
2017 APPENDIX

Center for Biofilm
Engineering

Montana State
University Bozeman

Reporting Period:
June 1, 2016–May 31, 2017

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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

RESEARCH:

2016–2017 CBE GRANT-FUNDED RESEARCH ACTIVITY

Current CBE Research Grants for Fiscal Year 2017 (July 1, 2016 to June 30, 2017)			
Research Area	Title	Principal Investigator	Funding Agency
Biofilm Mechanics	Characterizing Microbial Biofilms in Water Recovery Systems using Micromechanical Tools*	Wilking	NASA
Biofilm Mechanics	Exploring Biofilm Material Properties with Micromechanical Tools	Wilking	NSF
Biofilm Mechanics	Development of Robust Microbial Communities through Engineered Biofilms	Carlson	ARREOF
Biofilm Mechanics	VIPER: Viral Interdiction through Population Engineering and Restructuring	Chang	NCSU
Biofilms in Nature	USGS-BigHorn	Fields	USGS
Biofilms in Nature	Riverine Carbon Cycling as a Function of Seasonality	Foreman	MONACA
Biofilms in Nature	Continued Monitoring of the Bridger Bowl Wetland System	Stein	BRIBOW
Biofilms in Nature	Multidimensional omics characterization of microbial metabolism and dissolved organic matter in Antarctica	Foreman	NSF
Biofilms in Nature	Research on Airborne Ice Nucleating Species (RAINS)	D'Andrilli	FLOUNI
Education	Improving Montana community health through graduate education	Camper	NIH
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
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	Design and implementation of pilot vertical flow treatment wetland systems at Bridger Bowl	Stein	MT DEQ
Environmental Substance Technologies	Using Biomineralization Sealing for Leakage Mitigation in Shale during CO ₂ Sequestration	Gerlach	MT Emergent Technologies-DOE
Environmental Substance Technologies	Use of Saturated/Submerged Rock Fills for Water Quality Management	Peyton	SRK Consulting
Environmental Substance Technologies	Nitrifying WasteWater Biofilms and the Influence of Emerging Contaminants*	Lauchnor	USGS
Environmental Substance Technologies	Collaborative Research: Connecting omics to physical environment in community microbial ecology	Zhang	NSF
Environmental Substance Technologies	Application of biofilm covered carbon particles as a microbial inoculum delivery system in weathered PCB contaminated sediment	Stewart	U of Maryland-DOD
Environmental Substance Technologies	Saturated rock fill phase 3 laboratory column testing	Peyton	SRK Consulting
Environmental Substance Technologies	Sulfate reducer biofilm transcriptomics and thermodynamics under transient conditions	Fields	EXXMOB002

Industrial Systems	Engineering systems for the eradication of biofilms in metal working and machining fluids	Foreman	NSF
Instrumentation	MRI: Acquisition of Optical Coherence Tomography Instrumentation at Montana State University	Wilking	NSF
Medical Biofilms	Spatiotemporal distribution of oxygen in biofilm infections	Stewart	NIH
Medical Biofilms	Resensitization of Bacteria in Biofilms to Antibiotics	Stewart	DOD (USAMRAA)
Methods Development	Development and use of standard methods for the growth, treatment, sampling and analysis of biofilm bacteria	Goeres	EPA
Methods Development	Methods to assess biofilm prevention on medical devices	Goeres	Burroughs Wellcome Fund
Methods Development	Anti-biofilm technologies: Pathways to product development	Goeres	Burroughs Wellcome Fund
Methods Development	Antimicrobial Test Method - Statistical Support & Consultation	Goeres	EPA
Modeling	Predictive Multiscale Modeling of Microbial Consortia Biofilms	Carlson	NIH
Physiology & Ecology	Virtual institute for microbial stress & survival	Fields	DOE/LBNL
Physiology & Ecology	Collaborative Research: Hydrodynamic controls on microbial community dynamics	Cunningham & Fields	NSF
Water Systems	Water, Our Voice to the Future: Climate change adaptation and waterborne disease prevention on the Crow Reservation	Camper	Little Big Horn College

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

List of Acronyms

ARREOF	US Army Research Office
DOD	US Department of Defense
DOE	US Department of Energy
EPA	US Environmental Protection Agency
EXXMOB002	Exxon Mobil
FLOUNI	University of Florida
LBNL	Lawrence Berkeley National Lab
MT DEQ	Montana Department of Environmental Quality
NASA	National Aeronautics and Space Administration
NCSU	North Carolina State University
NIH	National Institutes of Health
NSF	National Science Foundation
USFWS	US Fish and Wildlife Service
USGS	US Geological Survey

FY17 New CBE Research Grants (July 1, 2016 to June 30, 2017)

New CBE Research Grants Awarded in Fiscal Year 2017 (July 1, 2016 to June 30, 2017)				
Sponsor	Title	PI	Period	Award Amount
Bridger Bowl Inc	Continued Monitoring of the Bridger Bowl Wetland System*	Otto Stein	2 yr 2 months	\$24,999
EPA	Antimicrobial Test Method – Statistical Support & Consultation	Darla Goeres	3 yr	\$104,859
Exxon Mobil	Sulfate reducer biofilm transcriptomics and thermodynamics under transient conditions	Matthew Fields	1 yr	\$160,000
LAWBER	Virtual Institute for Microbial Stress and Survival/Environmental Stress Pathways*	Matthew Fields	1 Yr	\$389,027
NIH	Predictive Multiscale Modeling of Microbial Consortia Biofilms*	Ross Carlson	1 yr	\$323,819
North Carolina State University (DARPA)	VIPER: Viral Interdiction through Population Engineering and Restructuring	Connie Wilking	5 yr	\$1,292,000
NSF	Engineering systems for the eradication of biofilms in metal working and machine fluids	Christine Foreman	1 yr	\$50,000
NSF	MRI: Acquisition of Optical Coherence Tomography Instrumentation of Montana State University	James Wilking	1 yr	\$105,000
University of Florida	Research on Airborne Ice Nucleating Species	Juliana D'Andrilli	1 yr	\$14,988
US Army Research Office	Development of Robust Microbial Communities through Engineered Biofilms	Ross Carlson	3 yr	\$655,400
US Geological Survey	USGS-BigHorn*	Fields	2 yr	\$7,000
Total Grant Awards to CBE in Fiscal Year 2017				\$3,127,092

*Additional funding awarded to existing grants in FY17 (budget increased by the amount listed)

RESEARCH:
 PUBLICATIONS
 June 2016–May 2017

2016 Publications

NOTE:

2016-001 through 2016-012 are listed in 2016 Appendix

Arbogast JW[‡], Moore-Schiltz L, Jarvis WR, Harpster-Hagen A, Hughes J, **Parker A** “Impact of a comprehensive workplace hand hygiene program on employer healthcare insurance claims plus costs, absenteeism, and employee perceptions and practices,” *J Occup Environ Med.*, 2016 Jun; 58(6). 2016-013

Smith HJ, Schmit A[^], Foster R, Littmann S, Kuypers MMM, **Foreman CM** “Biofilms on glacial surfaces: hotspots for biological activity,” *npj Biofilms and Microbiomes*, 2016 Jun; (2):16008. 2016-014

Stewart PS, Zhang T, Xu R, **Pitts B**, Walters MC, Roe F, Kikhney J, Moter A “Reaction–diffusion theory explains hypoxia and heterogeneous growth within microbial biofilms associated with chronic infections,” *npj Biofilms and Microbiomes*, 2016 June; (2):16012. 2016-015

Santillana GE, Smith HJ, Burr M, Camper AK “Archaeal ammonium oxidation coupled with bacterial nitrite oxidation in a simulated drinking water premise plumbing system” *Environ. Sci.: Water Res. Technol.*, 2016 July; 2: 658–669. 2016-016

James GA, Ge Zhao A, Usui M, Underwood RA, Nguyen H, Beyenal H, **deLancey Pulcini E**, Agostinho Hunt A, Bernstein HC, Fleckman P, Olerud J, **Williamson KS, Franklin MJ, Stewart PS** “Microsensor and transcriptomic signatures of oxygen depletion in biofilms associated with chronic wounds,” *Wound Repair Regen.*, 2016 Mar; 24(2):373–83. 2016-017

Guragain M, King MM, **Williamson KS**, Pérez-Osorio AC, **Akiyama T**, Khanam S, Patrauchan MA, **Franklin MJ** “The *Pseudomonas aeruginosa* PAO1 two-component regulator CarSR regulates calcium homeostasis and calcium-induced virulence factor production through its regulatory targets CarO and CarP,” *J Bacteriol.*, 2016 Mar 15; 198(6): 951–963. 2016-018

Barnhart EP, Weeks EP, Jones EJP, Ritter DJ, McIntosh JC, Clark AC, Ruppert LF, **Cunningham AB**, Vinson DS, Orem WH, **Fields MW** “Hydrogeochemistry and coal-associated bacterial populations from a methanogenic coal bed,” *International Journal of Coal Geology*, 2016 May 15; 162:14–26. 2016-019

Wang X, Koehler SA, **Wilking JN**, Sinha NN, Cabeen MT, Srinivasan S, Seminara A, Rubinstein S, Sun Q, Brenner MP, Weitz DA “Probing phenotypic growth in expanding *Bacillus subtilis* biofilms,” *Appl Microbiol Biotechnol.*, 2016 May; 100: 4607–4615. 2016-020

Wang R, Xiao F, Wang Y, **Lewandowski Z** “Determining the optimal transmembrane gas pressure for nitrification in membrane-aerated biofilm reactors based on oxygen profile analysis,” *Appl Microbiol Biotechnol.*, 2016 September; 100(17): 7699–7711. 2016-021

Hommel J*, Lauchnor E, Gerlach R, Cunningham AB, Ebigbo A, Helmig R, Class H “Investigating the influence of the initial biomass distribution and injection strategies on biofilm-mediated calcite precipitation in porous media,” *Transport in Porous Media.*, 2016 September; 114(2): 557–579. 2016-022

Pabst B[^], Pitts B, Lauchnor E, Stewart PS “Gel-entrapped *Staphylococcus aureus* bacteria as models of biofilm infection exhibit growth in dense aggregates, oxygen limitation, antibiotic tolerance, and heterogeneous gene expression,” *Antimicrob Agents Chemother.*, 2016 Sep 23; 60(10):6294–301. 2016-023

Corredor Arias LF, Luligo Espinal JS, Moncayo Ortiz, JI, Santacruz Ibarra JJ, Álvarez Aldana A “Relationship between super antigenicity, antimicrobial resistance and origin of *Staphylococcus aureus* isolated,” *Colombia Médica.*, 2016 Jan-Mar; 47(1): 15–20. 2016-024

Prather CA, Bray JM, **Seymour JD, Codd SL** “NMR study comparing capillary trapping in Berea sandstone of air, carbon dioxide, and supercritical carbon dioxide after imbibition of water,” *Water Resour. Res.*, 2016 Feb; 52:713–724. 2016-025

Bingham J, Abell G, Kienast L, Lerner L, Matuschek B, Mullins W, **Parker A**, Reynolds N, Salisbury D, Seidel J, Young E, Kirk J “Health care worker hand contamination at critical moments in outpatient care settings,” *Am J Infect Control*, 2016 Jun 7. 2016-026

De Serrano LO, Camper AK, Richards AM “An overview of siderophores for iron acquisition in microorganisms living in the extreme,” *Biometals*, 2016 Aug;29(4):551–71. 2016-027

Kaatz Wahlen L[‡], Parker A, Walker D, Pasmore M, **Sturman P** “Predictive modeling for hot water inactivation of planktonic and biofilm-associated *Sphingomonas parapaucimobilis* to support hot water sanitization programs,” *Biofouling*, 2016 Aug;32(7):751-61. 2016-028

Han X, **Schultz L,** Zhang W, Zhu J, Meng F, **Geesey GG** “Mineral formation during bacterial sulfate reduction in the presence of different electron donors and carbon sources,” *Chemical Geology*, 2016 Oct 01; 435: 49–59. 2016-029

Fridjonsson EO, **Seymour JD** “Colloid particle transport in a microcapillary: NMR study of particle and suspending fluid dynamics,” *Chemical Engineering Science*, 2016 October 22; 153: 165–173. 2016-030

Geesey GG, Barkay T, King S “Microbes in mercury-enriched geothermal springs in western North America,” *Sci Total Environ*, 2016 Nov 1; 569–570:321–331. 2016-031

Hise AM, Characklis GW, Kern J, **Gerlach R,** Viamajala, S, Gardner, RD, Vadlamani, A “Evaluating the relative impacts of operational and financial factors on the competitiveness of an algal biofuel production facility,” *Bioresour Technol.*, 2016 Nov; 220:271–281. 2016-032

2017 Publications

VanKempen-Fryling RJ, Camper AK “*Escherichia coli* O157:H7 attachment and persistence within root biofilm of common treatment wetlands plants,” *Ecological Engineering*, 2017 Jan;98:64–69. 2017-001

Phalak P, Chen J, **Carlson RP,** Henson MA “Metabolic modeling of a chronic wound biofilm consortium predicts spatial partitioning of bacterial species” *BMC Syst Biol*. 2016 Sep 7; 10(1):90. 2017-002

Hwang C, Copeland A, Lucas S, Lapidus A, Barry K, Detter JC, Glavina del Rio T, Hannon N, Israni S, Dalin E, Tice H, Pitluck S, Chertkov O, Brettin T, Bruce D, Han C, Schmutz J, Larimer F, Land ML, Hauser L, Kyrpides N, Mikhailova N, Ye Q, Zhou J, Richardson P, **Fields MW** “Complete genome sequence of *Alkaliphilus metalliredigens* strain QYMF, an alkaliphilic and metal-reducing bacterium isolated from borax-contaminated leachate ponds,” *Genome Announcements* 2016 Nov-Dec; 4(6). e01226-16.2017-003

Malone M, Barjnholt T, McBain AJ, **James GA,** Stoodley P, Leaper D, Tachi M, Shultz G, Swanson T, Wolcott RD “The prevalence of biofilms in chronic wounds: A systematic review and meta-analysis of published data” *J Wound Care* 2017 Jan 2;26(1):20-25. 2017-004

Mann EE[‡], Magin CM, Mettetal MR, May RM, Henry MM, DeLoid H, Prater J, Sullivan L, Thomas JG, Twite MD, **Parker AE,** Brennan AB, Reddy ST “Micropatterned endotracheal tubes reduce secretion-related lumen Occlusion,” *Annals of Biomedical Engineering* 2016 Dec;44(12):3645–3654. 2017-005

Schoen HR, Peyton BM, Knighton WB “Rapid total volatile organic carbon quantification from microbial fermentation using a platinum catalyst and proton transfer reaction-mass spectrometry,” *AMB Express*. 2016 Dec;6(1):90: 1–10. 2017-006

Hodgskiss LH, Nagy J, **Barnhart EP, Cunningham AB, Fields MWF,** “Cultivation of a native alga for biomass and biofuel accumulation in coal bed methane production water,” *Algal Research*, 2016 Nov; 19(1):63-68, 2017-007.

Montenegro-Burke JR, Phommavongsay T, Aisporna AE, Huan T, Rinehart D, Forsberg E, Poole FL, Thorgersen MP, Adams MW, **Krantz G, Fields MW,** Northen TR, Robbins PD, Niedernhofer LJ, Lairson L, Benton HP, Siuzdak G, “Smartphone analytics: mobilizing the lab into the cloud for omic-scale analyses,” *Anal Chem*, 2016 Oct 4;88(19):9753-9758. 2017-008

Şengör SS, Singh G, Dohnalkova A, Spycher N, Ginn TR, **Peyton BM,** Sani RK, “Impact of different environmental conditions on the aggregation of biogenic U(IV) nanoparticles synthesized by *Desulfovibrio alaskensis* G20,” *Biometals*. 2016 Dec;29(6):965–980. 2017-010

Hunt KA, Jennings RD, Inskeep WP, **Carlson RP,** “Stoichiometric modelling of assimilatory and dissimilatory biomass utilization in a microbial community,” *Environ Microbiol*. 2016 Dec;18(12):4946–4960. 2017-011

Smith HJ, Foster RA, McKnight DM, Lisle JT, Kuypers MMM, **Foreman CM** “Microbial formation of labile organic carbon in Antarctic glacial environments,” *Nature Geoscience* 2017 April; 1–6. 2017-012

de Valk S, Khadem AF, **Foreman CM,** van Lier JB, **de Kreuk MK***, “Physical and biochemical changes in sludge upon *Tubifex tubifex* predation,” *Environ Technol*, 2017 Jun;38(12):1524–1538. 2017-013

Rettberg P, Anesio AM, Baker VR, Baross JA, Cady SL, Detsis E, **Foreman CM,** Hauber E, Ori GG, Pearce DA, Renno NO, Ruvkun G, Sattler B, Saunders MP, Smith DH, Wagner D, Westall F, “Planetary protection and Mars special regions—a suggestion for updating the definition,” *Astrobiology*, 2016 Feb;16(2):119-25. 2017-014

Kirkland CM, Zanetti S, Grunewald E, Walsh DO, **Codd SL**, **Phillips AJ**, "Detecting microbially induced calcite precipitation in a model well-bore using downhole low-field NMR," *Environ Sci & Technol*, 2017 Feb 7;51(3):1537-1543. 2017-015

Akiyama T, **Williamson KS**, **Schaefer R**, **Pratt S**, **Chang CB**, **Franklin MJ**, "Resuscitation of *Pseudomonas aeruginosa* from dormancy requires hibernation promoting factor (PA4463) for ribosome preservation," *Proc Natl Acad Sci USA*, 2017 Mar 21;114(12):3204-3209. 2017-016

Fox C, **Parker A**, "Accelerated Gibbs sampling of normal distributions using matrix splittings and polynomials," *Bernoulli*; 2017 Nov; 23(4B):3711-43. 2017-017

Bray JM, **Lauchnor EG**, Redden GD, **Gerlach R**, Fujita Y, **Codd SL**, **Seymour JD**, "Impact of mineral precipitation on flow and mixing in porous media determined by microcomputed tomography and MRI," *Environ Sci & Technol*, 2017; 51 (3), 1562-1569. 2017-018

Hommel J, Ebigbo A, **Gerlach R**, **Cunningham AB**, Helmig R, Class H, "Finding a balance between accuracy and effort for modeling biomineralization," *Energy Procedia*, 2016 November; 97, 379-386. 2017-019

Kern JD, Hise AM, **Characklis GW**, **Gerlach R**, Viamajala S, Gardner RD, "Using life cycle assessment and techno-economic analysis in a real options framework to inform the design of algal biofuel production facilities," *Bioresource Technology*, 2017 Feb; 225:418-428. 2017-020

Capoor MN, Ruzicka F, Schmitz JE, **James GA**, Machackova T, Jancalek R, Smrcka M, Lipina R, Ahmed FS, Alamin TF, Anand N, Baird JC, Bhatia N, Demir-Deviren S, Eastlack RK, Fisher S, Garfin SR, Gogia JS, Gokaslan ZL, Kuo CC, Lee YP, Mavrommatis K, Michu E, Noskova H, Raz A, Sana J, Shamie AN, **Stewart PS**, Stonemetz JL, Wang JC, Witham TF, Coscia MF, Birkenmaier C, Fischetti VA, Slaby O, "*Propionibacterium acnes* biofilm is present in intervertebral discs of patients undergoing microdiscectomy," *PLoS One*, 2017 Apr 3; 12(4):e0174518. 2017-021

Okoye GA, Vlassova N, Olowoyeye O, Agostinho A, **James G**, **Stewart PS**, Leung S, Lazarus G, "Bacterial biofilm in acute lesions of *Hidradenitis suppurativa*," *Br J Dermatol*, 2017 Jan;176(1):241-243. 2017-022

Wang H, Bédard E, Prévost M, **Camper AK**, Hill VR, Pruden A, "Methodological approaches for monitoring opportunistic pathogens in premise plumbing: A review," *Water Res.*, 2017 Mar 25;117:68-86. 2017-023

Draughn GL, Allen CL, Routh PA, Stone MR, **Kirker KR**, **Boegli L**, Schuchman RM, Linder KE, Baynes RE, **James G**, Melander C, Pollard A, Cavanagh J, "Evaluation of a 2-aminoimidazole variant as adjuvant treatment for dermal bacterial infections," *Drug Des Devel Ther.*, 2017 Jan 16; 11:153-162. 2017-024

Kirker KR, **James GA**, "In vitro studies evaluating the effects of biofilms on wound-healing cells: a review," *APMIS*, 2017 Apr; 125(4):344-352. 2017-025

Manner S*, **Goeres DM**, Skogman M, Vuorela P, Fallarero A, "Prevention of *Staphylococcus aureus* biofilm formation by antibiotics in 96-Microtiter Well Plates and Drip Flow Reactors: critical factors influencing outcomes," *Sci Rep* 2017 Mar 2;7:43854. 2017-026

Malone M, **Goeres DM**, Gosbell I, Vickery K, Jensen S, Stoodley P, "Approaches to biofilm-associated infections: the need for standardized and relevant biofilm methods for clinical applications," *Expert Rev Anti Infect Ther* 2017 Feb;15(2):147-156. 2017-027

Barnhart EP, **Davis KJ**, Varonka M, Orem W, **Cunningham AB**, Ramsay BD, **Fields MW**, "Enhanced coal-dependent methanogenesis coupled with algal biofuels: Potential water recycle and carbon capture," *International Journal of Coal Geology*, 2017 Feb; 171:69-75. 2017-028

Zhang P, He Z, Van Nostrand JD, Qin Y, Deng Y, Wu L, Tu Q, Wang J, Schadt CW, **Fields MW**, Hazen TC, Arkin AP, Stahl DA, Zhou J, "Dynamic succession of groundwater sulfate-reducing communities during prolonged reduction of uranium in a contaminated aquifer," *Environ Sci & Technol*. 2017 Apr 4;51(7):3609-3620. 2017-029

Huan T, Forsberg EM, Rinehart D, Johnson CH, Ivanisevic J, Benton HP, Fang M, Aisporna A, Hilmers B, Poole FL, Thorgersen MP, Adams MWW, **Krantz G**, **Fields MW**, Robbins PD, Niedernhofer LJ, Ideker T, Majumder EL, Wall JD, Rattray NJW, Goodacre R, Lairson LL, Siuzdak G, "Systems biology guided by XCMS online metabolomics," *Nat Methods*. 2017 Apr 27;14(5):461-462. 2017-030

‡ Industrial or Federal Agency Co-author

* Previous Visiting Researcher

^ Undergraduate Student

RESEARCH:
 PRESENTATIONS
 June 2016–May 2017

Heidi Smith, postdoctoral research associate, presented “Microbial formation of labile organic matter” at Environmental Sciences: Waters Gordon Research Conference, Holderness School, Boston, MA, June 24–July 1, 2016.

The following CBE researchers presented their work at Goldschmidt Conference, Yokohama Japan, June 26–July 1, 2016:

Marnie Feder, CBE postdoctoral researcher, presented “Advancing ureolysis driven mineral sealing strategies for environmental engineering applications.”

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

Matthew Fields, CBE director, presented “Does forced cooperation lead to improved productivity in a multi-species biofilm?” at Biofilms7 Conference, Porto, Portugal, June 26–28, 2016.

The following CBE doctoral students presented research at 6th Annual Conference on Algal, Biomass, Biofuels, and Bioproducts, San Diego, CA, June 26–29, 2016:

Tisza Bell, PhD candidate, microbiology & immunology, presented a platform presentation “Monitoring community ecology in wastewater treatment lagoons for the production of algal biodiesel.”

Karen Moll, PhD student, microbiology & immunology presented the poster “Genomics of novel high biofuel-producing diatom.”

Muneeb Rathore, PhD student, chemical & biological engineering, presented two posters “Novel algal biofilm reactor with harvesting mechanism for enhanced biomass production” and “Promoting lipid accumulation in *Chlorella vulgaris* UTEX395 using nitrogen limitation and bicarbonate amendment under different nitrogen regimes.”

Adrienne Phillips, assistant professor, civil engineering, presented a poster “Biomining: A promising method to improving wellbore integrity,” at the Workshop on Well Integrity for Natural Gas Storage in Depleted Reservoirs and Aquifers, Denver, CO, July 12–13, 2016.

The following CBE researchers presented posters at the ENIGMA meeting, Berkeley, CA, August 1–6, 2016:

Sara Altenburg, CBE research lab manager, presented “Particle size impacts carrying-capacity for biofilm via reduction of free pore space and limitation for required resource ratio.”

Laura Camilleri, PhD candidate, microbiology & immunology, presented “Differential activity levels for bacterial and archaeal populations in an interdomain biofilm.”

Matthew Fields, CBE director, delivered an oral presentation “Soil particle mesogenomics— ‘Microparticles’ .”

Lauren Franco, PhD student, microbiology & immunology, presented “Resource ratio impacts *Desulfovibrio vulgaris* reduction and response to Cr(VI).”

Gregory Krantz, PhD student, microbiology & immunology, presented “Bulk phase resource ratio alters electron transfer mechanisms in sulfate-reducing biofilms grown on metal.”

Jim Wilking, assistant professor, chemical & biological engineering, presented “Structure and mechanics of microbial biofilms,” at the 2016 SIAM Conference on Nonlinear Waves and Coherent Structures meeting, Philadelphia, PA, August 8–11, 2016.

Gregory Krantz, PhD candidate, microbiology & immunology, presented “Bulk phase resource ratio alters electron transfer mechanisms in sulfate-reducing biofilms grown on metal,” at ISME Conference in Montreal, Quebec, Canada, August 21–26, 2016.

Phil Stewart, professor, chemical & biological engineering, as an invited speaker presented “Antimicrobial tolerance in biofilms: Physics, chemistry, biology,” at Vikki Biocenter Lecture, University of Helsinki, Finland, August 22, 2016.

Sarah Codd, professor, mechanical and industrial engineering, presented an invited lecture “Characterizing gels by NMR porous media methods: Direct measurement of glass dynamics and mesh network size in a solvent polymer system by multidimensional relaxometry and diffusometry,” at the 13th International Conference on Magnetic Resonance in Porous Media, Bologna, Italy, September 4–8, 2016.

Anne Camper, professor, civil engineering, presented “Water, our voice to the future: climate change adaptation and waterborne disease prevention on the Crow Reservation” at EPA’s 2016 STAR Tribal Research Meeting at Research Triangle Park in Durham, NC from September 20–21, 2016.

The following CBE faculty and students presented research at GSA, Denver, CO, September 25–28, 2016:

Oral Presentations:

Adrienne Phillips, assistant professor, civil engineering: “Biomineralization: A strategy to modify permeability in the subsurface.”

Katie Davis, PhD student, civil engineering: “Identifying the source, pathways, and rates of enhanced microbial coalbed methane.”

Poster presentations:

Katie Davis, PhD student, civil engineering: “Scale up of microbially enhanced coalbed methane strategies using a column upflow reactor.” Katie received the Outstanding Poster Presentation Award for the Environmental and Engineering Geology Division Student Research Competition.

Drew Norton, masters student, civil engineering: “Visualizing and quantifying biomineralization in a wellbore analog reactor.”

Margaux Meslé, CBE postdoctoral research associate, presented “Design of a small-scale high-pressure reactor system to study microbial bioconversion of coal to methane,” at GSA (Geological Society of America), Denver, CO, September 27, 2016.

Darla Goeres, associate research professor, chemical & biological engineering, was invited to present “The need for standardized biofilm methods for medically relevant applications” at the Antimicrobial Resistance in Microbial Biofilm and Options for Treatment Conference, Ghent, Belgium, October 5–7, 2016.

Diane Walker, CBE research engineer, as an invited speaker presented “Modifications to the CDC biofilm growth reactor method (ASTM E2562-12) for mixed species and *Legionella pneumophila* studies,” at the RAMC (Recent Advances in Microbial Control) Meeting in San Diego, CA, October 9–12, 2016.

John Doyle, project coordinator, microbiology & immunology, and **Mari Eggers**, CBE research scientist, presented “Exploring effects of climate change on Tribal water and health,” at the American Water Resources Association Montana Conference in Anaconda, MT from October 12–14, 2016.

Phil Stewart, professor, chemical & biological engineering, as an invited speaker presented “Preventing biofilm infections” at Biofilms, Ecology, and Human Health Symposium, University of Michigan, Ann Arbor, MI, October 21, 2016.

Robin Gerlach, professor, chemical & biological engineering, presented “Alkaliphilic algal cultivation as a means for improved productivity and stability of algae-based production systems,” and was a moderator for the ‘Synthetic Biology for Algae and Consortia’ panel at the Algal Biomass Summit in Phoenix AZ, October 25, 2016.

The following CBE faculty presented research at Reservoir Microbiology Forum in London England, November 15–16, 2016:

Matthew Fields, CBE director: “Bulk phase resource ratio alters electron transfer mechanisms in sulfate-reducing biofilms grown on metal” and “Aqueous sulfate levels control methanogen diversity and activity in subsurface coal seams.”

Robin Gerlach, professor, chemical & biological engineering: “Biocementation for wellbore integrity restoration and enhanced resource recovery,” and “Identifying the source, pathways, and rates of microbial coalbed methane production.”

Phil Stewart, professor, chemical & biological engineering, presented “Biofilm control and antimicrobial surfaces,” as an invited speaker at the National Academies of Sciences, Engineering, and Medicine Conference, Washington, DC, December 1, 2016.

Matthew Fields, CBE director, gave a seminar at New Castle University entitled “Trying to understand interactions and activities in biofilm,” in New Castle, England, January 14–20, 2017.

Matthew Fields, CBE director, gave a workshop during the 2017 Genomic Sciences Program Annual Principal Investigator PI Meeting in Washington, DC, February 6–8, 2017.

Heidi Smith, CBE postdoctoral researcher, presented a poster entitled “Temporal variability and microbial activity in groundwater ecosystems,” at the DOE PI Meeting in Washington, DC, February 5–8, 2017.

Jim Wilking, assistant professor, chemical & biological engineering, gave a lecture entitled “Mechanics and flow in microbial biofilms,” at the Biophysical Society 61st Annual Meeting in New Orleans, LA on February 11, 2017.

Connie Chang, assistant professor, chemical & biological engineering, presented “VIPER: Viral Interdiction through Population Engineering and Restructuring” at the annual Defense Advanced Research Projects Agency (DARPA) kickoff meeting in Arlington, VA, March 22–23, 2017.

Al Parker, CBE biostatistician, presented the poster “Evaluation of the effectiveness of 2% tetra sodium EDTA against six antibiotic resistant organisms in an in vitro vascular catheter model,” SHEA Spring 2017 Conference, St. Louis, MO, March 29–31, 2017.

Neerja Zambare, PhD student, chemical & biological engineering, presented “Optimizing microbially induced calcite precipitation under radial flow conditions,” at the 253rd American Chemical Society Meeting & Exposition in San Francisco, CA, April 2–6, 2017.

Garth James, associate research professor, chemical & biological engineering, presented “Biofilms in chronic wounds” during the 2017 Society for Biomaterials Meeting in Minneapolis, MN, April 7–8, 2017.

Emily Hultin, undergraduate, chemical & biological engineering, presented a poster entitled “Riverine

carbon cycling as a function of seasonality,” at the Montana Academy of Science, Butte, MT, April 7, 2017.

The following CBE researchers presented research at the National Council on Undergraduate Research, Memphis, TN, April 6–8, 2017:

Emily Hultin, undergraduate, chemical & biological engineering presented “Characterization of Antarctic algae for biofuel potential.” (oral presentation)

Taylor Oeschger, undergraduate, chemical & biological engineering, presented “Application of laser etching and 3D printed polymers for modeling ice vein habitats.” (oral presentation)

Rita Park, undergraduate student, microbiology & immunology, presented “Effect of coal particle size on microbial methanogenesis in the presence of oxygen.” (poster presentation)

Hanna Showers, undergraduate, chemical & biological engineering, presented “Rheological and atomic force microscopy investigation of carotenoid pigmented Antarctic heterotrophic bacteria.” (oral presentation)

MiKally Williams, undergraduate, chemical & biological engineering, presented “Growth and applications of biosurfactants in polar regions and space frontiers,” at the Montana Space Grant Consortium Student Research Symposium in Bozeman, MT on April 8, 2017.

Darla Goeres, associate research professor, chemical & biological engineering, presented “ISO Method 846 Part C: Update on modifications to make the test quantitative” at the IBRG Spring Meeting 2017 in Berlin, Germany from April 25–27, 2017.

Abby Thane, CBE research lab manager, gave a talk entitled “Remediation of coal combustion residuals using microbially-induced calcite precipitation,” at the World of Coal Ash Conference in Lexington, KY on May 8–11, 2017.

RESEARCH: NEWS HIGHLIGHTS

MSU team recognized for technology that seals oil and gas leaks

CBE affiliated faculty **Adrienne Phillips**, **Robin Gerlach**, and **Al Cunningham** were featured by *MSU News* for their research that has demonstrated the potential for biofilm and mineral-producing bacteria to stop tiny, hard-to-reach leaks in underground oil and gas wells.

Read the article at MSU News: [“MSU team shows biofilm and mineral-producing bacteria have potential for plugging oil and gas leaks”](#)

The story was also featured in the *Bozeman Daily Chronicle*: [“MSU research shows bacteria could plug oil and gas leaks”](#)

CBE biostatistician part of landmark study correlating hand-washing and health insurance claims

Al Parker, CBE biostatistician, provided statistical analysis on an important study that is the first to prove a direct link between the availability of a comprehensive hand hygiene program and a reduction in healthcare insurance claims tied to hand hygiene preventable illnesses. The study was conducted by Medical Mutual of Ohio and GOJO, a leading producer of skin health and hygiene solutions for commercial use. The full article “Impact of a comprehensive workplace hand hygiene program on employer healthcare insurance claims plus costs, absenteeism, and employee perceptions and practices,” was featured in the June 2016 issue of the *Journal of Occupational and Environmental Medicine*.

Related press release: [“PURELL® hand sanitizer and hand sanitizing wipes in workplace helped reduce healthcare insurance claims for cold and flu by 24%”](#)

Citation: Arbogast JW, Moore-Schiltz L, Jarvis WR, Harpster-Hagen A, Hughes J, **Parker A**, “Impact of a comprehensive workplace hand hygiene program on employer healthcare insurance claims plus costs, absenteeism, and employee perceptions and practices,” *J Occup Environ Med*. 2016 Jun; 58(6):e231–e240.

CBE faculty member to study biofilms and draught beer lines

CBE faculty **Darla Goeres**, associate research professor in chemical and biological engineering, partnered with the Brewers Association and NSF International Applied Research Center (ARC) to conduct a draught beer line study. This groundbreaking study will draw on the combined expertise of the ARC and the CBE, which includes decades of experience researching biofilm in industrial settings and internationally recognized quality standards related to public health and sanitation. “By combining the method development expertise of the CBE with the unique, rapid testing ability of the NSF International Applied Research Center, we are confident that a reliable, reproducible method will be created to assist the brewing industry with an effective draught beer line standard cleaning method,” stated Goeres.

Read more about this project at: [“BA addresses draught beer quality best practices with groundbreaking study”](#)

CBE researchers receive grant to address water issues on Crow Reservation

CBE researchers **Mari Eggers**, research scientist, and **Anne Camper**, Regents Professor in civil engineering, are part of a team that recently received a \$5 million grant to address well water issues on the Crow Reservation in southeastern Montana.

Read the full story at MSU News: [“MSU, Little Big Horn College researchers receive grant to address well water issues on Crow Reservation”](#)

CBE researchers receive funding to study eco-friendly alternatives to cleaning with biocides

CBE affiliated faculty **Christine Foreman**, associate professor in chemical and biological engineering, Kevin Cook, associate professor in mechanical engineering, and Markus Dieser, assistant research professor, were awarded funding from the National Science Foundation's Civil, Mechanical and Manufacturing Innovation program for their proposal "Eradication of microbial contamination in metalworking fluids." As explained in the proposal to NSF, in many manufacturing processes, metalworking fluids (MWFs) are applied to ensure reduced tool wear and workpiece quality. However, microbial contamination is a significant factor in the degradation of these fluids, causing biofouling and corrosion of equipment, imperilment of product quality, and posing occupational safety risks. Even after meticulous cleaning and the use of biocides, biofilms residing within the inaccessible regions of the system rapidly re-populate in MWFs. The study will investigate a novel MWF management strategy for biofilm eradication as an eco-friendly alternative to biocides.

CBE faculty member awarded grant from US Army Research Office

CBE faculty member **Ross Carlson**, professor in MSU's Department of Chemical and Biological Engineering, was awarded a three-year grant from the US Army Research Office for his research on the role different species of bacteria play in microbial communities. Read about Carlson's research at MSU News: ["MSU engineering professor awarded U.S. Army Research Office grant"](#)

CBE faculty member receives \$1.3M to develop virus fighting technology

CBE affiliated faculty member **Connie Chang**, assistant professor in MSU's Department of Chemical and Biological Engineering, received a \$1.3 million grant from the Defense Advanced Research Projects Agency (DARPA), an independent agency of the U.S. Department of Defense that funds high-risk, high-reward projects. Chang and her research group will explore the use of a sophisticated method called drop-based microfluidics for producing therapeutic interfering particles, or TIPs, for treating influenza.

Read more about Dr. Chang's research at MSU News: ["MSU researcher receives \\$1.3 million to develop virus-fighting technology"](#)

CBE researchers publish study on glacial carbon cycling in *Nature Geoscience*

Heidi Smith, CBE postdoctoral researcher, and **Christine Foreman**, CBE affiliated faculty member and associate professor of chemical and biological engineering, were co-authors of a paper published in the prestigious journal *Nature Geoscience*. The paper "Microbial formation of labile organic carbon in Antarctic glacial environments," explains an undiscovered dynamic carbon cycle in melting glaciers in the Arctic and Antarctic that has global implications as the bulk of Earth's glaciers shrink in response to a warming climate.

Read more about their publication at MSU News: ["MSU scientists publish study on glacial carbon cycle"](#)

The article was also featured on the NSF website:

https://www.nsf.gov/news/news_summ.jsp?cntn_id=191512&org=NSF&from=news

Citation: **Smith HJ**, Foster RA, McKnight DM, Lisle JT, Kuypers MMM, **Foreman CM**
 "Microbial formation of labile organic carbon in Antarctic glacial environments"
Nature Geosci., 2017 April 3; 10(5):356–9.

RESEARCH:
 CBE Affiliated Faculty and Their Specialties, 2016–2017

NAME	DEPARTMENT	SPECIALTY
Elliott Barnhart	Center for Biofilm Engineering	Environmental biotechnology
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
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
Ellen Lauchnor	Civil Engineering	Environmental engineering
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
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
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 and industrial systems
James Wilking	Chemical & Biological Engineering	Physical and material biofilm properties
Tianyu Zhang	Mathematical Sciences	Mathematical modeling

CBE Affiliated Faculty Awards & News

2017 College of Engineering Awards

MSU's College of Engineering honored faculty, staff, and students at its annual awards luncheon on May 3, 2017. Center for Biofilm Engineering affiliated faculty member **Christine Foreman** received the college's **Excellence in Advancing Diversity Award**. The award is given to a faculty or staff member engaged in advancing the careers of underrepresented people, and creating and championing diversity at Montana State University.

2016–2017 Tenure and Non-tenure Track Faculty Appointments

Roland Hatzenpichler was appointed to MSU's Department of Chemistry and Biochemistry as an assistant professor. Roland received his PhD in microbial ecology from the University of Vienna in Austria in 2011, and recently completed a postdoctoral scholar position in geobiology at the California Institute of Technology. Roland's research interest is in the function and activity of the "uncultivated majority" of microorganisms, and how their physiology impacts the environment across a range of scales, from micron to global. Roland also joined the CBE as an affiliated faculty member. For more information on Roland's work, visit his website: www.environmental-microbiology.com

Two CBE postdoctoral researchers were recently appointed to assistant research professor positions in MSU's Department of Chemical and Biological Engineering.

Markus Dieser received his PhD in ecology and environmental sciences from Montana State University in 2009. He joined the lab of Christine Foreman, associate professor chemical and biological engineering, as a postdoctoral fellow in 2013. Dieser's research focus is microbial ecology and biocorrosion.

Dana Skorupa earned her PhD in microbiology at MSU, studying acid-loving algae that inhabit some of Yellowstone National Park's hot springs. Her current research focuses on trying to isolate novel, relevant, and robust extremophilic microorganisms from alkaline hot springs in Yellowstone's Heart Lake Geyser Basin. Skorupa is also co-instructor of the MSU undergraduate course "Extreme Microbiology in Yellowstone," which allows students to experience hands-on field study in Yellowstone National Park.

CBE Staff Awards & News

2017 Outstanding Researcher Award

Laura Boegli, CBE research scientist, received the 2017 Outstanding Researcher Award at 2017 Montana Biofilm Meeting. Laura was recognized for her many behind-the-scenes yet significant contributions to CBE education, research, and outreach. Laura spends many hours mentoring students demonstrating great commitment to the highest standards of laboratory organization and hygiene and is an outstanding example of the willingness to collaborate and share.

New Staff

CBE welcomed the following postdoctoral researchers to its staff:

Heejoon Park joined the lab of **Ross Carlson**, professor of chemical and biological engineering. Heejoon earned his PhD from the University of Wyoming where he studied the synthesis of bioconjugates (enzyme-magnetic nanoparticles) to utilize recyclable biocatalysts in biological processes. After earning his PhD, he worked as a research engineer at Lotte Petrochemical Corporation. At the CBE, Heejoon will be working on Carlson's Army research project on the development of robust microbial communities through engineered biofilm. Heejoon enjoys playing all racquet sports, though tennis is his favorite. He's very happy to have joined the CBE and knows it will be the perfect place to explore the magical biofilm turf.

Niranjan Ghimire joined **Phil Stewart's** lab (professor of chemical and biological engineering). Niranjan earned his PhD in biomedical engineering from the University of South Dakota in May 2016. His research focus was developing antimicrobial orthopedic titanium material. Most recently, Niranjan worked as a research assistant in the Department of Biomedical

Engineering at the University of South Dakota. While at the CBE, he will be researching neutrophil-biofilm interactions in Dr. Stewart's lab. Niranjan hails from Bharatpur in Chitwan district, Nepal. When he's not in the lab, Niranjan likes to watch soccer and play tennis.

Viola Krukenberg is working for **Roland Hatzenpichler**, assistant professor in chemistry and biochemistry. Viola earned her PhD in marine microbiology from the University of Bremen, Germany in 2015. She was a postdoctoral researcher at the Max Planck Institute for Marine Microbiology before joining Dr. Hatzenpichler's lab. Viola will be studying the physiology of uncultured microbes in deep-sea sediments to understand their function in the transformation of diverse carbon compounds.

Sarah Gorlitz-Burk joined the CBE as business manager. Sarah graduated from Montana State University with a bachelor's degree in business accounting and has worked on campus for five years in MSU's business office and audit services. As the CBE business manager, Sarah oversees all budget and fiscal matters. A Bozeman native, Sarah enjoys skiing, boating, and spending time with her husband and two children. The CBE is pleased to have found someone with her strong credentials and positive attitude to fill this key position.

Coltran Hophan-Nichols joined the CBE as a computer systems analyst. Coltran graduated from Montana State University in May 2015 with a bachelor's degree in computer science. He has over four years of work experience in the information technology sector, both in operations and customer service. Coltran will be the CBE's go-to person for IT analysis and support including desktop and server support, security, computer hardware and devices, and user training. In his free time, Coltran enjoys Montana's outdoor activities including skiing, mountain biking, and hiking.

EDUCATION:

Undergraduate Students: Summer 2016, Fall 2016, Spring 2017

*Graduating

‡ Native American

1.	Aman, Lydia (Lauchnor)	F	Chem & Bio Eng	Homesdale, ID
2.	*Alagoz, Helin (Gerlach)	F	Chem & Bio Eng	Turkey
3.	*Alanazi, Khalid (Wilking)	M	Chem & Bio Eng	Saudi Arabia
4.	Anderson, Rebekah (Peyton)	F	Chem & Bio Eng	Golden, CO
5.	Avila, Nickolas (Gerlach)	M	Chem & Bio Eng	Richland, WA
6.	Benjamin, Aaron (Wilking)	M	Mech & Indust Eng	New Rochelle, NY
7.	Boise, Noelani (Peyton)	F	Land Resources & Environ Sci	Livingston, MT
8.	Blossom, Taylor (Carlson)	M	Chem & Bio Eng	Helena, MT
9.	Boyl-Davis, Martin (Fields)	M	Chem & Bio Eng	Snohomish, WA
10.	Bowditch, Mason (Stein)	M	Civil & Environ Eng	Missoula, MT
11.	Branine, Margaret (Hatzenpichler)	F	Microbiology & Immunology	Canon City, CO
12.	*Burt, Kevin (Lauchnor)	M	Civil & Environ Eng	Butte, MT
13.	*Crawford, James (Peyton)	M	Chem & Bio Eng	Bozeman, MT
14.	David, Jonas (James)	M	Modern Lang & Lit	Fort Collins, CO
15.	*Dickerman, Grace (Goeres)	F	Chem & Bio Eng	Cody, WY
16.	Dorle, Michael (Hatzenpichler)	M	Microbiology & Immunology	St. Cloud, MN
17.	Dupuis, Lauren (Chang)	M	Chem & Bio Eng	Polson, MT
18.	Eddy, Zachary (Fields)	M	Land Resources & Environ Sci	Great Falls, MT
19.	Ekness, Thayne (Peyton)	M	Chem & Bio Eng	Westby, MT
20.	*Exner, Katie (Chang)	F	Chem & Bio Eng	Hamilton, MT
21.	*Franz, Brian (Fields)	M	Chem & Bio Eng	Goodfield, IL
22.	*Fox, Amy (Chang)	F	Chem & Bio Eng	Belgrade, MT
23.	*Frieling, Zach (Gerlach/Phillips)	M	Chem & Bio Eng	Gallatin Gateway, MT
24.	Grodner, Ben (Wilking)	M	Chem & Bio Eng	Mosier, OR
25.	*Gutknecht, Andrew (Peyton)	M	Chemistry & Biochemistry	Buffalo, MN
26.	Haller, Gregory (Gerlach)	M	Chem & Bio Eng	Lakewood, CO
27.	*Hobbs, Trace (Lauchnor/Gerlach)	M	Chemistry & Biochemistry	Kalispell, MT
28.	*Hultin, Emily (Foreman)	F	Chem & Bio Eng	Helena, MT
29.	Lee, Fei San (Goeres)	F	Chem & Bio Eng	Malaysia
30.	Johnson, Spencer (Gerlach)	M	Chem & Bio Eng	Boise, ID
31.	Johnson, Timothy (Carlson/Heys)	M	Chem & Bio Eng	Renton, WA
32.	*Jones, Michael Steven (Phillips)	M	Civil & Environ Eng	Ennis, MT
33.	Keepseagle, Kayla (Codd/Seymour)	F	Chem & Bio Eng	Bismark, ND
34.	Kieffer, Whitney (Lauchnor)	F	Chem & Bio Eng	Richland, WA
35.	Klingelsmith, Korinne (Fields)	F	Chem & Bio Eng	Fort Collins, CO
36.	*Koc, Gunes (Peyton)	M	Chem & Bio Eng	Turkey
37.	Massey, KaeLee (Fields)	F	Chem & Bio Eng	Billings, MT
38.	*Meagher, Michelle (Peyton)	M	Chem & Bio Eng	Idaho Falls, MT
39.	Moeun, Youra (Wilking)	F	Chem & Bio Eng	Cambodia
40.	*Nuhoglu, Gulcin (Foreman)	F	Chem & Bio Eng	Turkey
41.	*Oeschger, Taylor (Foreman)	F	Chem & Bio Eng	Sacramento, CA
42.	*Oloff, Esther (Chang)	F	Chem & Bio Eng	Idaho Falls, ID
43.	Olson, Caitlin (Fields)	F	Chem & Bio Eng	Helena, MT
44.	Osborn, Alison (Fields)	F	Civil & Environ Eng	Fort Collins, CO
45.	*Parson, Amanda (Codd/Seymour)	F	Chem & Bio Eng	Acton, MT
46.	Parrett, Brian (James)	M	Microbiology & Immunology	Rochester, NY
47.	Park, Rita (Phillips/Fields)	F	Microbiology & Immunology	Butte, MT
48.	Peters, Daniel (Gerlach)	M	Chem & Bio Eng	Butte, MT
49.	*Platt, George (Gerlach)	M	Chem & Bio Eng	Big Timber, AK
50.	Polukoff, Natalya (Goeres)	F	Microbiology & Immunology	Park City, UT

51. *Pratt, Shawna (Chang)	F	Chem & Bio Eng	Miles City, MT
52. Scott, Derrick (Fields)	M	Microbiology & Immunology	Cody, WY
53. *Showers, Hanna (Foreman)	F	Chem & Bio Eng	Missoula, MT
54. Stangeland, James (Stewart)	M	Chem & Bio Eng	Helena, MT
55. Stockton, Bronwyn (Fields)	F	Microbiology & Immunology	South Jordan, UT
56. Stone, Kyle (Gerlach)	M	Chem & Bio Eng	Anchorage, AK
57. Szafraniec, Hannah (Chang)	F	Chem & Bio Eng	Bloomington, MN
58. Thompson, Jared (Chang)	M	Chem & Bio Eng	Whitefish, MT
59. *Wells, Makayla (James)	F	Chemistry & Biochemistry	Belgrade, MT
60. Wigle, Daniel (Chang)	M	Microbiology & Immunology	Kalispell, MT
61. *Williams, MiKalley (Foreman)	F	Chem & Bio Eng	Great Falls, MT
62. Worum, Bjorn (Gerlach)	M	Chem & Bio Eng	Fairbanks, AK

Undergraduates Summary: 2016–2017

Department (Program)	Male	Female	Total
Chemical & Biological Engineering	21M	21F	42
Chemistry & Biochemistry	2M	2F	4
Civil Engineering	3M	1F	4
Land Resources & Environ Sci (LRES)	1M	1F	2
Mechanical & Industrial Engineering	1M		1
Microbiology & Immunology	4M	4F	8
Modern Languages & Literature	1M		1
Totals	33 M	29 F	62

EDUCATION:

Graduate Students: Summer 2016, Fall 2016, Spring 2017

‡ Native American *Received degree

Masters Candidates

1.	*Berglund, Emily (Wilking)	F	Chem & Bio Engineering	Helena, MT
2.	*Bernard, Garrett (Chang)	M	Material Sciences	Leitchfield, KY
3.	Beser, Guneycon Dicle (Phillips)	F	Civil & Environ Engineering	Turkey
4.	*Ertuna, Cagan (Peyton)	M	Chem & Bio Engineering	Cyprus
5.	LeFevre, Thomas (Wilking)	M	Chem & Bio Engineering	Escanaba, MI
6.	Nitzinger, Violeta (Eggers)	F	Health & Human Develop	Livingston, MT
7.	Morasko, Vincent (Gerlach/Phillips)	M	Chem & Bio Engineering	Glendive, MT
8.	Ozcan, Safiye Selen (Foreman)	F	Chem & Bio Engineering	Turkey
9.	*Pelizzaro, Aline (Fields)	F	Microbiology & Immunology	Brazil
10.	*Pedersen, Todd (Peyton)	M	Chem & Bio Engineering	Poulsbo, WA
11.	Raeseide, Emma (Stein)	F	Civil & Environ Engineering	Rochester, NY
12.	Reichart, Nicholas (Hatzenpichler)	M	Microbiology & Immunology	Bel Air, MD
13.	*Schaefer, Robert (Chang)	M	Chem & Bio Engineering	Bothell, WA
14.	‡Schott, Ralene (Eggers)	F	Nursing	Butte, MT
15.	Silva, Esther (Eggers)	F	Nursing	Bozeman, MT
16.	Stoick, Emily (Lauchnor)	F	Civil & Environ Engineering	Kalispell, MT
17.	Summers, Jennifer (Goeres)	F	Chem & Bio Engineering	Conowingo, MD
18.	Wallis, Jack (Stein)	M	Civil & Environ Engineering	Vancouver, WA
19.	*White, Benjamin (Franklin)	M	Microbiology & Immunology	Grand Island, NE
20.	Woodhouse, Shayla (Stein)	F	Civil & Environ Engineering	San Diego, CA
21.	*Yanardag, Sila (Franklin)	F	Microbiology & Immunology	Turkey

PhD Candidates

1.	Abbasi, Reha (Wilking)	M	Chem & Bio Engineering	Turkey
2.	Akiyama, Tatsuya (Franklin)	M	Microbiology & Immunology	Japan
3.	Akyel, Arda (Gerlach)	M	Chem & Bio Engineering	Turkey
4.	Anjum, Sobia (Gerlach)	F	Civil & Environ Engineering	Pakistan
5.	Beck, Ashley (Carlson)	F	Microbiology & Immunology	Corning, ID
6.	*Bell, Tisza (Fields/Peyton)	F	Microbiology & Immunology	Littleton, CO
7.	Brame, Keenan (Camper)	M	LRES	Livingston, MT
8.	Camilleri, Laura (Fields)	F	Microbiology & Immunology	Ukiah, CA
9.	Corredor Arias, Luisa (Fields)	F	Microbiology & Immunology	Colombia
10.	Davis, Katherine (Gerlach/Fields)	F	Civil & Environ Engineering	Green Creek, NC
11.	Figgins, Devin (Chang)	M	Chem & Bio Engineering	Kent, WA
12.	Franco, Lauren (Fields)	F	Microbiology & Immunology	Moorpark, CA
13.	*Hunt, Kristopher (Carlson)	M	Chem & Bio Engineering	Thorp, WI
14.	Jackson, Matthew (Gerlach)	M	Civil & Environ Engineering	Naples, FL
15.	Koepnick, Hannah (Peyton)	F	Chem & Bio Engineering	Sherman, TX
16.	*Kirkland, Catherine (Codd/Seymour)	F	Civil & Environ Engineering	Bozeman, MT
17.	Krantz, Gregory (Fields)	M	Microbiology & Immunology	Tinmouth, VT
18.	Mery, Stephen (Lauchnor)	M	Civil & Environ Eng	Danielsville, PA
19.	McGill, Stacy (Carlson)	M	Microbiology & Immunology	Minor Hill, TN
20.	Moll, Karen (Peyton)	F	Microbiology & Immunology	Fairport, NY
21.	Rathore, Muneeb (Peyton)	M	Chem & Bio Engineering	Pakistan
22.	*Schoen, Heidi (Peyton)	F	Chem & Bio Engineering	Geneva, IL
23.	Schweitzer, Hannah (Fields)	F	Microbiology & Immunology	Chester, MT
24.	Sidar, Barkan (Wilking)	M	Chem & Bio Engineering	Turkey
25.	Simkins, Jeffrey (Stewart)	M	Chem & Bio Engineering	Bozeman, MT
26.	Smith, Pamela (Eggers)	F	Nursing	Butte, MT
27.	Thuen, Adam (Chang)	M	Microbiology & Immunology	Burlington, ND
28.	Walsh, Danica (Stewart)	F	Chemistry & Biochemistry	Olympia, WA
29.	Zambare, Neerja (Gerlach)	F	Chem & Bio Engineering	India
30.	Zath, Geoffrey (Chang)	M	Chem & Bio Engineering	Bend, OR
31.	Zelaya, Anna (Fields)	F	Microbiology & Immunology	Russellville, AK

EDUCATION:
 Graduate Students, 2016–2017

19: Chemical & Biological Engineering

MS: 8

5 M Ertuna, Cagan: MS, *Peyton*
 LeFevre, Thomas: MS, *Wilking*
 Morasko, Vinny: MS, *Gerlach/Phillips*
 Pedersen, Todd: MS, *Peyton*
 Schaefer, Robert: MS, *Chang*

3 F Berglund, Emily: MS, *Wilking*
 Ozcan, Safiye Selen: MS, *Foreman*
 Summers, Jennifer: MS, *Goeres*

PhD: 11

8 M Abbasi, Reha: PhD, *Wilking*
 Akyel, Arda: PhD, *Gerlach*
 Figgins, Devin: PhD, *Chang*
 Hunt, Kristopher: PhD, *Carlson*
 Rathore, Muneeb: PhD, *Peyton*
 Sidar, Barkan: PhD, *Wilking*
 Simkins, Jeffrey: PhD, *Stewart*
 Zath, Geoffrey: PhD, *Chang*

3 F Koepnick, Hannah: PhD, *Peyton*
 Schoen, Heidi: PhD, *Peyton/Carlson*
 Zambare, Neerja: PhD, *Gerlach*

1: Chemistry & Biochemistry

PhD: 1

1 F Walsh, Danica: PhD, *Stewart*

10: Civil / Environmental Engineering

MS: 5

1 M Wallis, Jack: MS, *Stein*

4 F Beser, Guneycon Dicle: MS, *Phillips*
 Raeside, Emma: MS, *Stein*
 Stoick, Emily: MS, *Lauchnor*
 Woodhouse, Shayla: MS, *Stein*

PhD: 5

2 M Mery, Stephen: PhD, *Lauchnor*
 Jackson, Matthew: PhD, *Gerlach*

3 F Anjum, Sobia: PhD, *Gerlach*
 Davis, Katie: PhD, *Gerlach/Fields*
 Kirkland, Catherine: PhD, *Codd*

1: Health & Human Development

MS: 1

1 F Nitzinger, Violeta: MS, *Eggers*

1: Land Resources & Environmental Sciences

PhD: 1

1 M Brame, Keenan: PhD, *Camper*

1: Material Sciences

MS: 1

1 M Bernard, Garrett: MS, *Chang*

16: Microbiology

MS:

2 F Pelizzaro, Aline: MS, *Fields*
 Yanardag, Sila: MS, *Franklin*

2 M Reichart, Nicholas: MS, *Hatzenpichler*
 White, Benjamin: MS, *Franklin*

PhD: 10

4 M Akiyama, Tatsuya: PhD, *Franklin*
 Krantz, Gregory: PhD, *Fields*
 McGill, Stacy: PhD, *Carlson*
 Thuen, Adam: PhD, *Chang*

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

3: Nursing

MS: 2

2F Schott, Ralene: MS, *Eggers*
 Silva, Esther: MS, *Eggers*

PhD: 1

1 F Smith, Pamela: PhD, *Eggers*

TOTALS

Total Grads: 52

Total MS: 21 9 M / 12 F
 Total PhD: 31 15 M / 16 F

Total Male: 24
 Total Female: 28

EDUCATION:

Graduating with advanced degrees: June 2016–June 2017

Kylie Bodle, MS, Civil Engineering, July 2016

Effects of Triclosan exposure on nitrification in activated sludge, biofilms, and pure cultures of nitrifying bacteria

Todd Pedersen, MS, Chemical and Biological Engineering, August 2016

Use of bicarbonate salts in algal growth for enhancement of lipid content

Kristopher Hunt, PhD, Chemical and Biological Engineering, September 2016

Multiscale analysis of trophic interactions in microbial communities

Ben White, MS, Microbiology & Immunology, October 2016

Pseudomonas aeruginosa biofilms in an *in vitro* chronic wound model

Tisza Bell, PhD, Microbiology & Immunology, November 2016

Exploring complex systems and relationships in the quest for renewable algal biodiesel

Garret Bernhard, MS, Materials Science, December 2016

Non-thesis master's degree

Heidi Schoen, PhD, Chemical and Biological Engineering, January 2017

Fungal production of biofuel and flavor compounds in liquid and solid state

Emily Berglund, MS, Chemical and Biological Engineering, April 2017

Breaking up isn't hard to do: Crystal pressure in nanoscale pores

Catherine Kirkland, PhD, Civil Engineering, May 2017

Nuclear magnetic resonance studies of biofilm–porous media systems

Sila Yanardag, MS, Microbiology & Immunology, June 2017

Characterization of the stability of the *Pseudomonas aeruginosa* ribosomal proteins under stress conditions

EDUCATION:

2017 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration Friday, April 21, 2017. Among the more than 200 students presenting their research, numerous students were connected with the Center for Biofilm Engineering.

POSTERS

Graduate Students

Kevin Burt: Civil Engineering

Mentor: **Ellen Lauchnor, Neerja Zambare** -- Civil Engineering, Center for Biofilm Engineering
 "Calcium precipitation and trace metal co-precipitation during fluid flow and mixing"

Geoffrey Zath: Chemical & Biological Engineering
 Mentor: **Connie Chang** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "A high-throughput, multiplexed microfluidic method utilizing an optically barcoded drop library"

Undergraduate Students

Lydia Aman: Chemical & Biological Engineering
 Mentor: **Ellen Lauchnor** -- Civil Engineering, Center for Biofilm Engineering
 "Quantifying ammonia oxidation kinetics of *Nitrosomonas europaea* with competitive inhibition"

Taylor Blossom: Chemical & Biological Engineering
 Mentor: **Ross Carlson** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Bio-fuel production by community biofilm"

Jacob Carter-Gibb: Civil Engineering
 Mentor: **Connie Chang** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Microfluidic particles as a tool for monitoring oxygen levels in biofilms in magnetic resonance microscopy"

Lauren Dupuis: Chemistry & Biochemistry
 Mentor: **Connie Chang, Sharon Neufeldt** -- Center for Biofilm Engineering, Chemistry & Biochemistry
 "Krytox-PEG triblock copolymer surfactant synthesis and modification" *Awarded INBRE Top Poster

Zachary Frieling: Chemical & Biological Engineering
 Mentor: **Robin Gerlach** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Urease inhibition, transport, and distribution to better understand its subsurface behavior"

Kayla Keepseagle: Chemical & Biological Engineering
 Mentor: **Joseph Seymour** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Learning engineering through research on multidisciplinary topics"

Whitney Kieffer: Chemical & Biological Engineering
 Mentor: **Ellen Lauchnor** -- Civil Engineering, Center for Biofilm Engineering
 "Sorption of contaminants in treatment wetlands"

Youra Moeun: Chemical & Biological Engineering
 Mentor: **James Wilking** -- Center for Biofilm Engineering
 "Quantifying pharmaceutical composite breakup using acoustic methods"

Esther Oloff: Chemical & Biological Engineering
 Mentor: **Connie Chang** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Microfluidic techniques for encapsulating gastric organoids"

Caitlin Olson: Chemical & Biological Engineering
 Mentor: **Matthew Fields** -- Microbiology & Immunology, Center for Biofilm Engineering
 "Linking microbial biofilms to nitrate removal in groundwater sediments"

Madison Owens: Chemical & Biological Engineering
 Mentor: **James Wilking** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Developing a biocompatible formulation for stereolithographic 3D printing"

Daniel Peters: Chemical & Biological Engineering
 Mentor: **Robin Gerlach** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Characterizing algae growth and biomass composition under autotrophic, mixotrophic and heterotrophic conditions"

George Platt: Chemical & Biological Engineering
 Mentor: **Robin Gerlach** -- Chemical & Biological Engineering, Center for Biofilm Engineering
 "Attempting to identify the sources of microbial methane production from coal"

Shawna Pratt: Chemical & Biological Engineering

Mentor: **Connie Chang** – Chemical & Biological Engineering, Center for Biofilm Engineering

“Monitoring single-cell bacterial growth using drop-based microfluidics” *Awarded INBRE Top Poster

Rita Park: Microbiology & Immunology

Mentor: **Margaux Mesle, Adrienne Phillips, Matthew Fields** – Center for Biofilm Engineering

“Effect of coal particle size on microbial methanogenesis in the presence of oxygen”

Bronwyn Stockton: Biotechnology

Mentor: **Matthew Fields** – Center for Biofilm Engineering

“Carbon utilization in an anaerobic interdomain consortium”

EDUCATION:

News highlights

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

Isaac Miller, CBE research technician, received a prestigious NSF Graduate Research Fellowship to study fish and algae.

Miller received his undergraduate degree in ecology from MSU and for two years worked at the Bozeman Fish Technology Center. With this fellowship, Miller will continue his work on investigating the bacteria, viruses and other microorganisms that live inside the gastrointestinal tracts of fish. According to Miller, learning more about the complex microbial communities that live in fish, the fish microbiome as it's called, can help scientists understand how fish digest food and use their nutrients. That knowledge can help in the management of fish nutrition and growth, lead to the discovery of unique natural products, and provide basic knowledge that lays the foundation for future research projects applied to water and food needs for society.

This NSF program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering, and mathematics disciplines who are pursuing research-based masters and doctoral degrees at accredited US institutions.

Read more about Miller and his research at MSU News: [“MSU researcher receives NSF Graduate Research Fellowship to study fish and algae”](#)

CBE undergrads present research at national conference

Five MSU-CBE undergraduate students presented their research at the 31st annual National Conferences on Undergraduate Research held in April at the University of Memphis in Tennessee. **Brooke Filanoski, Emily Hultin, Taylor Oeschger, Rita Park, and Hanna Showers** were among 13 MSU students who traveled to Tennessee to present their work. To read about their research and the conference, go to MSU News: [“MSU students present projects at national conference that promotes undergraduate research.”](#)

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

Drew Norton, MSU master's student in civil engineering, earned the Judges Prize for his presentation “Reducing leaky well emissions by growing biocement seals,” during the 3-Minute Thesis event on MSU's campus.

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

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

In three minutes, Norton was able to successfully explain how the application of *Sporosarcina pasteurii*, a mineral-producing bacteria, can stop tiny, hard-to-reach leaks in underground oil and gas wells and potentially prevent harmful

gases, like methane, from migrating to the surface and becoming airborne.

For a complete list of the finalists, go to MSU News Service: [“Three minute thesis event set for March 3 at MSU”](#)

College of Engineering Awards

Neerja Zambare, MSU-CBE PhD student in chemical and biological engineering, was honored with the **Raymond E. and Erin S. Schultz Emerging Fellowship Award** for the 2016–2017 academic year. The award is given to graduate students in MSU’s Department of Chemical and Biological Engineering in recognition of high academic performance in coursework and grades, and history of receiving awards, grants, and scholarships. The award also recognizes research accomplishments evidenced by publications and presentations.

Zambare earned her bachelor’s degree in chemical and biological engineering from Montana State University. She is now pursuing her doctorate degree at MSU studying the effects of reaction and transport of microbially induced calcium carbonate precipitation (MICP). MICP has been proven as an application to seal cracks in oil and gas wells. Zambare’s adviser is **Robin Gerlach**, CBE-affiliated faculty in chemical and biological engineering.

2017 W.G. Characklis Outstanding Student Award

The CBE presented the 2017 W.G. Characklis Outstanding Student Award to Catherine “Cat” Kirkland. Cat received the award in recognition of the intellectual curiosity and creativity that she brings to her interdisciplinary research project, the quality and productivity of her research including three first-author publications, her participation in service programs such as Engineers Without Borders and Shadow an Engineer Day, and her leadership in creating the Graduate Student Seminar Series and the Three Minute Thesis Competition.

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.

2017 CBE Student Citizen Award

Lauren Franco, PhD candidate in microbiology and immunology, received the 2017 CBE Student Citizen award. Lauren can be counted on to be kind and generous with her time and knowledge, but takes her responsibilities very seriously. She is a model of thoroughness and always shows respect for safety, equipment, training and her colleagues—qualities John Neuman strived to instill in students. Lauren also exemplifies the CBE culture of fellowship and togetherness outside the lab with her efforts organizing CBE TGIF events.

The Student Lab Citizen Award is open to any CBE student and recognizes a student's exceptional responsibility and good citizenship in his or her work at the CBE. Attributes that are considered in selecting awardees include: attention to laboratory safety and cleanliness, considerate use of shared spaces, respect for equipment and proper protocols, willingness to help fellow students and staff, strong work ethic, and commitment to CBE goals. The award is presented in honor of John Neuman, the CBE's Technical Operations Manager from 1994–2008 and was established by John’s family after his death in 2011.

EDUCATION:

CBE Seminar Series: Fall 2016

Montana State University, Roberts Hall 101, 4:10pm

Date	Speaker	Affiliation	Title/Topic
Sep 1	No Seminar—First Week of Classes		
Sep 8	Dr. Roland Hatzenpichler	Assistant Research Professor, Dept. of Microbiology & Immunology, MSU, CBE	Community dynamics and new cell-cell interactions of slow-growing archaeal-bacterial consortia from deep-sea methane seeps
Sep 15	Dr. Patricia Brennan	Visiting Professor, Dept. of Biological Sciences, Mount Holyoke College, South Hadley, MA	Time to step up in defense of science
Sep 22	No Seminar		
Sep 29	Dr. Chiachi Hwang	Industrial Research Scientist, CBE	Evaluation of Se reduction in saturated rocks backfills
Oct 6	Dr. Mike Franklin	Professor, Dept. of Microbiology & Immunology, MSU, CBE	Heterogeneity and dormancy in microbial biofilms
Oct 13	Dr. Megan Bergkessel	Post-Doctoral Fellow, Geobiology & Biological Engineering, California Institute of Technology, Pasadena, CA	Regulation of gene expression during slow growth in <i>Pseudomonas aeruginosa</i>
Oct 20	Dr. Marnie Feder	Post-Doctoral Research Associate, CBE	Investigating the kinetics and stability of eukaryotic and prokaryotic ureases for use in engineered applications
	Arda Akyel	MS Student, Dept. of Chemical & Biological Engineering, MSU, CBE	
Oct 27	Gregory Krantz	Ph.D. Candidate, Dept. of Microbiology & Immunology, MSU, CBE	Bulk phase resource ratio alters electron transfer mechanisms in sulfate-reducing biofilms grown on metal
Nov 3	Dr. J. Andrés Christen	Investigador Titular “B”, CIMAT, Guanajuato, Mexico	Bayesian statistics for scientific experiments: more kick for your experimental effort!
Nov 10	Dr. Patricia Tavormina	Associate Research Scientist, Geobiological & Planetary Sciences, California Institute of Technology, Pasadena, CA	A diverse assemblage of bacteria with atypical alkane oxidizing potential responded to the Porter Ranch gas leak
Nov 17	Dr. Dana Skorupa	Post-Doctoral Research Associate, CBE	A tale of two extremophiles: Enrichment of haloalkaliphilic biomineralizing bacteria & discovery of novel thermoalkaliphilic archaea
Nov 24	No Seminar- Thanksgiving Day		
Dec 1	Dr. Matthew Stott	Leader, Extremophiles Research Group at GNS Science, Taupō, New Zealand	The phenotypic, genomic and ecological characterisation of a candidate phylum OP10 representative: A cautionary tale
Dec 8	No Seminar- Last Week of Classes		

EDUCATION:

CBE Seminar Series: Spring 2017

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

Date	Speaker	Affiliation	Topic
Jan 12	No seminar—First week of classes		
Jan 19	No Seminar – CBE semi-annual rally		
Jan 23	Dr. Arwyn Edwards	Senior Lecturer, Biology, University of Wales, Aberystwyth, Wales	Exploring the microbial frontiers of our melting planet
Jan 26	Dr. Thomas Webster	Professor, Chair of the Department of Chemical Engineering, Northeastern University, Boston, Massachusetts	Nanotechnology for the control of bacterial functions
Feb 2	Dr. Qian Wang	Postdoctoral Visiting Scholar, Environmental Microbiology, MSU	Methylphosphonate metabolism contributes to the methane oversaturation paradox in oxic freshwater lakes
Feb 9	Dr. Seth Walk	Assistant Professor, Microbiology & Immunology, MSU	Engineered human intestinal organoids and arsenic detox by the human microbiome
Feb 16	Dr. Suzanne Ishaq	Postdoctoral Researcher, Land Resources and Environmental Sciences, MSU	Mapping the microbial development of the dairy calf digestive tract
Mar 9	Racheal Upton	PhD Candidate, Ecology, Evolution, Organismal Biology, Iowa State University, Ames, Iowa	A scaling approach to determine the drivers of complex soil microbial communities
Mar 15	No Seminar – Spring Break		
Mar 23	Dr. Blake Wiedenheft	Assistant Professor, Microbiology & Immunology, MSU	Bacteria, their viruses, and how they taught us to perform genome surgery
Mar 30	Joy Buongiorno	PhD Candidate, Microbiology, University of Tennessee, Knoxville, Tennessee	High-resolution microbial community abundance and composition analysis of two iron-rich fjords, Kongsfjorden and Van Keulenfjorden, Svalbard (79degN): implications for climate response
Apr 6	Undergraduate Research Day	Madison Owens, Chemical & Biological Engineering, MSU, CBE	Structuring synthetic biofilms with 3D printing
		Andrew Gutknecht, Chemistry & Biochemistry, MSU, CBE	Culturing thermoalkaliphilic <i>Aigarchaeota</i> from terrestrial geothermal environments
		Shawna Pratt, Chemical & Biological Engineering, MSU, CBE	Monitoring single bacterial cell growth using drop-based microfluidics
Apr 13	Dr. Andreas Teske	Professor, Marine Sciences, University of North Carolina, Chapel Hill, North Carolina	Sulfur-oxidizing bacterial mats in Guaymas Basin: dancing on the volcano
Apr 20	Dr. Sharon Neufeldt	Assistant Professor, Chemistry & Biochemistry, MSU	Designing a catalytic system to convert methane into heavier alkanes
Apr 27	Dr. Annelise Barron	W.M. Keck Associate Professor, Bioengineering, Stanford University, Stanford, California	Antibiofilm activities of peptoid mimics of antimicrobial peptides (ampetoids)
May 4	No Seminar – Finals Week		

TECHNOLOGY TRANSFER:
Industrial Associates, 2016–17

Bold denotes new member

*Small denotes business member

3M
Accuratus Lab Services*
Acelity, formerly KCI
American Chemet*
BASF
Baxter Healthcare
Church & Dwight Company
CleanSpot, Inc. *
DeLaval
Dow Microbial Control
Ecolab
ICU Medical, Inc.
Lonza
Masco Corporation
NASA
NCH Corporation
Next Science
PPG Industries
Procter & Gamble Company
S.C. Johnson & Son, Inc.
SANUWAVE Health*
Sharklet Technologies, Inc.*
Smith & Nephew
Solvay
Sterilex*
STERIS
The Sherwin-Williams Company
W.L. Gore & Associates
Zimmer Biomet

TECHNOLOGY TRANSFER:
 Montana Biofilm Meeting
 July 18–21, 2016

Monday, July 18

6:00–8:30 pm

Registration & welcome reception

Larkspur Foyer, Hilton Garden Inn
 Bozeman

Tuesday, July 19

7:30–8:00 am

Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

8:00–8:10

Introductory remarks

Larkspur Ballroom

Paul Sturman, CBE Industrial
 Coordinator

Matthew Fields, CBE Director

Chuck Pettigrew, Chair, CBE
 Industrial Associates Program;
 Principal Scientist, Procter &
 Gamble

SESSION 1:

Fungal Biofilms

8:10–8:20

Session introduction

Paul Sturman

8:20–8:50

**A reproducible protocol for
 growing relevant filamentous
 fungal biofilms for industrial
 consumer product applications**

Julia Kerrigan, Associate Professor,
 Mycology, Clemson University,
 Clemson, SC

8:50–9:20

**Relevance of fungal biofilms:
 An industrial perspective**

Tony Rook, Senior Manager,
 Microbiology Resource Center,
 The Sherwin-Williams Company,
 Cleveland, OH

9:20–9:50

**A review of lab protocols for fungal
 biofilm studies and our path
 forward**

Diane Walker, Research Engineer,
 CBE

9:50–10:20 Networking Break

10:20–10:50

**Effect of selenite on the
 morphology and respiratory activity
 of *Phanerochaete chrysosporium*
 biofilms**

Erika Espinosa-Ortiz, Postdoctoral
 Research Associate, CBE

10:50–11:20

**Volatile organic compounds of a
 filamentous fungal mat at varying
 oxygen conditions**

Heidi Schoen, PhD candidate,
 Chemical & Biological
 Engineering, MSU, CBE

11:20–11:50

***Candida* and *Malassezia* yeasts in
 biofilms**

Garth James, Associate Research
 Professor, Chemical &
 Biological Engineering, MSU;
 Manager, Medical Biofilms
 Laboratory, CBE

12:00–1:00

Catered lunch, Hilton Garden Inn

SESSION 2:

Industrial Biofilms

1:00–1:05

Session introduction

Paul Sturman

1:05–1:35

**Copper: An effective anti-
 microbial?**

Colin Anderson, R&D Director,
 American Chemet, E. Helena,
 MT

1:35–2:00

**Integrated molecular,
 physiological, and in silico
 characterization of two
 extremophilic *Halomonas* isolates**

Ross Carlson, Professor, Chemical
 & Biological Engineering, MSU,
 CBE

Chuck Pettigrew

2:00–2:25

**Acoustic pressure shock wave
 technology successfully disrupts
 medical and non-medical biofilms**

Iulian Cioanta, Vice President,
 R&D, SANUWAVE Health, Inc.
 Alpharetta, GA

CBE Open House:

**Lab demonstrations and poster
 session**

2:45–4:45

3rd Floor EPS Building, MSU

Wednesday, July 20

7:30–8:00 am

Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 3:

Biofilm Methods

8:00–8:40

**Methods to assess biofilm
 prevention on surface modified
 urinary catheters**

Darla Goeres, Associate Research
 Professor, Chemical & Biological
 Engineering, MSU; Manager,
 Standardized Biofilm Methods
 Laboratory, CBE

8:40–9:10

**EPA Regulatory Update: Use of
 the Single Tube Method to
 support biofilm claims for
 antimicrobial products**

Rebecca Pines, Biologist,
 Microbiology Laboratory Branch,
 Office of Pesticide Programs
 (OPP), US EPA, Fort Meade, MD

9:10–9:40

Using statistical confidence and power to assess performance standards for biofilm claims using the Single Tube Method

Al Parker, Assistant Research Professor, Mathematical Sciences, MSU; Bio-statistician, CBE

9:40–10:10 **Networking Break**

10:10–10:40

Quantifying biofilm development and structure with image analysis and high-resolution 3D imaging

Curtis Larimer, Postdoctoral Fellow, Pacific Northwest National Laboratory, Richland, WA

10:40–11:10

Osmotic pressure-induced rupturing of gastrointestinal organoids

Jim Wilking, Assistant Professor, Chemical & Biological Engineering, MSU, CBE

11:10–11:40

Montana Nanotechnology Facility: A powerful resource for biofilm science and engineering

David Dickensheets, Professor, Electrical & Computer Engineering; Director, Montana Nanotechnology Facility (MONT), MSU

11:40–12:00

State of the CBE

12:00–12:15

Presentation of CBE awards

Matthew Fields

12:15–1:15

Catered lunch, Hilton Garden Inn

SESSION 4:

Multi-Species Biofilms

1:15–1:20

Session introduction

Anne Camper, Regents Professor, Civil Engineering, Associate Dean, College of Engineering, MSU, CBE

1:20–1:50

The ecology of nitrification in water systems: A consortium of organisms and metabolisms

Anne Camper

1:50–2:20

Forced cooperation leads to improved productivity in a multispecies biofilm

Laura Camilleri, PhD student, Microbiology & Immunology, MSU, CBE

2:20–2:50

Biofilms enhance survival in extreme environments

Heidi Smith, Postdoctoral Researcher, CBE

2:50–3:20

Effects of chlorhexidine treatments on single and mixed species biofilms of *Streptococcus mutans* and *Lactobacillus acidophilus* as well as *S. mutans* and *Actinomyces naeslundii*

Rosa Oliveira, Postdoctoral Res., Araraquara School of Dentistry, UNESP–Univ. Estadual Paulista, Araraquara, São Paulo, Brazil

3:20–3:30 Break

3:30–5:00

Business Meeting

Hilton Garden Inn

6:00 **Dinner/Banquet**

Rockin' TJ Ranch, Bozeman

Thursday, July 21

7:30–8:00 am

Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 5:

Wound Biofilms

8:00–8:05

Session Introduction

Garth James

8:05–8:40

Biofilm-related oxygen consumption in wounds

Garth James

8:40–9:10

Chronic wounds in diabetic patients: Biochemical association between skin microbiome and metabolic landscape

Mary Cloud Ammons, Assistant Research Professor, Chem. & Biochemistry, MSU

9:10–9:40

Predictive multiscale modeling of microbial biofilm consortia

Ross Carlson

9:40–10:10

Bacterial fitness determinants in chronic wound infections: Correlation with *in vitro* biofilm fitness

Sarah Morgan, Sr. Postdoctoral Fellow, Microbiology, University of Washington, Seattle, WA

10:10–10:40 **Networking Break**

SESSION 6:

Device-Related Biofilms

10:40–10:45

Session Introduction

Garth James

10:45–11:15

Understanding *E. coli* biofilms on urinary catheters: Are there CAUTI-specific characteristics?

Maria Hadjifrangiskou, Assistant Professor, Pathology, Microbiology, & Immunology, School of Medicine, Vanderbilt University, Nashville, TN

11:15–11:45

Strategies to treat intracellular and biofilm forming *Staphylococcus aureus* in orthopedic infections

Devendra Dusane, Postdoctoral Researcher, Microbial Infection & Immunity, The Ohio State University, Columbus, OH

11:45–12:15

Preclinical wound biofilm models: Establishment, consequences, and topical antimicrobial effects

Eric Roche, R&D Manager, Smith & Nephew, Fort Worth, TX

12:15–12:25 **Meeting Wrap-up**

[Back to Table of Contents](#)

[Appendix ToC](#)

WORKSHOP:
 The Scale of Biofilms Studies
 July 18, 2016

9:00 – 9:15	Welcome	EPS 323
9:15 – 9:30	The Scale of Biofilms – <i>Paul Sturman</i>	EPS 323
9:30 – 10:15	Big to Small – <i>Muneeb Rathore, Darla Goeres, Connie Chang</i>	EPS 323
10:30 – 10:40	Morning Refreshments	EPS 323

Morning Laboratory Rotations:

	<u>Group 1</u>	<u>Group 2</u>	<u>Group 3</u>
10:40 – 11:05	A	B	C
11:05 – 11:30	B	C	A
11:30 – 11:55	C	A	B

- | | | |
|----|--|---------|
| A. | Algal Biofilms – <i>Muneeb Rathore</i> | COB 401 |
| B. | Microfluidic Cell Sorting – <i>Geoffrey Zath</i> | EPS 302 |
| C. | Standard Methods – <i>Kelli Buckingham Meyer, Lindsey Lorenz, Jen Summers</i> | EPS 301 |

12:00 - 1:00	LUNCH	SUB Ballroom B
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1:00 - 2:00	Introduction to the Montana Nanotechnology Facility (MONT) – <i>David Dickensheets, Betsey Pitts, Recep Avci</i>	EPS 323
2:15 - 2:30	Afternoon Refreshments	EPS 323

Afternoon Laboratory Rotations:

	<u>Group 1</u>	<u>Group 2</u>	<u>Group 3</u>
2:15 – 3:00	D	E	F
3:00 – 3:45	E	F	D
3:45 – 4:30	F	D	E

MONT Facility Tours:

- | | | |
|-------------|---|-----------|
| A. | ICAL Facility – <i>Recep Avci</i> | EPS 339 |
| B. | CBE Microscope Facility – <i>Betsey Pitts</i> | EPS 326/7 |
| C. | Microfabrication Facility – <i>David Dickensheets</i> | EPS 110 |
| 4:30 – 5:00 | Wrap-Up/Discussion – <i>All instructors</i> | EPS 323 |

TECHNOLOGY TRANSFER:
 Anti-Biofilm Technologies: Pathways to Product Development
 February 1, 2017
 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, Madison Ballroom	Matthew Fields, Director, CBE; Paul Sturman, Industrial Coord., CBE; Leti Vega, International Scientist, Human Research Program, NASA; Chair, Industrial Associates Program, CBE
8:10 a.m.–8:15 a.m.	SESSION 1: Medical Device Technologies Session Introduction	
8:15 a.m.–8:45 a.m.	An extraction free assay for quantifying residual protein and microbial biofilms on working surfaces	Allan Guan, ORISE Research Fellow, Office of Science & Eng. Labs, Ctr. for Devices & Radiological Health, FDA
8:45 a.m.–9:15 a.m.	Testing to support safety and effectiveness for medical devices containing antimicrobials	Brandon Kitchel, Microbiologist/Lead Reviewer, Office of Device Evaluation, Ctr. for Devices & Radiological Health, FDA
9:15 a.m.–9:45 a.m.	Antibiotic resistance in biofilms: A review	Garth James, Associate Research Professor, Chemical & Biological Engineering, MSU; CBE
9:45 a.m.–10:15 a.m.	BREAK	
10:15 a.m.–10:45 a.m.	Multimodal preclinical imaging in infectious disease research	Kevin Francis, Preclinical Imaging Fellow, PerkinElmer
10:45 a.m.–11:15 a.m.	Infected megaprotheses: How patients drive science that may help patients	Nicholas Bernthal, MD, Department of Orthopaedic Surgery, UCLA
11:15 a.m.–12:00 p.m.	Session 1 wrap up and panel discussion	
12:00 p.m.–1:00 p.m.	Networking Lunch, Adams	
1:00 p.m.–1:10 p.m.	SESSION 2: Surface Disinfection Technologies Session Introduction	
1:10 p.m.–1:40 p.m.	Evaluating antimicrobial agents against biofilms	Phil Stewart, Professor, Chemical and Biological Engineering, MSU, CBE
1:40 p.m.–2:00 p.m.	Laboratory attributes of a low-level biofilm claim	Darla Goeres, Associate Research Professor, Chemical & Biological Engineering, MSU, CBE
2:00 p.m.–2:20 p.m.	Changes in a method's variability when used for low-level claims	Darla Goeres
2:20 p.m.–2:50 p.m.	BREAK	
2:50 p.m.–3:20 p.m.	Biofilm method standardization: A regulatory perspective	Rebecca Pines, Biologist, Microbiology Laboratory Branch, Office of Pesticide Programs, US EPA
3:20 p.m.–3:50 p.m.	Public health biofilm claims for antimicrobial pesticide products: Pathways to registration	Alison Clune, Biologist, Antimicrobials Division, Office of Pesticide Programs, US EPA
3:50 p.m.–4:20 p.m.	European Union perspective on biofilm regulation	Minna Keinänen-Toivola, Faculty, Satakunta University of Applied Sciences, Rauma, Finland
4:20 p.m.–5:00 p.m.	Session 2 wrap up and panel discussion	

TECHNOLOGY TRANSFER:
 Beneficial-Biofilms Workshop
 January 31, 2017 Arlington, VA

Time	Title	Speaker
7:30 a.m.–8:15 a.m.	Registration and continental breakfast, Virginia Foyer, Plaza Level	
8:15 a.m.–8:30 a.m.	Welcome & opening remarks, Washington ballroom	Matthew Fields, CBE Director; Professor, Microbiology & Immunology, MSU Paul Sturman, CBE Industrial Coordinator
SESSION 1: Multi-Kingdom Biofilms		
8:20 a.m.–8:30 a.m.	Session introduction	Matthew Fields
8:30 a.m.–9:00 a.m.	From forced cooperation to forced clumping: Multi-domain interactions with biofilms	Matthew Fields
9:30 a.m.–10:00 a.m.	Characterizing multi-domain biofilms in biotechnology, the environment, and medicine	Robin Gerlach, Professor, Chemical & Biological Engineering, MSU, CBE
10:00 a.m.- 10:30 a.m.	Break	
11:00 a.m. – 11:30 p.m.	Inter-kingdom oral biofilm interactions: Implications for pathogenesis and treatment	Gordon Ramage, Professor, School of Medicine, Dentistry and Nursing, University of Glasgow, Scotland
11:30 a.m. – 12:00 p.m.	Discussion session	
12:00 a.m. – 12:30 p.m.	Catered Lunch, Adams	
Session 2: Biofilms in Women’s Health		
1:10 p.m.–1:20 p.m.	Session Introduction	
1:20 p.m.–1:50 p.m.	Issues surrounding breast implant infection	Garth James, Assoc. Research Professor, Chemical & Biological Engineering, MSU; Manager, Medical Biofilms Lab, CBE
1:50 p.m.–2:20 p.m.	Bacterial vaginosis	Elinor Pulcini, Assistant Research Professor, Chemical & Biological Engineering, MSU, CBE
2:20 p.m.–2:50 p.m.	Methods to assess urinary catheters designed to reduce CAUTI	Darla Goeres, Associate Research Professor, Chemical & Biological Engineering, MSU, CBE
2:50 p.m.–3:20 p.m.	Break	
3:20 p.m.–3:50 p.m.	Women’s health and cosmetic device infections—A combinatorial approach to interrupting the pathogenesis process: Prevention, practice, and preservation	Eva Wang, ORISE Research Fellow, Center for Devices & Radiological Health, FDA
3:00 p.m.–4:00 p.m.	Discussion & Brainstorming Session	

TECHNOLOGY TRANSFER: NEWS HIGHLIGHTS

CBE welcomed new members to its Industrial Associates Program:

CleanSpot, Inc.

CleanSpot, Inc. is the maker of ActiveClean, the first moisturizing hand sanitizer made with natural ingredients to protect your skin from germs without drying out your skin. It is the first moisturizing hand sanitizer formulated with beeswax, which has been used as a moisturizer for centuries because it forms a natural moisturizing barrier on your skin. CleanSpot's representative to the CBE is **Chuck Call**. For more information on the company, go to: www.activeclean.com

DeLaval

The CBE recently welcomed DeLaval as its newest Industrial Associate member. DeLaval is a world leader in the dairy farming industry, providing integrated milking solutions designed to improve dairy farmers' production, animal welfare, and overall quality of life. The company develops, manufactures, and markets equipment for milk production and animal husbandry worldwide. **Carolina Mateus**, DeLaval R&D Manager, is the CBE designated representative. Read more about DeLaval at: www.delavalcorporate.com

S.C. Johnson & Son

Founded in 1886, S.C. Johnson is a family-owned company and one of the world's leading producers of household brands. Their product portfolio is vast and includes global brands that help every household with cleaning, pest control, storage, shoe and auto care, and home fragrance. The CBE designated representative at SCJ is **Deliang Shi**. To read more about SCJ visit their website at www.scjohnson.com/en/home.aspx

Smith & Nephew

Smith & Nephew is a global medical technology company that supports healthcare professionals with pioneering designs of advanced medical products. Their products and services include: joint replacement systems for knees, hips and shoulders; wound care treatment and prevention products for hard-to-heal wounds; instruments and technologies for minimally invasive joint surgery; and products used to repair bone fractures. Smith & Nephew's CBE designated representative is **Paul Renick**. To read more about the company, go to www.smith-nephew.com/about-us

Solvay

Solvay is a specialty chemical company that was created in 1863 as a start-up enterprise for manufacturing sodium carbonate. Today, Solvay offers a wide range of products designed for food service, building products, consumer goods, and other industrial applications. Solvay's representatives to the CBE are **Gilda Lizarraga** and **Jaime Hutchison**. To read more about the company, visit their website at: www.solvay.com/en/index.html

Sharklet Technologies

Sharklet is the world's first technology to inhibit bacterial growth through pattern alone. The Sharklet surface is comprised of millions of microscopic features arranged in a distinct diamond pattern. The structure of the pattern alone inhibits bacteria from attaching, colonizing and forming biofilms. Sharklet contains no toxic additives or chemicals, and uses no antibiotics or antimicrobials. Sharklet's representative to the CBE is **Ethan Mann**. To view more about the company including a video on PBS' Nova series, visit their website at: www.sharklet.com/

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

Read about [CBE membership](#)

EPA is seeking public comment on proposed test methods for antimicrobial efficacy

In October 2016, the EPA announced that it was seeking public comment on two test methods and guidance for evaluating antimicrobial efficacy against biofilm bacteria in hospital settings. CBE's Standardized Biofilm Methods Laboratory (SBML) was part of the academic and industrial team that developed the test methods by providing statistical support, interlaboratory study design and analysis, and guidance through the standardization process at the American Society for Testing and Materials (ASTM). The SBML has worked with the EPA for over 20 years measuring how well anti-bacterial products perform against biofilm bacteria in both household and hospital settings. Below is the full press release from the EPA.

Press release from the EPA, October 4, 2016:

EPA is seeking public comment on two proposed test methods and associated testing guidance for evaluating antimicrobial pesticides against two biofilm bacteria, *Pseudomonas aeruginosa* and *Staphylococcus aureus*.

Bacterial biofilms excrete a slimy, glue-like substance (extracellular polymeric substances, called the biofilm matrix) that facilitates attachment to many hard surfaces such as glass, metals, and plastics, including those in health-care settings. The biofilm matrix provides embedded bacteria with protection from dehydration and other environmental stresses and interferes with the action of chemical disinfectants. Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the registrant of an antimicrobial product with a public health claim is required to submit efficacy data to EPA in support of the product's registration. EPA is soliciting comments on the clarity of the standard operating procedures and the regulatory guidance. Comments will be collected until December 5, 2016, at which point the EPA will finalize the procedures and provide the revised methods for use. The methods, guidance, and additional background documents are available in dockets EPA-HQ-OPP-2016-0357 at www.regulations.gov

Expert panel advises aggressive initial treatment for patients with chronic wounds

Garth James, manager of the CBE's Medical Biofilms Laboratory, participated in an international biofilm expert panel that included leading researchers from Australia, Denmark, Japan, United Kingdom, and the United States. Convened by CBE industrial member Smith & Nephew, a major medical manufacturing company based in London, the Global Wound Biofilm Expert Panel recently called for physicians around the world to reverse the longstanding practice of gradually escalating treatment of patients with chronic wounds.

"We are recommending physicians change course and start treating chronic wounds very aggressively initially," James says. "This is the exact opposite of traditional wound-care practice where you try something minimally invasive then get increasingly aggressive as needed."

The recommendation for the new treatment protocol appears in the cover story of January 2018 online edition of *Wound Repair and Regeneration* titled "Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds."

In 2017, the expert panel published an article titled, "The prevalence of biofilms in chronic wounds: a systematic review and meta-analysis of published data," in the January 2017 edition of the *Journal of Wound Care*.

TECHNOLOGY TRANSFER: Industry and Agency Interactions

CBE visits to industry & agencies

May 18, 2016: **Diane Walker**, CBE research engineer, met with Cliff Bradley, president of Montana BioAgriculture, Inc. and Andrea Stierle, research professor in University of Montana's Department of Biomedical & Pharmaceutical Sciences. Diane discussed potential collaborative projects.

May 19, 2016: **Phil Stewart** visited 3M and presented "The science of biofilm control with antimicrobial agents," in St. Paul, Minnesota.

The following CBE faculty made industry visits to discuss membership in the Industrial Associates Program:

Jim Wilking visited Solvay in Bristol, Pennsylvania, August 9, 2016.

Phil Stewart visited Smith & Nephew in Fort Worth, Texas, September 22, 2016.

Matthew Fields visited ExxonMobil in Annandale, New Jersey, and Solvay in Bristol, Pennsylvania, October 6–7, 2016.

March 2, 2017: **Darla Goeres** visited S.C. Johnson in Racine, WI to discuss CBE membership and present "Standardized biofilm methods development: Approach & applications."

Industry & agency visits to CBE

May 19, 2016: **Garth James**, associate professor in chemical and biological engineering, hosted **Dr. Ondrej Slaby** of Masaryk University Central European Institute of Technology, in Brno, Czech Republic, and **Dr. Manu N. Capoor** of Rockefeller University Lab of Bacterial Pathogenesis and Immunology, in New York, New York. The guests toured the Center and discussed possible testing projects.

January 26, 2017: **Paul Sturman**, CBE industrial coordinator, hosted Ricky Woofter, research chemist with Lubrizol. Lubrizol is a specialty chemical company that makes additives and coatings for automotive, personal and home care and oilfield applications. Woofter toured the CBE labs and met with several CBE faculty and researchers to discuss potential projects and membership.

February 28–March 1, 2017: **Diane Walker**, CBE research engineer, hosted a two-day workshop for Eunice Aquino and Amanda Faltynowski from member company DeLaval. The workshop covered the steps involved in working with the CDC Biofilm Reactor.

March 21, 2017: **Darla Goeres**, associate research professor, chemical and biological engineering, hosted Dan Sannito and Kevin Brandimarte from Keurig Green Mountain Roasters. The group spent their time working in the Standardized Biofilm Methods Lab investigating coffee brewers.

April 6–7, 2017: CBE Standardized Biofilm Methods Lab hosted Chuck Skyeck and Josh VanZee from the National Brewers Association and Zach Geurin and Atwain Atwain from NSF International. The group met to discuss their project on biofilms in beer draught lines.

April 10–11, 2017: **Matthew Fields**, CBE director, along with MSU's College of Engineering and the Alumni Foundation, hosted Jerry Kovacich, Dan Tyndall, and Sarah Ruddell from Carbon Cycle Energy of Boulder, Colorado. Carbon Cycle is a renewable energy development company that converts organic agricultural and industrial food waste into pipeline-grade biomethane for direct injection into the natural gas pipeline system. The group met with several faculty and administrators from across MSU's campus. They also discussed potential projects with CBE researchers. Kovacich, the company's CEO, graduated from MSU with a degree in chemical engineering.

OUTREACH: News highlights

Online training videos

The CBE's Standardized Biofilm Methods Lab has spent the last year developing and producing a series of videos for the world to watch and learn from. These videos teach methods for repeatable biofilm growth and sampling techniques, and offer the visualization of some of these standardized techniques. The latest of these videos is the Drip Flow Biofilm Reactor Training Video. Find this and other videos at: www.biofilm.montana.edu/standardized-biofilm-methods-training-videos.html

MSU American Indian Research Opportunities (AIRO) BRIDGES program

James Vallie worked at the CBE in summer 2016 as part of the American Indian Research Opportunities (AIRO) BRIDGES program. The program's objective is to build an educational experience between reservation-based colleges and Montana State University and, in the process, increase the number of underrepresented Native American students successfully transferring from the two-year tribal colleges to MSU and pursuing academic studies in the biomedical and other health-related sciences. Vallie earned his associates degree in business from Little Big Horn College in Crow Agency, Montana. While in the BRIDGES program, he studied algal biofuels under Dr. Brent Peyton, professor of chemical and biological engineering. Vallie is now enrolled as a student at Montana State University and will continue his work studying alternative fuel resources.

CBE visiting researcher explains black film on Jefferson Memorial

Dr. **Federica Villa**, long-time CBE visiting researcher from the University of Milan, was featured in an article in the *Washington Post*. The article "A grimy, black biofilm is starting to cover the Jefferson Memorial, and it can't be killed," focuses on the research that Villa and her collaborators at the US National Park Service are doing on national monuments. They are evaluating the black film that is appearing on many stone monuments and if the film will cause damage to the structures or could be a protective barrier. Read more at the *Washington Post*: ["A grimy, black biofilm is starting to cover the Jefferson Memorial, and it can't be killed"](#)

Visiting Researchers

Visiting Student Researchers

The CBE welcomed the following visiting students conducting research with faculty during the 2016–2017 academic year:

Kristina Block, Masters student
 Hometown: Berlin, Germany
 Area of study & home university: Environmental Engineering, Berlin Technological University
 Research at the CBE: Use of struvite from different sources (synthetic, biogen, and wastewater) as an alternative nutrient for cultivation of algae
 CBE Host: **Robin Gerlach**, professor, chemical & biological engineering

Marta Bottagisio, PhD student
 Hometown: Milan, Italy
 Area of study & home university: Veterinary biotechnology, University of Milan, Italy; Affiliate of the IRCSS Galeazzi Orthopedic Institute in Milan

Research at the CBE: Protein expression in *Staphylococcus epidermidis* biofilms grown on titanium
 CBE host: **Garth James**, associate research professor, chemical and biological engineering; manager, CBE medical biofilms laboratory

Marketa Hulkova, Fulbright PhD student
 Hometown: Brodek u Přerova, Czech Republic
 Home university: Masaryk University, Brno, Czech Republic
 Research at the CBE: Ecotoxicity of silver nanomaterials
 CBE Host: **Ross Carlson**, professor, chemical & biological engineering

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

Sepideh Ebadi, PhD student
 Hometown: Tehran, Iran
 Area of study, home university: Biomathematics, Florida State University, Tallahassee, Florida
 CBE Host: **Jim Wilking**, assistant professor, chemical & biological engineering

Maria Clara Tarifa, PhD student
 Hometown: Bahia Blanca, Buenos Aires, Argentina
 Area of study, home university: Biology, Universidad Nacional Del Sur, Bahia Blanca, Buenos Aires, Argentina
 Research at the CBE: Microrheology of yeast biofilms
 CBE Supervisor: **Phil Stewart**, professor, chemical & biological engineering

James Vallie, Undergraduate Student
 Hometown: Hardin, Montana
 Area of study, home university: Alternative fuel sources, Little Big Horn College, Hardin, Montana

CBE Supervisor: **Brent Peyton**, professor, chemical & biological engineering

Visiting Research Faculty

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

Birthe Venø Kjellerup, Assistant Professor, Civil & Environmental Engineering, University of Maryland, College Park
 Research area: Biofilms in complex microbial systems
 CBE host: **Phil Stewart**, professor, chemical and biological engineering

CBE Tours

July 24, 2016: CBE hosted a tour for fifteen undergraduates from the China University of Geosciences in Beijing. Their visit was sponsored by MSU's Office of International Programs. The tour was led by **Shipeng Lu**, CBE postdoctoral researcher and **Kristen Brileya**, CBE technical operations manager.

October 25, 2016: **John Delaney**, executive director for research at Amgen, toured the CBE while visiting Montana State University to discuss possible collaborative projects with the Department of Microbiology & Immunology and the College of Engineering. Amgen is one of the world's leading biotechnology companies.

October 25, 2016: MSU President **Waded Cruzado** was joined by MSU administrators **Renee Reijo-Pera**, vice president of research, **Bob Mokwa**, provost, and **Brett Gunnink**, dean of the College of Engineering for a tour of the CBE. This was Dr. Cruzado's second tour of the center since joining MSU in January 2010. She heard directly from students and staff, in their laboratories, about diverse projects related to algal biofuels, chronic wounds, metabolic exchanges between species, and

standardized biofilm methods. After the tour, the group met with the CBE executive committee for a CBE overview on student education, interdisciplinary research, and technology transfer.

May 2, 2017: **Matthew Fields**, CBE director, and **Paul Sturman**, CBE industrial coordinator, hosted a tour for **Greg Zikos** and **Freddie Daver** from the Alfred E. Mann Institute for Biomedical Engineering (AMI) at the University of Southern California. AMI's mission is to help bridge the gap between biomedical innovation and the creation of commercially successful medical products to improve public health. Zikos and Daver were visiting Montana State University and stopped by the CBE to learn more about the Center and discuss possible collaborative projects.

OUTREACH:

Web image library use 2016-2017

Total image downloads: **347**

Requests for CBE graphics were submitted from **31** of the U.S. states and Puerto Rico:

Alabama	Illinois	Missouri	Oklahoma	Virginia
Arkansas	Indiana	Montana	Oregon	Washington
California	Kentucky	New Hampshire	Puerto Rico	Wisconsin
Colorado	Maryland	New Jersey	Rhode Island	
Florida	Massachusetts	New York	South Carolina	
Georgia	Michigan	North Carolina	Texas	
Idaho	Minnesota	Ohio	Utah	

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

Argentina	Ireland
Australia	Italy
Austria	Japan
Belgium	Malaysia
Brazil	Mexico
Canada	New Zealand
Chile	Nigeria
China	Norway
Colombia	Portugal
Costa Rica	Saudi Arabia
Croatia	Singapore
Denmark	South Africa
Finland	Spain
France	Sweden
Germany	Switzerland
India	Tunisia
Iran	United Kingdom
Iraq	

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.

Mass Spectrometry Facility

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

Microsensor Laboratory

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.

Microscope Facilities

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

The Optical Microscopy Lab houses two Nikon Eclipse E-800 research microscopes which are used for transmitted light and epi-fluorescent imaging. Both microscopes are equipped with Photometrics MYO cooled CCD cameras and use Universal Imaging Corporation's MetaVue software (v 7.4.6) for digital image acquisition. We have a large collection of fluorescence filter cubes for the Nikons, including those optimized for the following fluorescent stains: FITC (gfp), TRITC (propidium iodide), DAPI, CTC, ELF-97, CY5, cfp, and we also have a B2E cube. Both Nikons are equipped with Nomarski/DIC, and we have a 100x oil phase contrast objective and condenser especially for use with imaging spores.

Our microscope collection has expanded with the acquisition of a new Leica M 205 FA computer-controlled stereomicroscope and a Leica DFC3000G fluorescence camera. This stereoscope can be used to image samples using fluorescence, brightfield with or without polarization or Rotterman contrast, and reflected white light. The software will also allow a z-stack of images to be collected and recombined using simple deconvolution. Other equipment in the Optical Microscopy Lab includes a Nikon SMZ-1500 barrel zoom stereomicroscope equipped with a color camera, a Leica CM1800 cryostat, a Zeiss Palm Laser Capture Dissection microscope and a dry ice maker.

The **Confocal Microscopy Lab** contains two fairly new (2011) Leica SP5 Confocal Scanning Laser Microscopes (CSLMs). One is an inverted confocal microscope with 405, 488, 561 and 633 nm laser excitation lines. It is equipped with a tandem scanner, so it can be switched from standard scanning mode to operate in Resonant Scanner mode, which enables scanning at exceptionally high frequencies for fluorescent imaging. This faster scanning is necessary for most live cell imaging (note: “live cell imaging” doesn’t generally refer to imaging bacterial cells, but rather mammalian cells and processes). This inverted SP5 also includes a heated stage with an environmental control chamber (i.e. it can be used to provide an enclosed CO₂ atmosphere), and a motorized stage with Mark-and-Find and image tiling capabilities.

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

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

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

Computer Facilities

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

Additionally, CBE staff and students have access to the centrally maintained computational cluster for data manipulation, analysis, and mathematical modeling. This cluster consists of 65 nodes with a total of 1080 hyper-threaded cores and 18 teraflops of computing power.

SPECIALIZED CBE RESEARCH GROUPS

Ecology/Physiology Laboratory

The Ecology/Physiology Laboratory headed by Dr. Matthew Fields has general microbiology equipment, anaerobic gassing stations in two lab spaces, Shimadzu UV-VIS spectrophotometer, Ultra-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.

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

Medical Biofilm Laboratory

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

Standardized Biofilm Methods Laboratory

The Standardized Biofilm Methods Laboratory (SBML) was designed to meet research and industry needs for standard analytical methods to evaluate innovative biofilm control technologies. SBML staff and students develop, refine, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBML members work with international standard setting organizations (AOAC International, ASTM International, IBRG, and OECD) on the approval of biofilm methods by the standard setting community. Under a contract with the U.S. Environmental Protection Agency (EPA), the SBML provides statistical services 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 lies at the intersection of microbial and ecosystem ecology and uses a combination of field and laboratory studies, as well as approaches ranging from the single-cell to the community level. Staff in this lab are interested in understanding how the environment controls the composition of microbial communities and how, in turn, those microbes regulate whole ecosystem processes such as nutrient and organic matter cycling.

Ongoing research examines carbon flux through microbial communities, with the long-term goal of improving predictions of carbon fate (metabolism to CO₂, sequestration into biomass, long-term storage in ice) in the context of a changing environment. Additionally, they are interested in physiological adaptations to life in icy environments. Regardless of the environment, the group employs microbiological, limnological, biochemical and molecular biology approaches to investigate fundamental processes carried out by microbes.

Microfluidics Laboratory

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

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

OTHER Montana State University facilities available for collaborative research

Montana Nanotechnology (MONT) Facility

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

Montana Microfabrication Facility (MMF)

The Montana Microfabrication Facility is a cleanroom user facility located at MSU-Bozeman. As part of the NSF NNCI consortium MMF is a user facility open to university students and faculty as well as extramural users from industry and academia. The MMF facility comprises three separate areas: the 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

Furnaces

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

MSU ICAL Laboratory

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

Current Instrumentation

- Atomic Force Microscopes (AFMs)
- Field Emission Scanning Electron Microscope with EBSD (FE SEM/EBSD)
- Scanning Electron Microscope with EDX (SEM/EDX)
- X-ray Photoelectron Spectrometer with cryo-stage (XPS)
- Time-of-Flight Secondary Ion Mass Spectrometer (ToF-SIMS)
- X-Ray powder Diffraction Spectrometer (XRD)
- Field Emission Scanning Auger Nanoprobe (FE AUGER/EDX/EBSD)
- Epifluorescence Optical Microscope
- Critical point drying
- Contact angle system
- Zeta Potential system

For more information on each system, see the ICAL website at: www.physics.montana.edu/ical/

MSU Proteomics, Metabolomics, Mass Spectrometry Facility

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

MSU in compound identification and metabolomics taking advantage of coupled LC-SPE-NMR-MS instrumentation. Please contact the facility personnel listed below if you wish to discuss training or submit samples for analysis.

Facility Manager: Dr. Ganesh Balasubramanian, ganesh@montana.edu

Facility Director: Dr. Brian Bothner, bbothner@montana.edu

MSU Magnetic Resonance Microscopy (MRM) Facility

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

MSU High Field Nuclear Magnetic Resonance (NMR) Facility

A state-of-the-art solution NMR facility is available on campus a short 5-minute walk from the College of Engineering and CBE laboratories. The Department of Chemistry and Biochemistry NMR facility is located on the bottom floor (rm# 18), and currently houses four NMR spectrometers. These include two easily accessible walk-in use older NMR spectrometers: A two-channel Bruker DPX 300 MHz NMR equipped with a room temperature 5mm QNP probe for detection of ^1H , ^{13}C , ^{31}P and ^{19}F nuclei, and an Oxford AS 500 MHz NMR coupled to a Bruker Avance I console utilized with several room temperature probes (e.g. a 5 mm BBI broadband inverse (^{13}C , ^1H , ^2H ,) probe, a 5 mm QNP (^1H , ^{13}C , $^{31}\text{P}/^{19}\text{F}$) probe, a 3 mm (^2H , ^1H , ^{13}C) Protasis Microcoil probe and a Bruker (^2H , ^1H , ^{13}C) Flow probe. Both of these NMR's are used for routine organic and bioinorganic work, and occasionally for characterization of metal ion clusters.

In September of 2016, the NMR facility received and installed a brand new Bruker Ascend 500 MHz (^1H Larmor Frequency) NMR. This instrument is equipped with an Avance III console and a liquid nitrogen cooled broad band BBO (500S1 BB-H&F-05 Z) prodigy Cryoprobe. This instrument is designed for enhanced carbon detection along with several other NMR active nuclei. The instrument is also equipped with an automatic sample loading system (SampleJet™) for high-through-put sample analysis.

Finally, the 600 MHz (^1H Larmor Frequency) NMR spectrometer was upgraded in 2011 from a DRX to an AVANCE III spectrometer, and is equipped with a helium-cooled ^1H -optimized, inverse detection, (^1H , ^{15}N , ^{13}C) TCI cryoprobe and a SampleJet™ automatic sample loading system. The 600 MHz NMR is dedicated to protein structure determination, characterization of macromolecular complexes (protein-protein or protein-nucleic acid interactions), protein dynamics studies (using ^{15}N and ^{13}C NMR relaxation approaches) and, more recently, is being used for broadly based untargeted NMR metabolomic analyses and structural characterization of unknown metabolites. The TCI cryoprobe installed on MSU's 600 MHz NMR provides a significant increase in sensitivity for the NMR experiments (>4 fold, amounting to a > 16 time saving in data acquisition time requirements for low mM concentration samples). It also allows for detection of low abundance metabolites in sub-micromolar concentrations.

Acquisition of the two cryoprobes in the NMR facility has opened new research opportunities for identification of small molecules such as metabolites that may be present in low concentrations, and together with the 500MHz and 600 MHz opens new avenues for automated high-throughput profiling of metabolites (for example the SampleJet has five positions for 96 well-plate sized NMR tube racks. This allows the loading of to 480 sample tubes. It also accommodates and provides 96 positions for standard 3 mm and 5 mm NMR tubes). The NMR facility has access to several multi-user license (> 5) to operate the Chenomx™ metabolite profiler software required to process and analyze NMR metabolomics data has been purchased.

In addition to the above NMR's, the NMR facility has a state of the art LC-MS-SPE-NMR system. This system couples highperformance liquid chromatography (HPLC) with real-time mass spectrometry (MicroTof) and UV detection to allow for unknowns or metabolites/small-molecule organics of interest to be captured on solid-phase extraction columns which can then be dried and automatically filled into NMR tubes for subsequent NMR analysis.

For more information, contact Dr. Valérie Copié, Professor of Chemistry and Biochemistry, and Director of MSU's High Field NMR Center at vcopie@montana.edu, and Dr. Brian Tripet, Full-time NMR Facility Manager and Research Professor at brian.tripet@montana.edu