic BTEX degrading biofilm bacteria
Sept 21	Dr. Leon van Paassen	Associate Professor, School of Sustainable Engineering & the Built Environment, Arizona State University	Advances in bio-based geotechnical engineering
Sept 28	Seminar cancelled		
Oct 5	Dr. Sara Branco	Assistant Professor, Microbiology & Immunology, MSU	Fungal adaptation: From communities to genes
Oct 12	Amanda Fuchs	PhD Student, Chemistry & Biochemistry, MSU	Metabolic changes in macrophages as a result of exposure to <i>Pseudomonas aeruginosa</i> biofilms
Oct 19	No Seminar		
Oct 26	Dr. Garth James	Principal Investigator, CBE Medical Biofilms Lab; Assoc. Research Professor, Chemical and Biological Eng., MSU	What's new in CBE Medical Biofilms Laboratory?
	Dr. Kelly Kirker	Asst. Research Professor, Chemical and Biological Engineering, MSU, CBE	
	Dr. Elinor Pulcini	Asst. Research Professor, Chemical and Biological Engineering, MSU, CBE	
Nov 2	Dr. Tyler Nygaard	Assistant Research Professor, Microbiology and Immunology, MSU	Interaction of <i>Staphylococcus aureus</i> with leukocytes in human blood
Nov 9	Dr. Geoffrey Puzon	Team Leader and Senior Research Scientist, Environmental and Industrial Biotechnology Team, CSIRO Land and Water Flagship, Western Australia	Biofilms in recycled storm water and pathogen removal
Nov 16	Jeffrey Simkins	PhD Candidate, Chemical & Biological Engineering, MSU, CBE	Non-invasive quantification of oxygen distribution in biofilm systems using ¹⁹ F NMR
Nov 23	No Seminar- Thanksgiving Day		
Nov 30	Dr. Brent Peyton	Professor, Chemical & Biological Engineering, MSU, CBE	Hot brain eating biofilms, synthetic extremophiles, microbial ecology of coal mine-impacted waters, and kangaroos
Dec 7	No Seminar- Last Week of Classes		

EDUCATION:

CBE Seminar Series: Spring 2018

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

Date	Speaker	Affiliation	Title/Topic
Jan 11	Dr. Jeffrey Marlow	Postdoctoral Scholar, Organismic & Evolutionary Biology, Harvard University	Methane oxidation on the seafloor: Decoding the determinants of metabolic rate
Jan 18	No Seminar		
Jan 25	No Seminar		
Feb 1	Dr. Karen Lloyd	Assistant Professor, Microbiology, University of Tennessee, Knoxville	Determining the environmental functions of phylogenetically divergent uncultured microbes
Feb 8	Dr. Elliott Barnhart	Research Hydrologist & Microbiologist, USGS Wyoming-Montana Water Science Center, Helena, MT	Moving microbiology and DNA analysis out of the lab and into the field with new technology
Feb 15	Dr. Adrienne Phillips Vincent Morasko Ryenne Daily Dr. Catherine Kirkland Zach Frieling	Assistant Professor, Civil Eng., CBE MS Student, Chem. & Bio. Eng., CBE MS Student, Chem. & Bio. Eng., CBE Asst. Research Professor, Civil Eng., CBE MS Student, Chem. & Bio. Eng., CBE	Urease: A journey from the laboratory to the field
Feb 22	Dr. Darla Goeres Dr. Garth James Dr. Phil Stewart Dr. Paul Sturman	Assoc. Research Professor, Chem. & Bio. Eng., MSU, CBE Assoc. Research Professor, Chem. & Bio. Eng., MSU, CBE Professor, Chem. & Bio. Eng., MSU, CBE CBE Industrial Coordinator	Debrief on the CBE-sponsored biofilm regulatory meeting in Washington, D.C. and our path forward
Mar 1	Dr. David Hodge	Associate Professor, Chemical and Biological Engineering, MSU	Production of renewable fuels, chemicals, and materials from plant biomass through integrated conversion processes
Mar 8	Ashley Beck	PhD Candidate, Microbiology and Immunology, MSU, CBE	Doctoral Defense: Microbial interactions and the role of environmental stress in natural and synthetic consortia
Mar 15	No Seminar- Spring Break		
Mar 22	Dr. Stephanie Wettstein	Assistant Professor, Chemical and Biological Engineering, MSU	Heterogeneous catalysts for lignocellulosic biomass upgrading
Mar 29	Dr. Stephan Warnat	Assistant Professor, Mechanical & Industrial Engineering, MSU	Environmental monitoring using MEMS and microfluidic devices
Apr 5	Dr. Tammy Kielian	Professor, Choudari Kommineni, DVM, Dept. of Pathology and Microbiology, University of Nebraska Medical Center	Hiding in plain sight: How <i>Staphylococcus aureus</i> biofilms trigger innate immune cell dysfunction
Apr 12	Undergraduate Research Day	Daniel Peters, Chemical and Biological Eng., MSU, CBE	Characterizing algae growth and biomass composition under phototrophic, mixotrophic, and heterotrophic conditions
		Hannah Szafraniec, Chemical and Biological Eng., MSU, CBE	Viral characterization of Influenza A virus in microfluidic drops
		Aaron Benjamin, Mechanical & Industrial Eng., MSU, CBE	3D-printed sub-millimeter vasculature in hydrogel
Apr 19	Dr. William B. Whitman	Professor, Microbiology, University of Georgia, Athens	Heterologous expression of the methylreductase of methanogens: A peek into the making of a complex enzyme system
Apr 26	No Seminar- Last Week of Classes		

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TECHNOLOGY TRANSFER:

Industrial Associates, 2017–18

Bold, new *Small business member

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

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TECHNOLOGY TRANSFER:

**Montana Biofilm Meeting
 July 18–20, 2017**

Monday, July 17

6:00–8:30 pm

Registration & welcome reception
 Larkspur Foyer, Hilton Garden Inn
 Bozeman

Tuesday, July 18

7:30–8:00 am

**Registration & continental
 breakfast**
 Larkspur Foyer, Hilton Garden Inn

8:00–8:10

Introductory remarks
 Larkspur Ballroom
Matthew Fields, CBE Director
Paul Sturman, CBE Industrial
 Coordinator
Leticia Vega, Chair, CBE Industrial
 Associates Program;
 International Scientist, NASA,
 Houston, TX

SESSION 1:

Food Biofilms

8:10–8:40

**Biofilm formation in draught beer
 dispense lines**
Kelli Buckingham-Meyer, Research
 Assistant III, CBE
Lindsey Lorenz, Research Assistant
 III, CBE

8:40–9:10

Biofilms in the dairy industry
Carolina Mateus, R&D Director
 MQAH, DeLaval, Kansas City,
 MO

9:10–9:40

**Creating a test system for the
 removal of biofilms using
 microfiber wipes**
Fei San Lee, Undergraduate
 Student, Chemical & Biological
 Engineering, MSU, CBE

9:40–10:10 Networking Break

SESSION 2:

Biofilm Imaging

10:10–10:35

Live/dead staining challenges
Elinor Pulcini, Assistant Research
 Professor, Chemical &
 Biological Eng., MSU, CBE

10:35–11:05

**BiyoTrap: A rapid, efficient, and
 cost-effective bacteria
 concentrator**
Recep Avci, Associate Research
 Professor, Physics; Director,
 Image & Chemical Analysis
 Laboratory (ICAL), MSU

11:05–11:30

**Structuring biofilms using 3D
 printing**
Garth James, Assoc. Research
 Professor, Chemical &
 Biological Eng., MSU;
 PI, Medical Biofilms
 Laboratory, CBE

11:30–12:00

**Imaging mass spectrometry:
 A technology to advance
 understanding and diagnosis of
 bacterial infections**
Tim Hamerly, Postdoctoral
 Associate, Infectious
 Disease & Immunology,
 University of Florida,
 Gainesville, FL

12:00–1:00

Catered lunch, Hilton Garden Inn

SESSION 3:

Biofilm Methods

1:00–1:15

**Drip flow reactor training video:
 Second video in the SBML
 methods technology transfer
 initiative**
Darla Goeres, Assoc. Research
 Professor, Chemical &
 Biological Eng., MSU;
 PI, Standardized Biofilm
 Methods Laboratory, CBE

1:15–1:40

**Understanding the development
 of mixed fungal-bacterial biofilms**
Erika Espinosa-Ortiz, Postdoctoral
 Research Associate, CBE

1:40–2:05

**ISO Method 846 Part C:
 Evaluation of plastic surfaces for
 the ability to support bacterial
 growth**
Natalya Polukoff, Undergraduate
 Student, Microbiology &
 Immunology, MSU, CBE

2:05–2:35

**Production and analysis of a
Bacillus subtilis biofilm with
 spores using a modified colony
 biofilm model**
Laura Wahlen, Research Assoc. III,
 Baxter Healthcare, Chicago,
 IL

CBE Open House:

**Lab demonstrations and poster
 session**

3:00–5:00

3rd Floor Barnard Hall, MSU

Wednesday, July 19

7:30–8:00 am

Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 4:

Biofilm in the Built Environment

8:00–8:30

Building microbiome control

Jordan Peccia, Professor, Chemical & Environmental Eng., Yale University, New Haven, CT

8:30–9:00

Mold contamination of indoor materials for the built environment: Shipping, storage and preservation aspects

Daniel Price, Director, Microbiology, Interface Inc., Atlanta, GA

9:00–9:30

Living lab studies on biofilms in Finland

Minna Keinänen-Toivola, Research Manager, Satakunta Univ. of Applied Sciences, Pori, Finland

9:30–10:00 Networking Break

10:00–10:45

Characterizing biofilm growth on elastomeric roof coatings subjected to ponded waters

Joseph Moore, Senior Chemist, Dow Microbial Control, Collegeville, PA

10:45–11:15

A multi-scale modeling framework for biofilm development

Ting Lu, Asst. Professor, Bioengineering, University of Illinois at Urbana-Champaign, IL

11:15–11:50

State of the CBE

Presentation of CBE awards

Matthew Fields

11:50–12:50

Catered lunch, Hilton Garden Inn

SESSION 5:

Industrial Biofilms

12:50–1:20

Biofilms in metalworking fluids

Christine Foreman, Associate Professor, Chemical & Biological Eng., MSU, CBE

1:20–1:50

Bulk phase resource ratio alters electron transfer mechanisms in sulfate-reducing biofilms grown on metal

Greg Krantz, PhD Candidate, Microbiology & Immunology, MSU, CBE

1:50–2:15

Organic molecules and biofilm driven processes of metal deterioration: Exploring an uncharted territory

Iwona Beech, Research Professor, Microbiology & Plant Biology, University of Oklahoma, Norman, OK

2:15–2:40

Metabolomic and genomic imaging as novel ways of investigating biofilm-influenced processes in industrial systems and in medical settings

Iwona Beech

2:40-3:05

Particle size impacts carrying-capacity for biofilm via reduction of free pore space and resources

Sara Altenburg, Research Associate, CBE

3:05–3:30 Break

3:30-5:00

Business Meeting

Hilton Garden Inn

6:00 Dinner/Banquet

Rockin' TJ Ranch, Bozeman

Thursday, July 20

7:30–8:00 am

Registration & cont. breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 6:

Medical Biofilms

8:00–8:05

Chemical and biological gradients in biofilm infections

Phil Stewart, Professor, Chemical & Biological Eng., MSU, CBE

8:30–9:00

Interactions of human neutrophils with nascent *Staphylococcus aureus* biofilm

Niranjan Ghimire, Postdoctoral Fellow, Wake Forest Univ., Winston-Salem, NC

9:00–9:30

Do biofilms play a role in Lyme disease?

Garth James

9:30–10:00 Networking Break

10:00–10:30

Detection and treatment of bacterial biofilms in chronic wounds

Greg Schultz, Professor, Obstetrics & Gynecology, University of Florida, Gainesville, FL

10:30–11:00

Perspectives, controversies, & research needs regarding perioperative antimicrobial prophylaxis for implantable medical devices

Roger Wixtrom, President, LSCI Solutions, Springfield, VA

11:00–12:00

Advancing biofilm removal via surgical wound lavage—

A collaborative development

Matt Myntti, VP, R&D, Next Science, Jacksonville, FL
Chris Hosler, Associate Brand Director, Zimmer Biomet, Warsaw, IN

WORKSHOP:

**The Basics: Standardized Biofilm Methods
 July 17, 2017**

9:00 – 9:15	Welcome – <i>Matthew Fields</i> , CBE Director • Group introductions	BH 323
9:15 – 9:30	An Introduction to Biofilms – <i>Paul Sturman</i>	BH 323
9:30 – 10:15	ASTM Methods for growing biofilms – <i>Darla Goeres</i>	BH 323
10:30 – 10:40	Morning Refreshments	BH 323
10:45 – 11:30	A Statistical Assessment of Standard Methods: Case Studies of the MBEC & CDC/STM – <i>Al Parker</i>	BH 323

11:30 – 11:30	Workshop Group Photos	Outside (weather permitting)
11:45 – 1:00	LUNCH – MSU Strand Union Building	SUB Alumni Room

1:15 - 1:45	Biofilm Basics: Reactor theory & set-up <i>Grace Dickerman, Fei San Lee, Taly Polukoff, Kelli Buckingham-Meyer, Lindsey Lorenz & Diane Walker</i>	BH 301
1:45 - 2:00	Afternoon Refreshments	BH 301
2:00 – 3:15	Hands-on Biofilms! <i>Grace Dickerman, Fei San Lee, Taly Polukoff, Kelli Buckingham-Meyer, Lindsey Lorenz & Diane Walker</i>	BH 301
3:15 – 3:45	Now You Got It—What Do Ya Do With It? Data Analysis – <i>Al Parker</i>	BH 323
3:45 – 4:00	Wrap-Up/Discussion	BH 323

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TECHNOLOGY TRANSFER:

Anti-Biofilm Technologies: Pathways to Product Development
February 7, 2018 Arlington, VA

Time	Title	Speaker
7:15 a.m. – 8:00 a.m.	Registration and continental breakfast, Virginia Foyer, Plaza Level	
8:00 a.m. – 8:10 a.m.	Welcome and opening remarks Williamsburg/Yorktown Ballrooms, Lower Level	Paul Sturman, CBE Industrial Coordinator Laura Wahlen, CBE IA Program Chair; Research Assoc. III, Baxter Healthcare
8:10 a.m. – 8:15 a.m.	SESSION 1: Medical Device Technologies Session Introduction	
8:15 a.m. – 8:45 a.m.	What can we learn about medical device associated infection pathogenesis from skin explant models?	K. Scott Phillips, Reg. Research Scientist, Center for Devices & Radiological Health, FDA
8:45 a.m. – 9:15 a.m.	Bad to the bone: Antimicrobial devices in surgical infection and needed standards	Kenneth Urish, MD, PhD, Director, Arthritis and Arthroplasty Design Lab, Dept. of Orthopaedic Surgery, University of Pittsburgh
9:15 a.m. – 9:45 a.m.	Antibiotic resistance and biofilm: An overview of research at the FDA Center for Drug Evaluation and Research Division of Applied Regulatory Science	Rodney Rouse, DVM, Research Veterinary Medical Officer and Assoc. Division Director, Div. of Applied Regulatory Science, Ctr. for Drug Evaluation & Research, FDA
9:45 a.m. – 10:15 a.m.	Break, Commonwealth Foyer	
10:15 a.m. – 10:35 a.m.	Update on methods used to assess biofilm prevention on surface modified urinary catheters	Jennifer Summers, Masters Student, Chemical & Biological Eng., MSU, CBE
10:35 a.m. – 11:05 a.m.	Animal model for testing anti-microbial and anti-thrombogenic effectiveness of vascular catheter technologies	Nisha Gupta, Manager, Technology Development, Vascular R&D, Teleflex, Inc
11:05 – 11:25 a.m.	In-vitro and ex-vivo analysis of vascular catheters for biofilm	Garth James, Assoc. Research Professor, Chemical & Biological Eng., MSU; CBE
11:25 a.m. – 12:00 p.m.	Session 1 wrap up and panel discussion	
12:00 p.m.–1:00 p.m.	Networking Lunch, Crystal Ballroom, Plaza Level	
1:00 p.m.–1:10 p.m.	SESSION 2: Surface Disinfection Technologies Session Introduction	
1:10 p.m.–1:40 p.m.	What’s next for biofilm standard methods?	Darla Goeres, Assoc. Research Professor, Chemical & Biological Eng., MSU, CBE
1:40 p.m. – 2:10 p.m.	Translating bench science into policy: How to drive policy toward science and technology	Jennifer Buss, VP, Science and Technology Policy, Potomac Institute for Policy Studies
2:10 p.m. – 2:40 p.m.	Biofilm claims on EPA-registered biocides—Opportunities for public health and industrial applications	Elaine Black, Principal Regulatory Specialist, Ecolab
2:40 p.m. – 3:10 p.m.	Break, Commonwealth Foyer	
3:10 p.m. – 3:40 p.m.	Navigating the regulatory landscape in bringing hygiene solutions to market	Jim Arbogast, Vice President, Hygiene Sciences & Public Health Information, GOJO Industries
3:40 p.m. – 4:10 p.m.	Standardization and use of uniform terminology in biofilm research—A European perspective	Tom Coenye, Professor, Pharmaceutical Sciences, University of Ghent
4:10 p.m. – 5:00 p.m.	Session 2 wrap up and panel discussion	

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Beneficial-Biofilms Workshop
February 6, 2018 Arlington, VA

Time	Title	Speaker
7:30 a.m.–8:15 a.m.	Registration and continental breakfast, Commonwealth Foyer, Lower Lever	
8:15 a.m.–8:20 a.m.	Welcome & opening remarks, Williamsburg/ Yorktown Ballrooms, Lower Level	Paul Sturman, CBE Industrial Coordinator Laura Wahlen, CBE IA Program Chair; Research Assoc. III, Baxter Healthcare
SESSION 1: Industrial Biofilms		
8:20 a.m.–8:30 a.m.	Session introduction	Paul Sturman
8:30 a.m.–9:00 a.m.	Biofilm response to fluid shear in water systems	Paul Sturman
9:00 a.m.–9:30 a.m.	Microbially influenced corrosion (MIC) management in the oil and gas industries	Ken Wunch, Energy Technology Platform Leader, Dow Microbial Control
9:30 a.m.–10:00 a.m.	Legionella in building water	Frank Sidari, Technical Director, Special Pathogens Laboratory
10:00 a.m.- 10:30 a.m.	Break, Commonwealth Foyer	
SESSION 2: Food-Related Biofilms		
10:30 a.m. – 10:35 a.m.	Session Introduction	Paul Sturman
10:35 a.m. – 11:00 a.m.	Modifications to ASTM Standards for growing laboratory biofilms important to the food & beverage industry: A literature review	Paul Sturman on behalf of Diane Walker, CBE Research Engineer
11:00 a.m. – 11:30 a.m.	From lab bench to market	Carolina Mateus, R&D Director MQAH, DeLaval
11:30 a.m. – 12:00 p.m.	Detection, control, and monitoring of biofilms in production environments and its implications for food safety	Dumitru Macarasin, Research Microbiologist, Molecular Methods and Subtyping Branch, Office of Regulatory Science, Ctr. for Food Safety and Applied Nutrition, FDA
12:00 p.m. – 1:10 p.m.	Lunch, Crystal Ballroom, Plaza Level	
Session 3: Medical Biofilms		
1:10 p.m.–1:20 p.m.	Session Introduction	Phil Stewart, Professor, Chemical & Biological Engineering, MSU; CBE
1:20 p.m.–1:50 p.m.	Strategies for preventing biofilm infections on medical devices	Phil Stewart
1:50 p.m.–2:20 p.m.	Tricking your host immune response to battle biofilms	Mark Shirliff, Professor, Dept. of Microbial Pathogenesis; Dept. of Microbiology & Immunology, University of Maryland
2:20 p.m.–2:50 p.m.	Biomaterial-associated infection: Novel strategies against multidrug resistant biofilms and host tissue colonization	Sebastian A.J. Zaat, MD, Amsterdam Infection & Immunology Institute, Academic Medical Center, Amsterdam, The Netherlands
2:50 p.m.–4:00 p.m.	Break & Discussion session	

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TECHNOLOGY TRANSFER: **NEWS HIGHLIGHTS**

MSU researchers help EPA with first-ever biofilm product standards

In August 2017, the EPA announced the availability of two test methods that can be used to determine the effectiveness of antimicrobial pesticides against two biofilm bacteria, *Pseudomonas aeruginosa* and *Staphylococcus aureus*, as well as regulatory guidance for claims for those products. Research conducted by the CBE's Standardized Biofilm Methods Lab provided the scientific backbone for the new testing standards. [Read how MSU researchers helped with the first ever biofilm product standards at MSU News](#)

CBE launches second methods training video

The Center for Biofilm Engineering, in collaboration with Montana State University's Department of Visual Media and BioSurface Technologies, launched its second methods training video in 2017. The video focuses on the steps involved in working with the Drip Flow Biofilm Reactor. View the [Drip Flow Biofilm Reactor video](#).

CBE hosts fifth annual conference to help move life-saving products to the marketplace

In February 2018, the CBE marked its fifth annual regulatory meeting on biofilm science and technology in Washington, D.C. The CBE hosts the yearly meeting to bring together industry and federal agencies to discuss recent advances in anti-biofilm science and technology and the impact on medical devices and surfaces. [Read more about the Center and their annual regulatory conference at MSU News](#).

2018 Industrial Associate New Members

In fiscal year 2018, CBE welcomed three new member companies to its Industrial Associates program—**Boston Scientific Urology**, **Medentech Infection Control**, and **Decon7 Systems**.

[Boston Scientific](#) is a global leader in infection prevention in medical devices including catheters, stents, and many other implants.

[Medentech](#), headquartered in Wexford, Ireland, makes disinfection products for water purification, hospital infection control, and general surface disinfection.

[Decon7 Systems](#) is located in Scottsdale, Arizona and makes commercial disinfectants used mainly in the food industry.

[View the list of CBE Industrial Associates](#)
[Read about CBE membership](#)

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TECHNOLOGY TRANSFER:

Industry and Agency Interactions

Darla Goeres, associate research professor in chemical & biological engineering, and **Paul Sturman**, CBE industrial coordinator, were invited to present at **STERIS** Corporation’s Scientific Conference in Columbus, Ohio. Darla presented “Standardized biofilm methods development: Approach & applications,” and Paul presented “Biofilm growth and response to antimicrobial treatment.” STERIS is a leading provider of infection prevention and other procedural products and services, focusing primarily on healthcare, pharmaceutical and medical device customers. They have been a member of the CBE’s Industrial Associates Program since 2011. (September 14–15, 2017)

Matthew Fields, CBE director, was invited to present at the **Alfred E. Mann Institute for Biomedical Engineering** at the University of Southern California in Los Angeles. Matthew presented an overview of the CBE to the AMI-USC staff and discussed potential projects with faculty. (October 12, 2017)

Al Parker, CBE biostatistician, and **Diane Walker**, CBE research engineer, traveled to **Sharklet Technologies** in Denver, Colorado to present two workshops on statistical assessments of biofilm methods and the ASTM standardization process. Al presented “A statistical assessment of microbiological methods: Case studies of the ASTM’s CDC, STM, & MBEC biofilm methods,” and Diane presented “Systematic approach for standardizing research methods.” (October 16, 2017)

Jessyka Fortin and **Olivier Gagne** from Amoéba Biocides visited the CBE Standardized Biofilm Methods Lab. The group discussed the CBE membership program and potential testing projects. (October 18–19, 2017)

Alan Bowers from **Vanderbilt University** and **Matt Madolora** from **Premier Magnesia** visited the Center to discuss potential collaborative projects. Premier Magnesia is the global market leader in magnesia-based product applications and technical expertise supporting dozens of industries. (December 6, 2017)

Sean Riley and **Kyle Landry** of **Liberty BioSecurity** visited the CBE. They discussed the membership program and potential testing projects. Liberty Biosecurity is company of scientists, physicians and national security practitioners that develop cutting edge capabilities across the life sciences. (January 11, 2018)

Al Parker and **Lisa Bowersock**, masters student in mathematical sciences, visited **GOJO** Industries in Akron, OH. They discussed the CBE membership program with GOJO representatives and Al presented “Using statistical thinking to make decisions: A long term collaboration between GOJO and CBE.” (February 8, 2018)

Paul Sturman, visited **Solvay** in Bristol, Pennsylvania. Paul spent the day consulting with stakeholders and presented “Biofilm growth and response to antimicrobial treatment.” Solvay has been a member of the CBE Industrial Associates Program since March 2017. (February 8, 2018)

Matthew Fields visited **Decon7** Systems in Scottsdale, Arizona, to discuss membership and potential projects. Decon7 joined the IA program, as a small business member, in April 2018. (March 23, 2018)

Paul Sturman, hosted **Mark Drake** from **L’Oreal** and **Bob Sullivan** from **PureLine Systems**. L’Oreal is the number one cosmetics company, worldwide, with many internationally renowned products. PureLine designs and implements technologies to improve the quality of vital water supplies for a variety of industries. The visitors toured the CBE labs and met with several faculty and researchers to learn about the Center and discuss membership. (April 16, 2018)

Phil Stewart gave a keynote lecture “Science and Technology of Biofilm Control,” at the Johnson & Johnson 2018 Cross Sector R&D Biofilm Symposium in Skillman, New Jersey. (April 27, 2018)

Robin Gerlach, professor in chemical & biological engineering, hosted **Paul Howard** from **Carboceramics**. Carboceramics sells a variety of products and services related to oil and gas, industrial processes, and environmental applications. Paul toured the CBE, met with a variety of researchers, and discussed membership as well as potential collaboration on looking at the formation of biofilms to benefit water filtration. (May 8, 2018)

OUTREACH:

News highlights

ASTM International

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

CBE image selected for Life in the Universe exhibit

A published image taken by a CBE researcher has been selected for the exhibit “Life in the Universe” at the NEMO Science Museum in Amsterdam, the Netherlands. The selected image, a biofilm of *Desulfovibrio vulgaris*, was obtained by **Kristen Brileya** using a scanning electron microscope from MSU’s Image and Chemical Analysis Lab. Brileya is an MSU-CBE doctoral graduate and currently serves as the CBE’s technical operations manager.

InterPore 2018 Annual Meeting

CBE researchers took an active role in InterPore’s 2018 annual meeting in New Orleans, LA. InterPore (the International Society for Porous Media) is a non-profit organization dedicated to advancing and disseminating knowledge of natural and industrial porous media systems. Their annual meeting runs for four days and draws about 1,000 scientists and engineers from across the globe.

CBE affiliated faculty **Sarah Codd**, professor in mechanical and industrial engineering, was one of four keynote speakers in the program. Sarah opened the general session on Tuesday, May 15th with the presentation “Magnetic resonance studies of transport in porous media.” Sarah was also a co-organizer for a mini-symposium—Magnetic Resonance in Porous Media: From structure to transport. Among the over 900 presenters and program organizers, several CBE researchers of porous media systems are involved in the program. See the full list below.

Program Organizers:

Al Cunningham, professor emeritus in civil engineering
Robin Gerlach, professor in chemical and biological engineering
Adrienne Phillips, assistant professor in civil engineering
Joseph Seymour, professor in chemical and biological engineering

Fifteen-minute oral presentations:

Catherine Kirkland, assistant research professor, civil engineering, will present “MICP in the Field: Enhancement of wellbore cement integrity and permeability modification.

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Neerja Zambare, PhD student, chemical and biological engineering, will present “Calcium carbonate precipitation and strontium co-precipitation in porous media flow reactors.”

Poster presentations:

Adrienne Phillips will present “Overview of experimental systems and approaches supporting in situ mineral precipitation research,” and “Visualizing and quantifying biomineralization in a wellbore analog reactor.”

[Read the full details about InterPore 2018](#)

Biofilms 8

Biofilms 8 is a bi-annual European conference that focuses on the fundamental research of bacterial biofilms, asking basic scientific questions of how biofilms form, grow, and interact with their surroundings. The 2018 meeting took place May 27–29 in Aarhus, Denmark. **Matthew Fields**, CBE director, served on the scientific committee as well as delivering a talk “Secreted, large-scale, extracellular membrane systems in microbial biofilms,” and presenting a poster “Differential population activity in an archaeal-bacterial biofilm.”

CBE affiliated faculty member **Ross Carlson**, professor in chemical and biological engineering, was an invited speaker and presented “Multiscale analysis of microbial cross-feeding in biofilms: From Yellowstone hot springs to chronic wounds.” **Kristen Brileya**, CBE technical operations manager, presented the poster “Nitrogen fixation in a syntrophic coculture alters biofilm structure and function.”

European Society of Clinical Microbiology and Infectious Disease (ESCMID)

Online Study Group for Biofilm

Phil Stewart, CBE affiliated faculty in chemical and biological engineering, was part of the teaching faculty for the online study course “Bacterial biofilms and their role in chronic disease,” held in fall 2018. This online course can be followed by masters and PhD students, as well as professionals based on the admissions criteria.

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OUTREACH:

Visiting Researchers

Visiting Researchers

The CBE welcomed the following visiting researchers during the 2017–2018 academic year:

Carolina Dequech Garcia, Undergraduate Student
 Home university: Montana State University
 Area of study: Cell Biology and Neuroscience; Garcia received an MSU Vice President of Research Scholarship for her project “The evaluation of pre-operative soak solutions for the prevention of bacterial attachment and biofilm formation on breast implant materials.”
 CBE host: **Elinor Pulcini**, assistant research professor in chemical and biological engineering and CBE Medical Biofilms Lab.
 Visiting Summer 2017

Tibor Benedek, Postdoctoral Researcher
 Home university: Szent István University in Gödöllő, Hungary
 Area of study: Subsurface biofilms for bioremediation of hydrocarbon contaminated groundwater. While at the CBE, Tibor is working on creating reactive barriers for containment and decontamination of hydrocarbon polluted groundwater.
 CBE host: **Ellen Lauchnor**, assistant professor in civil engineering.
 Visiting September 2017

Jontana Allkja, PhD Student
 Home university: University of Porto, in Porto, Portugal
 Area of study: Chemical and biological engineering; While at the CBE, she will be working on standardized biofilm methods and urinary catheter models.
 CBE host: **Darla Goeres**, associate research professor, chemical and biological engineering; PI, CBE Standardized Biofilm Methods Laboratory
 Visiting June 2017–September 2017

Lenno van den Berg, PhD student
 Home university: Delft University of Technology, The Netherlands
 Area of study: Wastewater treatment
 CBE hosts: **Sarah Codd**, professor, mechanical and industrial engineering; **Cat Kirkland**, associate research professor, civil engineering
 Visiting May 2018–August 2018

Rachel Kleiman, Masters student
 Home university: University of North Carolina, Chapel Hill
 Area of study: Algal biofuels
 CBE host: **Robin Gerlach**, professor in chemical and biological engineering
 Visiting June 2018–August 2018

Elizabeth Lee, High School student
 Hometown: Bozeman, MT
 CBE Project: Growth and use of algae as a biofertilizer
 CBE host: Matthew Fields, CBE director; professor, microbiology and immunology
 Visiting June 2018–August 2018

Hannah Sylvester, Undergraduate student
 Home university: Carroll College, Helena, MT
 Area of study: Biology and health sciences
 CBE host: Connie Chang, assistant professor, chemical and biological engineering
 Visiting May 2018–August 2018

Luiz Pereira Da Silva Jr., Undergraduate student
 Home university: Federal University of Pernambuco, Brazil
 Area of study: Wastewater systems
 CBE hosts: **Ellen Lauchnor**, assistant professor, and **Otto Stein**, professor, both in civil engineering

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Visiting Faculty

The CBE hosted the following visiting faculty during the 2017–2018 academic year:

Bastiaan Krom, University of Amsterdam, The Netherlands

Area of study: Oral biofilms, host interactions

CBE host: Garth James, associate research professor, chemical & biological engineering

Visiting June 2018–August 2018

Ayrat Ziganshin, Kazan Federal University, Kazan, Russia

Home department: Microbiology

Area of study: Fungi

CBE host: Robin Gerlach, professor, chemical & biological engineering

Visiting June 2018–September 2018

Elvira Ziganshina, Kazan Federal University, Kazan, Russia

Home department: Microbiology

Area of study: Urinary tract stone formation

CBE host: Robin Gerlach

Visiting June 2018–September 2018

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OUTREACH:

Web image library use 2017-2018

Total image downloads: **271**

Requests for CBE graphics were submitted from **24** of the U.S. states:

Arizona	Illinois	Minnesota	New York	Texas
California	Indiana	Missouri	North Carolina	Virginia
Colorado	Iowa	Montana	Ohio	Washington
Florida	Massachusetts	New Hampshire	Oregon	Wisconsin
Georgia	Michigan	New Jersey	South Carolina	

There were requests from an additional **35** countries:

Algeria	Ireland
Argentina	Italy
Australia	Japan
Austria	Mexico
Bangladesh	Netherlands
Belgium	New Zealand
Brazil	Norway
Canada	Poland
Chile	Portugal
China	South Africa
Czech Republic	Spain
Denmark	Sweden
Ecuador	Switzerland
Finland	Thailand
France	Tunisia
Germany	United Kingdom
India	Venezuela
Indonesia	

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FACILITIES:

Center for Biofilm Engineering Facilities Overview

The CBE moved into MSU's former Engineering and Physical Sciences Building when it was built in 1997. Now Barnard Hall, the building was renamed after a private donation was made in 2016 which contributed toward remodeling common areas and the building exterior. 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, and a general molecular area with two thermocyclers, a gel running and imaging station, as well as an isolated radioactive isotope lab. Facilities of particular note are described below.

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Microscope Facilities

The microscopy and chemical imaging 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, fluorescent and Raman confocal microscopy. The microscopy facilities include four separate laboratories—the Optical Microscopy Lab, the Confocal Microscopy Lab, the Chemical Imaging Lab, and the Microscope Resource Room and Digital Imaging Lab—which are detailed below.

The **Optical Microscopy Lab** houses two Nikon Eclipse E-800 research microscopes which are used for transmitted light and epi-fluorescent imaging. Both microscopes are equipped with 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 LMD6 Laser Microdissection System equipped with a color camera, fluorescence filter cubes (FITC, TRITC, DAPI), and a UV laser for sample dissection. Another recent addition is the GAN210 Optical Coherence Tomography (OCT) imaging system. OCT is a high resolution, non-contact, non-invasive, and non-fluorescent based technique that is well suited for imaging thick specimens. The OCT light source centered around 930 nm with a bandwidth >100 nm and has a scan rate of up to 36 kHz with an axial field of view of 2.9 mm / 2.2 mm. Depending on the scan objective the field of view (FOV) and resolution can be adjusted and vary between a larger FOV of 16x16 mm² at 12 μm resolution, and a FOV of 10x10 mm² with a higher resolution of 8 μm.

Additionally, within the Optical Microscopy Lab is a 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 cryostat, and a dry ice maker.

The **Confocal Microscopy Lab** contains two 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 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.

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The **Chemical Imaging Lab** contains a Horiba Confocal Raman Microscope. Raman is a vibrational spectroscopic method that provides a fingerprint of the molecular, and to some extent the isotopic composition of a sample. The Horiba LabRam HR Evolution NIR is dedicated to studying the molecular composition of a sample. This is a fully integrated high-resolution Raman microscope for confocal Raman analysis, optimized for the visible to IR range (400nm-2500nm) microscope. It includes a confocal Raman microscope with an automated xyz-stage with fast-mapping capabilities, transfer optics, stigmatic spectrometer equipped with two gratings (600 and 1800 l/mm gratings), multichannel air-cooled CCD detector, and computer package with the latest version of the LabSpec6 software and the KnowItAll Raman spectra library, Horiba edition. It is equipped with 532nm 100mW laser, HeNe 633nm laser, 785nm 90mW laser, and 10x, 50x, 100x, 20xLWD and 50xLWD objectives.

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 computer systems including 10 high performance data and image analysis workstations and servers in addition to three 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 nine 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 77 nodes with a total of 1300 hyper-threaded cores and 22 teraflops of computing power.

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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.

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-Centrifuge, 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. Additionally, the lab has a large capacity refrigerated incubator (5-70°C) for temperature critical studies.

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 focuses on industrially relevant medical research 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, three technicians, and one undergraduate research assistant.

Currently, twelve companies, including CBE Industrial Associates, sponsor MBL projects. These 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 also researching the role of biofilms in Lyme disease with funding from a private foundation. The MBL is a prime example of integration at the CBE, bringing together applied biomedical science, industrial interaction, and student educational opportunities.

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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, validate, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBML members work with international standard setting organizations (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 relevant to the EPA's Office of Pesticide Programs Microbiology Laboratory Branch to assess the performance of antimicrobial test methods—including those for biofilm bacteria. 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 (www.foremanresearchgroup.com) 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 extreme environments, as extremophiles are natural resources for the discovery of pigments, biosurfactants, novel enzymes and other bioactive compounds of industrial relevance.

Microfluidics Laboratory

Dr. Connie Chang runs a soft materials and microfluidics laboratory to study microbes (bacteria, biofilms, and viruses). We are applying drop-based microfluidics, the creation and manipulation of picoliter-sized drops of fluid, for high-throughput screening and assaying in biology. We are developing novel tools for quantifying the behavior of individuals and how they can collectively contribute to large-scale population dynamics. Ongoing

projects within my group include the screening of persister and dormant bacteria cells in biofilms and the study of influenza evolution and population dynamics.

Dr. Chang has shared laboratory space in the CBE and an individual laboratory space in the Chemistry and Biochemistry Building (CBB) at MSU. The laboratory spaces include common space for equipment, chemical storage, freezers and reagents. The lab is outfitted with a qPCR machine and also includes a dedicated a room for epifluorescence microscopy and a custom-built microscope stand (200 square feet). The lab contains all the equipment and instrumentation necessary for fabrication of new devices, microfluidics handling, PCR, and cell culture.

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Microsensor Laboratory

The Microsensor Laboratory provides the capability of measuring microscale chemical and physical parameters within biofilms, microbial mats and other compatible environments. 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 micromanipulators for depth profiling. A Leica stereoscope is used to visualize the sensors while positioning them on the biofilm surface. The laboratory has experience with diverse microsensor applications including biofilms in wastewater, catheters and hollow fiber membrane systems in addition to algal and fungal biofilms.

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 EPS cleanroom, the Cobleigh process cleanroom and the Cobleigh packaging room. The EPS 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. Current major equipment:

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
- AML AWB-04 aligner bonder

Furnaces

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

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