
2016 APPENDIX

Center for Biofilm
Engineering

Montana State
University Bozeman

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

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RESEARCH:
 CBE RESEARCH AREAS

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

CBE RESEARCH:

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

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

APPLIED RESEARCH AREAS & PROJECTS

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

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

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

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

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

Standardized methods product claims | regulatory issues | ASTM methods acceptance

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

FUNDAMENTAL TOPICS

Biofilms in nature microbes in hot & cold environments | role of biofilms in natural processes | biomimetics | biogeochemistry

Cellular/intracellular phenotype | genetics | metabolic pathways | proteomics

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

Ecology/physiology population characterization | spatial and temporal population dynamics

ANALYTICAL TOOLS & TECHNIQUES

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

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

Modeling cellular automata modeling | mathematics | hydrodynamics | cohesive strength

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

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

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RESEARCH:

2015–2016 CBE GRANT-FUNDED RESEARCH ACTIVITY

Current CBE Research Grants for Fiscal Year 2016 (July 1, 2015 to June 30, 2016)			
Research Area	Title	Principal Investigator	Funding Agency
Biofilm Mechanics	Characterizing microbial biofilms in water recovery systems using micromechanical tools ³	Wilking	NASA
Biofilm Mechanics	Exploring Biofilm Material Properties with Micromechanical Tools	Wilking	NSF
Biofilm Mechanics	Resuscitation of <i>P. aeruginosa</i> biofilm cells from dormancy ¹	Franklin	NIH
Biofilms in Nature	Clark Fork River Biofilms	Fields	USGS
Biofilms in Nature	USGS-Big Horn	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
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	Selenium Bioremediation	Peyton	Teck Coal Ltd
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 ²	Lauchnor	USGS
Environmental Substance Technologies	Saturated Rock Fill Research Program	Peyton	Teck Coal Ltd
Environmental Substance Technologies	Collaborative Research: Connecting Omics to Physical Environment in Community Microbial Ecology	Zhang	NSF
Environmental Substance Technologies	Proposal to Analyze Microbial Community Change with Depth in Samples from EV-F2-15-01	Peyton	Teck Coal
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
Instrumentation	New Frontiers in Nanoscience and Nanotechnology ⁵	Stewart	NSF
Medical Biofilms	<i>Staphylococcus aureus</i> Biofilms Mediate Keratinocytes Apoptosis	Kirker	NIH
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
Modeling	Predictive Multiscale Modeling of Microbial Consortia Biofilms	Carlson	NIH
Physiology & Ecology	Virtual Institute for Microbial Stress & Survival	Fields	DOE/LBNL
Physiology & Ecology	Molecular Level Characterization of Dissolved Organic Carbon and Microbial Diversity in the WAIS Divide Replicate Core	Foreman	NSF
Physiology & Ecology	Collaborative Research: Hydrodynamic Controls on Microbial Community Dynamics	Cunningham & Fields	NSF
Physiology & Ecology	Investigating How Microorganisms Thrive in the Hostile Conditions of Yellowstone's Hot Springs ⁴	Peyton	W.M. Keck Foundation
Water Systems	Water, our Voice to the Future: Climate Change Adaptation and Waterborne Disease Prevention on the Crow Reservation	Camper	Little Big Horn College

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

¹MSU Department of Microbiology & Immunology

²Montana Water Center

³NASA EPSCOR

⁴MSU Thermal Biology Institute

⁵Montana Nanotechnology Facility (MONT)

List of Acronyms

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

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

New CBE Research Grants Awarded in Fiscal Year 2016 (July 1, 2015 to June 30, 2016)				
Sponsor	Title	PI	Period	Award Amount
Lawrence Berkley Natl Lab	Virtual Institute for Microbial Stress and Survival/Environmental Stress Pathways*	Fields	1 yr	\$537,000
US Geological Survey	USGS-Big Horn	Fields	2 yrs	\$7,000
Montana Academy of Science	Riverine Carbon Cycling as a Function of Seasonality	Foreman	1 yr	\$750
University of Toledo	Nutrient and Water Integration and Recycling for Sustainable and Algal Biorefineries*	Gerlach	1 yr	\$405,519
MT Emergent Technologies	Using Biomineralization Sealing for Leakage Mitigation in Shale during CO ₂ Sequestration*	Gerlach	1 yr	\$221,062
US EPA	Development and Use of Standard Methods for the Growth, Treatment, Sampling and Analysis of Biofilm Bacteria*	Goeres	1 yr	\$35,000
Burroughs Wellcome Fund	Methods to Assess Biofilm Prevention on Medical Devices	Goeres	5 yrs	\$500,000
Burroughs Wellcome Fund	Anti-Biofilm Technologies: Pathways to Product Development	Goeres	1 yr	\$5,000
Office of the Commissioner of Higher Education	One Medicine: Reducing the Impacts of Inflammatory and Infectious Diseases on Animal and Human Health	James	2 yrs	\$18,750
Church & Dwight Inc.	Lipid-Derived biofuels: Bicarbonate-Induced Microalgae for Biofuel and Specialty Chemicals*	Peyton	1 yr	\$160,000
Teck Coal	Proposal to Analyze Microbial Community Change with Depth in Samples from EV-F2-15-01	Peyton	1 yr	\$9,788
SRK Consulting	Saturated Rock Fill Phase 3 Laboratory Column Testing	Peyton	1 yr	\$142,421
US Fish and Wildlife	Cooperative Research Program on Constructed Wetland Design and Implementation*	Stein	1 yr	\$170,000
MT Dept of Env. Quality	Design and Construction of Pilot Vertical Flow Treatment Wetland System at Bridger Bowl*	Stein	1 yr	\$15,000
Bridger Bowl Inc.	Continued Monitoring of the Bridger Bowl Wetland System	Stein	1 yr	\$10,000
University of Maryland	Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment	Stewart	4.5 yrs	\$7,488
NSF	Connecting Omics to Physical Environment in Community Microbial Ecology	Zhang	3 yrs	\$99,999
	Total Grant Awards to CBE in Fiscal Year 2016			\$2,344,777
	<i>*Additional funding awarded to existing grants in FY16 (budget increased by the amount listed)</i>			

RESEARCH:
 PUBLICATIONS
 June 2015–May 2016

2015 Publications

NOTE:

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

Aristotelous AC, **Klapper I**, Grabovsky Y, **Pabst B**, **Pitts B**, **Stewart PS** “Diffusive transport through a model host-biofilm system,” *Phys Rev E Stat Nonlin Soft Matter Phys.* 2015 Aug; 92(2): 022703. 2015-023

Barnhart EP, McClure MA, Johnson K, Cleveland S, **Hunt KA**, **Fields MW** “Potential role of Acetyl-CoA Synthetase (acs) and Malate Dehydrogenase (mae) in the evolution of the acetate switch in bacteria and archaea,” *Sci Rep.*, 2015 Aug 3; 5:12498. 2015-031

Cattò C*, Dell’Orto S, **Villa F**, Villa S, Gelain A, Vitali A, Marzano, V, Baroni, S, Forlani, F “Unravelling the structural and molecular basis responsible for the anti-biofilm activity of zosteric acid,” *PLoS ONE*, 2015; 10(7): e0131519. 2015-029

Chihara K, **Matsumoto S**, Kagawa Y, Tsuneda S “Mathematical modeling of dormant cell formation in growing biofilm,” *Front Microbiol.*, 2015 May 28; 6:534. 2015-032

Connolly J, **Gerlach R**, Book Chapter: “Microbially induced carbonate precipitation in the subsurface: Fundamental reaction and transport processes,” Book Title: *Handbook of Porous Media. 3rd Edition*. Vafai K (ed.), *CRC press Taylor and Francis Group*, 2015; pp. 891–922. 2015-053

Connolly JM, **Jackson B**, **Rothman AP**, **Klapper I**, **Gerlach R** “Estimation of a biofilm-specific reaction rate: Kinetics of bacterial urea hydrolysis in a biofilm,” *npj Biofilms and Microbiomes*, 2015; 1: 15014. 2015-027

D’Andrilli J, Cooper WT, **Foreman CM**, Marshall AG “An ultra high-resolution mass spectrometry index to estimate natural organic matter lability,” *Rapid Commun. Mass Spectrom.* 2015 Dec 30; 29(24):2385–401. 2015-043

De León KB, Utturkar SM, **Camilleri LB**, Elias DA, Arkin AP, **Fields MW**, Brown SD, Wall JD “Complete genome sequence of *Pelosinus fermentans* JBW45, a member of a remarkably competitive group of *Negativicutes* in the Firmicutes Phylum,” *Genome Announc.*, Sep 24 2015; 3(5): pii: e01090–15. 2015-036

Figueroa LO, **Schwarz B**, **Richards AM** “Structural characterization of amphiphilic siderophores produced by a soda lake isolate, *Halomonas sp.* SL01, reveals cysteine-, phenylalanine- and proline-containing head groups,” *Extremophiles*, November 2015; 19(6): 1183–1192. 2015-045

Folsom JP, **Carlson RP** “Physiological, biomass elemental composition and proteomic analyses of *Escherichia coli* ammonium-limited chemostat growth, and comparison with iron- and glucose-limited chemostat growth,” *Microbiology*, 2015 Aug; 161(8): 1659-1670. 2015-026

Franklin M, **Chang C**, **Akiyama T**, Bothner B Book chapter: “New technologies for studying biofilms,” Book title: *Microbial Biofilms, 2nd Edition*. Ghannoum MA, Parsek M, Whiteley M, Mukherjee P (eds.) *ASM Press*, 2015; pp. 1–23. Also featured in: *Microbiol Spectr.*, 2015 Aug; 3(4). 2015-025

Hemme CL, Tu Q, Shi Z, Qin Y, Gao W, Deng Y, VanNostrand JD, Wu L, He Z, Chain PS, **Fields MW**, Rubin EM, Tiedje JM, Hazen TC, Arkin AP, Zhou J “Comparative metagenomics reveals impact of contaminants on groundwater microbiomes,” *Front Microbiol.*, 2015 Oct 31; 6:1205. 2015-052

Hommel J, **Lauchnor E**, **Phillips A**, **Gerlach R**, **Cunningham AB**, Helmig R, Ebigbo A, Class H “A revised model for microbially induced calcite precipitation: Improvements and new insights based on recent experiments,” *Water Resour. Res.*, 2015; 51: 3695–3715. 2015-034

Inskeep WP, **Jay ZJ**, **Macur RE**, Clingenpeel S, Tenney A, Lovalvo D, Beam JP, Kozubal MA, Shanks WC, Morgan LA, Kan J, Gorby Y, Yooseph S, Nealson K “Geomicrobiology of sublacustrine thermal vents in Yellowstone Lake: Geochemical controls on microbial community structure and function,” *Front Microbiol.*, 2015 Oct 26; 6:1044. 2015-049

Jewell S, Zhou X, Apple ME, **Dobeck LM**, Spangler LH, **Cunningham AB** “Bulk electric conductivity response to soil and rock CO₂ concentration during controlled CO₂ release experiments: Observations and analytic modeling,” *GEOPHYSICS*, 2015; 80(6): E293-E308. 2015-035

Kirker KR, **Fisher ST**, **James GA** “Potency and penetration of telavancin in staphylococcal biofilms,” *Int J Antimicrob Agents*, Oct 2015; 46(4):451–455. 2015-46

Kirkland CM, Herrling MP*, Hiebert R, Bender AT, Grunewald E, Walsh DO, **Codd SL** "In situ detection of subsurface biofilm using low-field NMR: A field study," *Environ Sci Technol.*, 2015 Sep 15; 49(18):11045–52. 2015-037

Kirkland CM, Hiebert R, Phillips A, Grunewald E, Walsh DO, **Seymour JD, Codd SL** "Biofilm detection in a model well-bore environment using low-field magnetic resonance," *Groundwater Monitoring & Remediation*, 2015 Fall; 35(4) 36–44. 2015-051

Ling F, **Hwang C,** LeChevallier MW, Andersen GL, Liu WT "Core-satellite populations and seasonality of water meter biofilms in a metropolitan drinking water distribution system," *ISME J.*, 2015 Aug 7. 2015-024

Lohman EJ, Gardner RD, Pedersen T, Peyton BM, Cooksey KE, **Gerlach R** "Optimized inorganic carbon regime for enhanced growth and lipid accumulation in *Chlorella vulgaris*," *Biotechnol Biofuels*, 2015 Jun 11; 8: 82. 2015-020

Pérez-Díaz MA, **Boegli L, James G,** Velasquillo C, Sánchez-Sánchez R, Martínez-Martínez RE, Martínez-Castañón GA, Martínez-Gutiérrez F "Silver nanoparticles with antimicrobial activities against *Streptococcus mutans* and their cytotoxic effect," *Mater Sci Eng C Mater Biol Appl.*, 2015 Oct 1; 55: 360–366. 2015-028

Richards CL, Broadaway SC, **Eggers MJ, Doyle JT,** Pyle BH, **Camper AK,** Ford TE "Detection of pathogenic and non-pathogenic bacteria in drinking water and associated biofilms on the Crow Reservation, Montana, USA," *Microb Ecol.*, 2015; Mar 22. Doi:10.1007/s00248-015-0595-6. 2015-042

Ritter D, Vinson D, **Barnhart E,** Akob DM, **Fields MW, Cunningham AB,** Orem W, McIntosh JC "Enhanced microbial coalbed methane generation: A review of research, commercial activity, and remaining challenges," *Intl J Coal Geology.*, July 2015; 146:28–41. 2015-019

Sánchez-Gómez S, Ferrer-Espada R, **Stewart PS, Pitts B,** Lohner K, Martínez de Tejada G "Antimicrobial activity of synthetic cationic peptides and lipopeptides derived from human lactoferricin against *Pseudomonas aeruginosa* planktonic cultures and biofilms," *BMC Microbiol.*, 2015 Jul 7; 15:137. 2015-033

Schultz L, Connolly J, Lauchnor EL, Hobbs T^, Gerlach R, Book Chapter: "Struvite stone formation by ureolytic biofilm infections." Book Title: *The Role of Bacteria in Urology*. Lange D, Chew B, (Eds.): Springer, 2015; pp. 41–49. 2015-054

Singh D, **Carlson R,** Fell D, Poolman M "Modelling metabolism of the diatom *Phaeodactylum tricornutum*," *Biochem Soc Trans.* 2015 Dec 1; 43(6):1182-6. 2015-050

Stewart BD, Cismasu AC, Williams KH, **Peyton BM,** Nico PS "Reactivity of uranium and ferrous iron with natural iron oxyhydroxides," *Environ. Sci Technol.*, 2015; 49(17): 10357–10365. 2015-022

Stewart PS Book chapter: "Antimicrobial tolerance in biofilms," Book title: *Microbial Biofilms, 2nd Edition*. Ghannoum MA, Parsek M, Whiteley M, Mukherjee P (eds.) ASM Press, 2015; pp. 269–285. Also featured in: *Microbiol Spectr.*, 2015 Jun; 3(3). 2015-021

Stewart PS "Prospects for anti-biofilm pharmaceuticals," *Pharmaceuticals (Basel)*, 2015 Aug 27; 8(3):504–11. 2015-038

Stewart PS, Franklin MJ, Williamson KS, Folsom JP, Boegli L, James GA "Contribution of stress responses to antibiotic tolerance in *Pseudomonas aeruginosa* biofilms," *Antimicrob Agents Chemother.*, July 2015; 59(7):3838–47. 2015-018

Tao Y, Rotem A, Zhang H, Cockrell SK, Koehler SA, **Chang CB,** Ung LW, Cantalupo PG, Ren Y, Lin JS, Feldman AB, Wobus CE, Pipas JM, Weitz DA "Artifact-free quantification and sequencing of rare recombinant viruses by using drop-based microfluidics," *Chembiochem.*, 2015 Oct 12; 16(15):2167–71. 2015-048

VanKempen-Fryling RJ, Stein OR, Camper AK "Presence and persistence of wastewater pathogen *Escherichia coli* O157:H7 in hydroponic reactors of treatment wetland species," *Water Sci Technol.*, 2015; 72(1):135–40. 2015-030

Villa F, Pitts B, Lauchnor E, Cappitelli F, **Stewart PS** "Development of a laboratory model of a phototroph-heterotroph mixed-species biofilm at the stone/air interface," *Front Microbiol.*, 2015; 6:1251. 2015-047

Zhang P, Van Nostrand JD, He Z, Chakraborty R, Deng Y, Curtis D, **Fields M,** Hazen TC, Arkin AP, Zhou J "A slow-release substrate stimulates groundwater microbial communities for long-term in-situ Cr(VI) reduction," *Environ Sci Technol.* 2015 Nov 3; 49(21):12922–31. 2015-039

Zhou A, He Z, Redding-Johanson AM, Mukhopadhyay A, Hemme CL, Joachimiak MP, Luo F, Deng Y, Bender KS, He Q, Keasling JD, Stahl DA, **Fields MW,** Hazen TC, Arkin AP, Wall JD, Zhou J "Hydrogen peroxide-induced oxidative stress responses in *Desulfovibrio vulgaris* Hildenborough," *Environmental Microbiology*, 2015; 12:2645–2657. 2015-044

Zhou A, Hillesland KL, He Z, Schackwitz W, Tu Q, Zane GM, Ma Q, Qu Y, Stahl DA, Wall JD, Hazen TC, **Fields MW,** Arkin AP, Zhou J. "Rapid selective sweep of pre-existing polymorphisms and slow fixation of new mutations in experimental evolution of *Desulfovibrio vulgaris*," *ISME J.*, 2015 Nov; 9(11):2360–72. 2015-040

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

2016 Publications

Beck A, Hunt KA, Bernstein HC, **Carlson RP** Book chapter "Interpreting and designing microbial communities for bioprocess applications, from components to interactions to emergent properties," Book title: *Biotechnologies for Biofuel Production and Optimization*, 1st edition. Eckert CA, Trinh CT (eds.) *Elsevier*, 2016; pp. 407–432. 2016-005

Bell TA, Prithiviraj B, Wahlen BD, **Fields MW, Peyton BM** "A lipid-accumulating alga maintains growth in outdoor, alkaliphilic raceway pond with mixed microbial communities," *Front Microbiol.*, 2016 Jan 7; 6:1480. 2016-007

Carlson RP, Oshota O, Shipman M, Caserta JA, Hu P, Saunders CW, Xu J, **Jay ZJ**, Reeder N, **Richards A, Pettigrew C[‡], Peyton BM** "Integrated molecular, physiological and in silico characterization of two *Halomonas* isolates from industrial brine," *Extremophiles*, 2016 May; 20(3):261–74. 2016-010

Espinosa-Ortiz EJ, Pechaud Y, **Lauchnor E**, Rene ER, **Gerlach R, Peyton BM**, van Hullebusch ED, Lens PN "Effect of selenite on the morphology and respiratory activity of *Phanerochaete chrysosporium* biofilms," *Bioresour Technol.*, 2016; Feb 26. 2016-004

Figueroa LO, Pitts B, Uchida M, **Richards AM** "Vesicle self-assembly of amphiphilic siderophores produced by bacterial isolates from Soap Lake, Washington," *Can. J. Chem.*, 2016; 94(1): 35-43. 2016-001

Keil D, Buck B, Goossens D, Teng Y, Leetham M, Murphy L, Pollard J, **Eggers M**, McLaurin B, Gerads R, DeWitt J "Immunotoxicological and neurotoxicological profile of health effects following subacute exposure to geogenic dust from sand dunes at the Nellis Dunes Recreation Area, Las Vegas, NV," *Toxicol Appl Pharmacol.*, 2016 Jan 15; 291:1-12. 2016-002

Maier RS, Nybo E, **Seymour JD, Codd SL** "Electroosmotic flow and dispersion in open and closed porous media," *Transp Porous Med.*, 2016 May; 113(1): 67–89. 2016-011

Moberly J, **D'Imperio S[‡], Parker A, Peyton B** "Microbial community signature in Lake Coeur d'Alene: Association of environmental variables and toxic heavy metal phases," *Applied Geochemistry*, 2016 March; 66: 174–183. 2016-003

Phillips AJ, Cunningham AB, Gerlach R, Hiebert R, Hwang C, Lomans BP, Westrich J, Mantilla C, Kirksey J, Esposito R, Spangler L "Fracture sealing with microbially-induced calcium carbonate precipitation: A field study," *Environmental Science and Technology*, 2016; 50(7) pp. 4111–4117. 2016-006

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

Teske A, de Beer D, **McKay LJ**, Tivey MK, Biddle JF, Hoer D, Lloyd KG, Lever MA, Røy H, Albert DB, Mendlovitz HP, MacGregor BJ. "The Guaymas Basin hiking guide to hydrothermal mounds, chimneys, and microbial mats: Complex seafloor expressions of subsurface hydrothermal circulation," *Front Microbiol.*, 2016 Feb 18;7:75. 2016-012

Villa F, Stewart PS, Klapper I, Jacob JM, Cappitelli F "Subaerial biofilms on outdoor stone monuments: changing the perspective towards an ecological framework," *Bioscience*, 2016 April 1; 66(4): 285–294. 2016-008

[‡] Industrial or Federal Agency co-author

[^] Undergraduate Student

^{*} Previous Visiting Researcher

[#] Previous Staff/Faculty

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RESEARCH:
 PRESENTATIONS
 June 2015–May 2016

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

Invited talks:

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

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

Student travel award:

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

Poster presentations:

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

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

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

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

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

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

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

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

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

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

“Mechanics of biofilm detachment in flowing fluids,” Eurobiofilms 2015, Brno, Czech Republic, June 23–26, 2015.

“Persistence and initiation of biofilms on medical devices,” The 3rd Stevens Conference on Bacteria-Material Interactions, Hoboken, NJ, June 17–18, 2015.

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

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

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

Juliana D’Andrilli, assistant research professor, chemical & biological engineering, presented the poster “Bulk and molecular level characterization of organic matter in glacial ice.”

Garth James, associate research professor, chemical & biological engineering, as an invited speaker presented “Biofilms and chronic wounds,” at the following meetings:
 Why Wounds Won’t Heal Conference, Bozeman Deaconess Wound Clinic, Bozeman, MT, September 25, 2015.

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

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

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

Tisza Bell, PhD student, microbiology & immunology, as a track panel speaker presented “Can ecology provide insight for algal lipid accumulation strategies in open systems?”
 Track: Systems Ecology; Algae Technology: Tools for understanding and optimizing crop assessment.

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

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

Mari Eggers, CBE research scientist, as a speaker presented “Investigating sources of water to Chief Plenty Coups Spring near Pryor, Montana: Water chemistry and microbial communities reveal seasonably variable contamination pathways,” Montana Section-American Water Resources Association 2015 Conference, Missoula, MT, October 7–9, 2015.

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

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

Pre-meeting workshop:

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

Poster presentations:

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

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

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

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

Mike Franklin, professor, microbiology: “Characterization of the *Pseudomonas aeruginosa* PAO1 biofilm matrix by fluorescence-based imaging.”

Darla Goeres, associate research professor, chemical & biological engineering, attended the ASTM subcommittee E35.15 meeting, Tampa, FL, October 28–30, 2015. Goeres was there to discuss various microbial methods under development. ASTM subcommittee E35.15 studies antimicrobial agents and ASTM main committee E35 studies pesticides, antimicrobials, and alternative control agents.

Mari Eggers, CBE research scientist, presented “Community-based cumulative risk assessment of exposure to waterborne contaminants on the Crow Reservation,” at NIEHS Conference on Traditional Ecological Knowledge (TEK) Workshop, Bethesda, MD, December 1–5, 2015. Co-presenters: Lefthand M, **Doyle J**

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

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

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

Phil Stewart, professor, chemical & biological engineering, as an invited speaker presented “How biofilms resist sanitizers,” at the Beef Industry Safety Summit, Austin, TX, March 1–3, 2016.

Neerja Zambare, PhD student, chemical engineering, presented, “Optimizing microbially induced calcite precipitation under radial flow conditions,” at the 251st American Chemistry Society (ACS) National Meeting, San Diego, CA, March 13–17, 2016.

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

Matthew Fields, CBE director, presented “Coal-dependent natural gas production in the Powder River Basin,” at the Montana Energy 2016, Billings, MT, March 29–31, 2016.

Adrienne Phillips, assistant professor, civil engineering, presented “Biom mineralization sealing technology: A technology developed in Montana,” at the Montana Energy Conference, Billings, MT, March 29–31, 2016.

Darla Goeres, associate research professor, chemical & biological engineering, presented “New proposed standard for measuring biofilm resistance on antimicrobial treated textiles,” at the ASTM subcommittee E35.15 meeting in San Antonio, TX, April 11–13, 2016.

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

“Biofilm-host interaction in chronic wounds,” at the World Healing Society meeting in Atlanta, GA, April 13, 2016.

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

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

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

Juliana D’Andrilli, assistant research professor, chemical & biological engineering, delivered an oral presentation “Integrating chemistry, microbiology, and ecosystem ecology to discern the nature and fate of dissolved organic matter in streams,” at Society for Freshwater Science, Sacramento, CA, May 22–26, 2016.

RESEARCH:
NEWS HIGHLIGHTS

Darla Goeres awarded Burroughs Wellcome Innovation in Regulatory Science Award

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

Read more about Goeres and her Burroughs Wellcome award at *MSU News*: [“MSU faculty member earns grant award for biofilm methodology research”](#)

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

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

Read more about the award and the anticipated nanotechnology center at *MSU News*: [“NSF awards \\$3 million to MSU to expand nanotechnology”](#)

Publication Spotlight

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

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

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

Connolly JM, Jackson B, Rothman AP, Klapper I, Gerlach R “Estimation of a biofilm-specific reaction rate: Kinetics of bacterial urea hydrolysis in a biofilm,” *npj Biofilms and Microbiomes* 2015; 1, 15014.

First author: James Connolly, PhD graduate, March 2015, chemical & biological engineering, MSU, CBE

Co-authors:

Ben Jackson, PhD graduate, August 2015, mathematics, MSU, CBE

Adam Rothman, bachelor’s degree, 2012, chemical & biological engineering, MSU, CBE

Isaac Klapper, professor, mathematics, Temple University (formerly professor in mathematics at MSU and CBE)

Robin Gerlach, professor, chemical & biological engineering, MSU, CBE

CBE bio-statistician earns top EPA award

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

To read about Parker's research and his EPA award [click here](#)

MSU team awarded Keck Foundation grant to study extreme Yellowstone microbes

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

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

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

Read more about the potential of Yellowstone's extreme microbes at *MSU News*: "[MSU team awarded Keck Foundation grant to study extreme Yellowstone microbes](#)"

RESEARCH:
 CBE Affiliated Faculty and Their Specialties, 2015–2016

NAME	DEPARTMENT	SPECIALTY
Jennifer Brown	Chemical & Biological Engineering	Rheology and biofilm mechanics
Mark Burr	Land Resources & Environ Sciences	Microbial community analysis
Anne Camper	Civil Engineering	Biofilms in environmental systems
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic networks
Connie Chang	Chemical & Biological Engineering	Microfluidics
Kevin Cook	Mechanical & Engineering Technology	Tool and machine design
Sarah Codd	Mechanical & Industrial Engineering	Magnetic resonance imaging
Al Cunningham	Civil Engineering	Subsurface biotechnology and bioremediation
Juliana D'Andrilli	Chemical & Biological Engineering	Physical and environmental chemistry
Jack Dockery	Mathematical Science	Mathematical models of biofilms
Matthew Fields	Microbiology	Physiology and ecology
Christine Foreman	Chemical & Biological Engineering	Microbial ecology in cold temperature environments
Michael Franklin	Microbiology	Molecular genetics, gene expression, alginate biosynthesis
Gill Geesey	Microbiology	Molecular and cellular interactions at interfaces
Robin Gerlach	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Darla Goeres	Chemical & Biological Engineering	Standardized biofilm methods
Marty Hamilton	Statistics	Applied biostatistical thinking
Jeff Heys	Chemical & Biological Engineering	Fluid-structure interactions
Garth James	Chemical & Biological Engineering	Medical biofilms
Erick Johnson	Mechanical & Industrial Engineering	Fluid mechanics
Lisa Kirk	Chemical & Biological Engineering	Treatment of mine effected water
Kelly Kirker	Chemical & Biological Engineering	Medical biofilms
Isaac Klapper	Mathematical Science	Mathematical modeling
Ellen Lauchnor	Civil Engineering	Environmental engineering
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
Richard Macur	Chemical & Biological Engineering	Biofuels, geochemistry, geomicrobiology
Albert Parker	Mathematical Sciences	Mathematics and Statistics
Brent Peyton	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Adie 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
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	Mathematics	Mathematical modeling

CBE Affiliated Faculty Awards & News

New CBE Director

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

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

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

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

Sarah Codd receives national recognition as an inspiring woman in STEM

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

Read more about Sarah and her award at *MSU News Service*: [MSU professors receive national recognition as inspiring women in STEM](#)

Engineering a perfect fit

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

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

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

Read more about Richards in MSU's *Mountain & Minds*: "[Engineering a perfect fit](#)"

CBE faculty earn MSU 2016 awards

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

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

Women in Science Distinguished Professor Award

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

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

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

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

President's Commission on the Status of University Women Award

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

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

2016 College of Engineering Awards

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

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

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

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

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

2016 CBE Outstanding Faculty Award

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

CBE Staff Awards & News

2016 Outstanding Staff Award

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

2015 Outstanding Researcher Award

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

New Staff

CBE welcomed the following postdoctoral researchers to its staff:

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

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

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

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

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

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

The CBE welcomed new staff member **Joseph Parchen** in May 2016. Joey replaces **Peg Dirckx** as the CBE's visual communications specialist and serves as the CBE's go-to person for graphics and communication needs. His role provides leadership and expertise in visual and multimedia communications and editing to extend the CBE's standing as a world-

leading institution for biofilm research, education, methods development, and industrial partnership. Joey has over 10 years of experience designing print and digital media. He looks forward to the opportunity to apply his graphics experience to the disciplines of science and engineering.

Faculty and staff retirements

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

Al Cunningham, professor, civil engineering, 35 years of service

Peg Dirckx, director of visual communications, 36 years of service

Rocky Ross, professor, computer science, 30 years of service

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EDUCATION:

Undergraduate Students: Summer 2015, Fall 2015, Spring 2016

*Graduating

‡ Native American

1. *Abassi, Reha (Chang)	M	Chem & Bio Eng	Turkey
2. *Alperen, Ece (Gerlach/Peyton)	F	Chem & Bio Eng	Turkey
3. Almeida de Jesus, Aline (Gerlach)	F	Civil/Environmental Eng	Brazil
4. Aman, Lydia (Lauchnor)	F	Chem & Bio Eng	Homedale, ID
5. *Avera, Erika (James)	F	Microbiology & Immunology	Grass Valley, CA
6. *Aytac, Mert (Wilking)	M	Chem & Bio Eng	Turkey
7. Bain, Matthew (Fields)	M	LRES	Missoula, MT
8. * ‡Bermel, Emily (Foreman)	F	Chem & Bio Eng	Big Fork, MT
9. *Berninghaus, Ashley (Gerlach)	F	Chem & Bio Eng (USP)	Poulsbo, WA
10. Beser, Guneycon Dicle (Phillips)	F	Civil/Environmental Eng	Turkey
11. Brennan, Shannon (Fields)	F	Microbiology & Immunology	Bend, OR
12. Burt, Kevin (Stein)	M	Civil/Environmental Eng	Butte, MT
13. *Cetin, Didem (Wilking)	F	Chem & Bio Eng	Turkey
14. Coelho, Ana Paula (Phillips)	F	Civil/Environmental Eng	Bahia, Brazil
15. *Conrad, Stephanie (Lauchnor)	F	Chem & Bio Eng	Pittsburg, PA
16. Crawford, James (Peyton)	M	Chem & Bio Eng	Bozeman, MT
17. David, Jonas (James)	M	Modern Lang & Lit	Fort Collins, CO
18. Delridge, Alexa (Phillips)	F	Chem & Bio Eng	Missoula, MT
19. Dickerman, Grace (Walker)	F	Chem & Bio Eng	Cody, WY
20. ‡Dupuis, Lauren (Chang)	F	Chem & Bio Eng	Polson, MT
21. *Durmus, Cadan Ece (Wilking)	F	Chem & Bio Eng	Turkey
22. Eddy, Zachary (Fields)	M	LRES	Great Falls, MT
23. Eickelberg, Makayla (James)	F	Chem & Biochemistry	Belgrade, MT
24. Ekness, Thayne (Peyton)	M	Chem & Bio Eng	Westby, MT
25. Exner, Katie (Chang)	F	Chem & Bio Eng	Hamilton, MT
26. Filanoski, Brooke (Phillips)	F	Chem & Bio Eng	Spokane, WA
27. *Fisch, Laura (Foreman)	F	Chem & Bio Eng	Colorado Springs, CO
28. Franz, Brian (Fields)	M	Chem & Bio Eng	Goodfield, IL
29. Frieling, Zach (Gerlach)	M	Chem & Bio Eng	Gallatin Gateway, MT
30. *Fox, Amy (Chang)	F	Chem & Bio Eng (USP)	Belgrade, MT
31. Gutknecht, Andrew (Peyton)	M	Chem & Bio Eng	Buffalo, MN
32. Hobbs, Trace (Gerlach/Lauchnor)	M	Chem & Biochem (Hughes)	Kalispell, MT
33. Hoskins, Reece (Lauchnor)	M	Civil/Environmental Eng	Columbus, IN
34. Hultin, Emily (Foreman)	F	Chem & Bio Eng	Helena, MT
35. ‡Keepseagle, Kayla (Codd/Seymour)	F	Chem & Bio Eng	Bismark, ND
36. *Koc, Gune (Peyton)	M	Chem & Bio Eng	Turkey
37. Lee, Fei San (Walker)	F	Chem & Bio Eng	Malaysia
38. Kieffer, Whitney (Lauchnor)	F	Chem & Bio Eng	Richland, WA
39. Klingelsmith, Korinne (Fields)	F	Chem & Bio Eng	Fort Collins, CO
40. Lemelin, Kale (Chang)	M	Chem & Bio Eng	Billings, MT
41. *Lund, Thomas (Brown)	M	Chem & Bio Eng	East Helena, MT
42. *McFarland, Colleen (Phillips)	F	Microbiology & Immunology	San Francisco, CA
43. Meagher, Michelle (Peyton/Skorupa)	F	Chem & Bio Eng	Idaho Falls, ID
44. *Miller, Isaac (Fields)	M	Ecology	East Helena, MT
45. Moeun, Yora (Wilking)	F	Chem & Bio Eng	Cambodia
46. Morasko, Vincent (Phillips/Gerlach)	M	Chem & Bio Eng	Glendive, MT
47. Obert, Kevin (Fields/Hwang)	M	Microbiology & Immunology	Billings, MT
48. Oeschger, Taylor (Foreman)	F	Chem & Bio Eng	Sacramento, CA
49. Oloff, Esther (Chang)	F	Chem & Bio Eng	Idaho Falls, ID
50. Olson, Caitlin (Fields)	F	Chem & Bio Eng	Helena, MT

51. Osborn, Alison (Fields)	F	Civil/Environmental Eng	Fort Collins, CO
52. Ozcan, Safiye (Chang)	F	Chem & Bio Eng	Turkey
53. Park, Rita (Phillips)	F	Microbiology & Immunology	Butte, MT
54. *Parsons, Amanda (Seymour)	F	Chem & Bio Eng	Acton, MT
55. *Pedersen, Stephen (Walker/Peyton)	M	Chem & Bio Eng	Clayton, CA
56. Peters, Daniel (Gerlach)	M	Chem & Bio Eng	Butte, MT
57. Platt, George (Gerlach/Fields)	M	Chem & Bio Eng	Eagle River, AK
58. *Pintar, Kathryn (Carlson)	F	Chem & Bio Eng	Spokane, WA
59. Polukoff, Natalya (Walker)	F	Microbiology & Immunology	Park City, UT
60. Pratt, Shawna (Chang)	F	Chem & Bio Eng	Miles City, MT
61. *Rao, Varsha (Codd/Seymour)	F	Chem & Bio Eng	Canada
62. *Schrammeck, Ashley (Carlson)	F	Chem & Bio Eng	Hamilton, MT
63. *Schultz, Johanna (Walker)	F	Chem & Bio Eng	Glasgow, MT
64. Scott, Derrick (Fields)	M	Microbiology & Immunology	Cody, WY
65. Stangeland, James (Stewart)	M	Chem & Bio Eng	Helena, MT
66. Stockton, Bronwyn (Fields)	F	Microbiology & Immunology	South Jordan, UT
67. *Summers, Jennifer (Walker)	F	Chem & Bio Eng	Conowingo, MD
68. Thompson, Madison (Lauchnor)	F	Civil/Environmental Eng	Santa Ana, CA
69. *Troyer, Eric (Gerlach)	M	Chem & Bio Eng	Hardin, MT
70. *Vigers, Michael (Wilking)	M	Chem & Bio Eng	Boulder, CO
71. *West, Cody (Phillips)	M	Civil/Environmental Eng	Butte, MT
72. Westerhoff, Lilly (Macur/Richards)	F	Chem & Bio Eng	Worden, MT
73. Williams, Kai (Foreman)	F	Chem & Bio Eng	Great Falls, MT
74. *Ying Wee, Shu (Foreman)	F	Chem & Bio Eng	Malaysia
75. *Zare, Ruya (Peyton)	F	Chem & Bio Eng	Turkey
76. Zhu, Sophie (Fields)	F	Microbiology & Immunology	Bozeman, MT

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Undergraduates Summary: 2015–2016

Department (Program)	Male	Female	Total
Chemical & Biological Engineering	17M	36F	53
Chemistry & Biochemistry	1M	1F	2
Civil/Environmental Eng	3M	5F	8
Ecology	1M		1
Land Resources & Environ Sci (LRES)	2M		2
Microbiology & Immunology	2M	7F	9
Modern Languages & Literature	1M		1
Totals	27 M	49 F	76

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EDUCATION:

Graduate Students: Summer 2015, Fall 2015, Spring 2016

‡ Native American *Received degree

Masters Candidates

1.	Akyel, Arda (Gerlach)	M	Chem & Bio Eng	Turkey
2.	Berglund, Emily (Wilking)	F	Chem & Bio Eng	Helena, MT
3.	*Bodle, Kylie (Lauchnor)	F	Civil/Environmental Eng	Camano Island, WA
4.	*‡Doig, Lakotah (Fields)	F	Micro & Immunology	Gypsum, CO
5.	Ertuna, Cagan (Peyton)	M	Chem & Bio Eng	Cyprus
6.	Hill, Morgan (Brown)	F	Chem & Bio Eng	Turner, ME
7.	*‡Martin, Christine (Camper/Eggers)	F	Health & Human Dev	Hardin, MT
8.	*Moss, Jefferson (Stein)	M	Civil/Environmental Eng	Colorado Springs, CO
9.	Nitzinger, Violeta (Camper/Eggers)	F	Health & Human Dev	Livingston, MT
10.	Norton, Drew (Lauchnor)	M	Civil/Environmental Eng	Olympia, WA
11.	Pedersen, Todd (Peyton)	M	Chem & Bio Eng	Poulsbo, WA
12.	*Schaefer, Robert (Chang)	M	Chem & Bio Eng	Bothell, WA
13.	*Spengler, Justin (Carlson/Camper)	M	Chem & Bio Eng	Jacksonville, FL
14.	Stoick, Emily (Lauchnor)	F	Civil/Environmental Eng	Kalispell, MT
15.	*Thane, Abby (Phillips)	F	Civil/Environmental Eng	Missoula, MT
16.	Wallis, Jack (Stein)	M	Civil/Environmental Eng	Vancouver, WA
17.	White, Benjamin (Franklin/James)	M	Micro & Immunology	Grand Island, NE
18.	Woodhouse, Shayla (Stein)	F	Civil/Environmental Eng	San Diego, CA
19.	Yanardag, Sila (Franklin)	F	Chem & Bio Eng	Turkey
20.	*Zath, Geoffrey (Chang)	M	Chem & Bio Eng	Bend, OR

PhD Candidates

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

EDUCATION:
 Graduate Students, 2015–2016

20: Chemical & Biological Engineering

MS: 9

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

3 F Berglund, Emily: MS, *Wilking*
 Hill, Morgan: MS, *Brown*
 Yanardag, Sila: MS, *Franklin*

PhD: 11

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

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

10: Civil / Environmental Engineering

MS: 7

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

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

PhD: 3

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

1 F Kirkland, Catherine: PhD, *Codd*

2: Health & Human Development

MS: 2

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

3: Land Resources & Environmental Sciences

PhD: 3

2 M Brame, Keenan: PhD, *Camper*
 Jennings, Ryan: PhD, *Carlson*
 1 F Smith, Heidi: PhD, *Foreman*

1: Mathematics

PhD: 1

1 M Jackson, Benjamin: PhD, *Klapper*

1: Materials Science

PhD: 1

1 M Bernard, Garrett: PhD, *Chang*

14: Microbiology & Immunology

MS: 2

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

PhD: 12

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

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

2: Nursing

PhD: 2

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

TOTALS

Total Graduate Students: 53

Total MS: 20 10 M / 10 F
 Total PhD: 33 14 M / 19 F

Total Male: 24
 Total Female: 29

EDUCATION:

Graduating with advanced degrees: June 2015–May 2016

Ryan deMontmollin Jennings, PhD, Land Resources and Environmental Sciences, May 2015

Inorganic carbon fixation and trophic interactions in high-temperature geothermal springs of Yellowstone National Park, WY, USA

Justin Spengler, MS, Civil Engineering, August 2015

Denitrification at the microscale in treatment wetlands

Benjamin Jackson, PhD, Mathematics, August 2015

Transport of dissolved and particulate material in biofilm-lined tubes and channels

Jeff Moss, MS, Civil Engineering, November 2015

Operation and optimization of a two-stage, vertical-flow treatment wetland in an alpine environment

Heidi Smith, PhD, Land Resources and Environmental Sciences, March 2016

Microbial community composition and the transformation of dissolved organic matter in supraglacial environments

Lakotah Doig, MS, Microbiology and Immunology, April 2016

Lipid accumulation in mixed photoautotrophic cultures from municipal wastewater

Geoffrey Zath, MS, Chemical Engineering, April 2016

A high-throughput, multiplexed microfluidic method utilizing an optically barcoded drop library

Chris Allen, PhD, Civil Engineering, May 2016

Nitrogen removal and associated greenhouse gas production from carbon limited synthetic wastewater in lab scale treatment wetlands

EDUCATION:

2016 MSU Student Research Celebration: CBE Participants

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

TOPICAL SESSION

McNair Scholars Program

12:15 p.m. SUB 233

Amanda Parsons – Chemical Engineering

Faculty Mentor – **Joseph Seymour**

“Formation and magnetic resonance imaging of alginate gels”

POSTERS

Graduate Students

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

Undergraduate Students

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

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

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

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

Amy Fox: Chemical & Biological Engineering
 Mentor: **Connie Chang**, Phillip Himmer -- Chemical &
 Biological Engineering, Electrical & Computer Engineering

“Investigation of microfluidic temperature control for
 organoid growth”

Danielle Hanger: Psychology

Mentor: Keith Hutchison – Psychology

“The Role of Working Memory Capacity and Cognitive
 Load in Producing and Detecting Deception”

Trace Hobbs: Chemistry & Biochemistry

Mentor: **Robin Gerlach** -- Chemical & Biological

Engineering “Comparison of struvite precipitation under
 biotic and abiotic conditions”

Reece Hoskins: Civil Engineering

Mentor: **Ellen Lauchnor**, Christopher Allen -- Civil

Engineering “Ennis treatment wetlands: A baseline study
 of organic pollution in the Blaine Spring Creek ecosystem

Kayla Keepseagle: Chemical & Biological Engineering

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

Michelle Meagher: Chemical & Biological Engineering

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

Esther Oloff: Chemical & Biological Engineering

Mentor: **Connie Chang** -- Chemical & Biological

Engineering “Manipulating the growth of organoids using
 microfluidic techniques”

Amanda Parsons: Chemical & Biological Engineering

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

Miguel Strunk: Chemical & Biological Engineering

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

Shu Ying Wee: Chemical & Biological Engineering

Mentor: **Christine Foreman** -- Chemical & Biological

Engineering “Role of pigments in Antarctic bacteria stress
 response”

EDUCATION: News Highlights

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

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

Two CBE doctoral candidates awarded NSF-EAPSI Fellowships

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

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

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

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

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

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

Finalist **Jeff Simkins** took first place in the competition with his presentation "MRI: A new tool in the fight to end infectious disease." For a list of the finalists go to *MSU News Service*: "[Three-Minute Thesis event set for March 3 at MSU](#)"

2016 MSU Awards for Excellence

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

The event is co-hosted by the MSU Alumni Association and the Bozeman Chamber of Commerce. Honored students were nominated by faculty in their college or department. Qualified seniors must have at least a 3.5 grade point average on a 4.0 scale, as well as demonstrated campus leadership and community service. CBE undergraduate student **Kathryn Pintar**, chemical and biological engineering, was honored at the ceremony.

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

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

To read more about Pintar's community involvement go to *MSU News*:

<http://www.montana.edu/news/15980/eight-msu-students-win-torley-awards-for-community-involvement>

View the full list of recipients of the Awards for Excellence at *MSU News*:

<http://www.montana.edu/news/15979/msu-students-and-mentors-honored-with-annual-awards-for-excellence>

MSU-CBE undergraduate wins regional Montana Mathematics Modeling Challenge

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

2016 W.G. Characklis Outstanding Graduate Student Award

The CBE is proud to announce the 2016 W.G. Characklis Outstanding Graduate Student Award recipient—**Katherine "Katie" Davis**. Katie was recognized for her exceptional management of her PhD project in the face of significant research challenges, her role as a valuable resource for colleagues and industrial collaborators on coal bed methane research, and her ability to work successfully with students, staff, and faculty across disciplines. The W.G. Characklis Award is presented annually to CBE doctoral students for their contributions to research and education. The award honors Center Founder Bill Characklis, who envisioned students working in interdisciplinary teams, participating in innovative educational programs, interacting with industry, and assuming leadership roles.

CBE Student Citizen Award

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

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EDUCATION:

CBE Seminar Series: Fall 2015

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

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

EDUCATION:

CBE Seminar Series: Spring 2016

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

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

TECHNOLOGY TRANSFER:
Industrial Associates, 2015–16
Bold, new *Small business member

3M
Accuratus Lab Services*
American Chemet*
BASF
Baxter Healthcare
BP
Church & Dwight Company
Colgate-Palmolive
Dow Corning Corporation
Dow Microbial Control
Ecolab
ICU Medical, Inc.
KCI, An Acelity Company
Lonza
Masco Corporation
NASA
NCH Corporation
Next Science
Novozymes
PPG Industries
Procter & Gamble Company
Sani-Marc, Inc.
SANUWAVE Health*
Sealed Air Corporation
Sterilex*
STERIS
The Clorox Company
The Sherwin-Williams Company
W.L. Gore & Associates
Zimmer Biomet

TECHNOLOGY TRANSFER:
 Montana Biofilm Meeting
 July 13–16, 2015

Monday, July 13

6:00–8:30 p.m.

Pre-registration and welcome reception

Larkspur Foyer, Hilton Garden Inn, Bozeman

Tuesday, July 14

7:30–8:00 a.m.

Registration and continental breakfast

Larkspur Foyer, Hilton Garden Inn

8:00–8:10

Introductory remarks

Larkspur Ballroom

Paul Sturman, CBE Industrial Coordinator

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

Matthew Fields, CBE Director

SESSION 1:

Oilfield Biofilms

8:10–8:15

Session Introduction

Paul Sturman

8:15–8:45

Visualization and quantification of biofilm removal

TJ Tidwell, Principal Microbiologist, Nalco Champion Company, Sugar Land, TX

8:45–9:20

Mechanisms and mitigation of severe microbial corrosion by sulfate-reducing bacteria

Dennis Enning, Senior Research Engineer, ExxonMobil Upstream Research Company, Houston, TX

9:20–9:50

Modeling the growth and chemistry of sulfate-reducing biofilms

Robin Gerlach, Professor, Chemical & Biological Engineering, MSU-CBE

9:50–10:20 Networking Break

10:20–10:50

Thiosulfate-reducing microbes in oil field systems: Too often overlooked

Kathleen Duncan, Research Associate Professor, Microbiology & Plant Sciences, University of Oklahoma, Norman, OK

10:50–11:20

Transformation of hydraulic fracturing chemicals underground—Focus on glutaraldehyde

Genevieve Kahrilas, PhD Candidate, Chemistry, Colorado State University, Fort Collins, CO

11:20–11:50

Enhancement of biogenic coalbed methane production

Katie Davis, PhD student, Chemical & Biological Engineering, MSU-CBE

12:00–1:00

Catered lunch, Hilton Garden Inn

SESSION 2:

Regulatory Agency Update

1:00–1:30

Meeting Highlights: Anti-biofilm Technologies—Pathways to Product Development, Feb 2015

Paul Sturman

1:30–1:55

Biofilm claims for antimicrobial products: U.S. EPA regulatory perspective

Steve Tomasino, Senior Scientist, U.S. EPA Office of Pesticide Programs, Fort Meade, MD

1:55–2:20

Results from continued optimization of the Single Tube Method

Darla Goeres, Associate Research Professor, Chemical & Biological Engineering, MSU-CBE

CBE Open House: Lab demonstrations and poster session

3:00–5:00

3rd Floor EPS Building, MSU

Wednesday, July 15

7:30–8:00 a.m.

Registration and continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 3:

Medical Biofilms

8:00–8:05

Session introduction

Garth James, Associate Research Professor, Chemical & Biological Engineering, MSU-CBE

8:05–8:30

3D imaging of oral biofilms

Garth James

8:30–9:00

***Clostridium difficile* and health care-associated infection**

Seth Walk, Assistant Professor, Microbiology & Immunology, MSU

9:00–9:30

In vitro analysis of *Clostridium difficile* biofilms: Imaging and antimicrobial treatment

Elinor deLancey Pulcini, Assistant Research Professor, Chemical & Biological Engineering, MSU-CBE

9:30–10:00 Networking Break

10:00–10:30

Antimicrobial and anticancer β 2, 2-amino acid derivatives: Peptide mimetics with potential for oral administration

Dominik Ausbacher, CBE visiting Postdoctoral Researcher, Department of Pharmacy, UiT—The Arctic University of Norway, Tromsø, Norway

10:30-11:00

***Staphylococcus aureus* biofilms and keratinocyte apoptosis**

Kelly Kirker, Assistant Research Professor, Chemical & Biological Engineering, MSU-CBE

YOUNG INVESTIGATORS

11:00-11:30

Phenazine antibiotic inspired discovery of biofilm-eradicating small molecules

Robert Huigens III, Assistant Professor, Medicinal Chemistry, University of Florida, Gainesville, FL

11:30-12:00

Coupling multi-scale in situ determination of biofilm mechanical properties to mathematical modeling of biofilm fluid-structure interaction

Juan Pavissich, Postdoctoral Researcher, Department of Biotechnology, Delft University of Technology, The Netherlands

12:00-12:10

Presentation of CBE awards

Phil Stewart, Professor, Chemical & Biological Engineering, MSU-CBE

12:10-1:10

Catered lunch, Hilton Garden Inn

SESSION 4:

Biofilm Mineral Interactions

1:10-1:15

Session introduction

Robin Gerlach

1:15-1:35

From speleogenesis to sewer corrosion

Phil Stewart

1:35-2:15

Subaerial biofilms: New horizons in stone biodeterioration research

Federica Villa, CBE Visiting Postdoctoral Researcher, University of Milan, Italy

2:15-2:45

Biomining of kidney stones

Logan Schultz, Postdoctoral Researcher, MSU-CBE

2:45-3:15

Overview of biofilm mediated mineralization and engineering applications

Adie Phillips, Assistant Professor, Civil Engineering, MSU-CBE

3:30-5:00 Business Meeting

Hilton Garden Inn

6:00 Dinner/Banquet

Rockin' TJ Ranch, Bozeman

Thursday, July 16

7:30-8:00 a.m.

Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 5:

Biofilm Fundamentals

8:05-8:10

Session introduction

Matthew Fields

8:10-8:35

Novel extracellular membrane structures in a sulfate-reducing biofilm

Lauren Franco, PhD student, Microbiology & Immunology, MSU-CBE

8:35-9:00

Antimicrobial tolerance in biofilms

Phil Stewart

9:00-9:25

Biofilms formed by the archaeon *Haloferax volcanii* exhibit cellular differentiation, social motility, and facilitate horizontal gene transfer

Thane Papke, Associate Professor, Molecular & Cell Biology, University of Connecticut, Storrs, CT

9:25-9:50

Biofilm formation mechanisms of *Pseudomonas aeruginosa* predicted via metabolic models

Francisco Vital-Lopez, Research Scientist, DoD Biotechnology High-Performance Computing Software Applications Institute (BHSI), Frederick, MD

9:50-10:20 Networking Break

SESSION 6:

New Tools & Methods

10:20-10:25

Session introduction

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

10:25-10:50

Quantifying biofilm characteristics over time from 3-D confocal microscope movies

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

10:50-11:15

Drop-based microfluidics for high-throughput biological assaying

Connie Chang, Assistant Professor, Chemical & Biological Engineering, MSU-CBE

11:15-11:40

Developing materials-based understanding of biofilm mechanics

Jim Wilking

11:40-12:05

Applications of microelectrodes for biofilm kinetics and inhibition studies

Ellen Lauchnor, Assistant Professor, Civil Engineering, MSU-CBE

WORKSHOP:
 Biofilm Methods for Your Lab
 July 13, 2015

9:00–9:15	Welcome – <i>CBE Director</i> <ul style="list-style-type: none"> • Group introductions 	EPS 323
9:15–9:30	An Introduction to Biofilms – <i>Paul Sturman</i>	EPS 323
9:30–10:15	Adapting Standardized Biofilm Growth Methods for Other Bacteria – <i>Darla Goeres</i>	EPS 323
10:15–10:30	<i>Morning Refreshments</i>	EPS 323
10:30–11:15	Adapting Biofilm Growth Methods around the CBE <ul style="list-style-type: none"> • Medical Biofilms – <i>Garth James, Medical Biofilms Lab</i> • Biofilms in Cold Environments – <i>Emily Bermel, Microbial Ecology & Biogeochemistry Lab</i> • Anaerobic Biofilms – <i>Sara Altenburg, Physiology & Ecology Lab</i> 	EPS 316/334/336
11:15–11:45	Keepin’ it Real: The R’s of Statistical Methods – <i>Al Parker</i>	EPS 323
11:45–1:00	LUNCH – Computer Science Conference Room	EPS 347
1:00–2:15	Adapting & Optimizing Biofilm Growth Methods in the Standardized Biofilm Methods Laboratory – <i>Lindsey Lorenz, Kelli Buckingham-Meyer, Diane Walker, Jennifer Summers, Stephen Pedersen, Grace Dickerman</i>	EPS 301
2:15–2:30	<i>Afternoon Refreshments</i>	EPS 323
2:30–3:00	Microscopy: Overview of the Treatment Flow Cell with CSLM & Imaging Reactor Coupons – <i>Lindsey Lorenz</i>	EPS 326/7
3:00–3:15	Treatment Flow Cell Movies – <i>Kelli Buckingham-Meyer</i>	EPS 323
3:15–3:45	Quantitation via Image Analysis – <i>Al Parker</i>	EPS 323
3:45–4:00	Wrap-Up/Discussion	EPS 323

TECHNOLOGY TRANSFER:
 Anti-Biofilm Technologies: Pathways to Product Development
 February 10, 2016 Arlington, VA

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

TECHNOLOGY TRANSFER:
 Beneficial-Biofilms Workshop
 February 9, 2016 Arlington, VA

Time	Title	Speaker
7:30 a.m.–8:15 a.m.	Registration and continental breakfast, Studio E, Studio F	
8:15 a.m.–8:30 a.m.	Welcome and opening remarks, Studio E	Matthew Fields, CBE Director; Professor, Microbiology & immunology, MSU Paul Sturman, CBE Industrial Coordinator; Chuck Pettigrew, Chair, CBE Industrial Associates Program; Principal Scientist, Procter & Gamble
SESSION 1: Industry Perspectives		
8:30 a.m.–9:00 a.m.	Beneficial biofilms in crop care and protection	Ted Deisenroth, Principal Scientist, BASF
9:00 a.m.–9:30 a.m.	Beneficial microbes in spaceflight or: How I learned to stop worrying and love the bugs	Leticia Vega, Scientist, Water Recovery Systems Group, NASA-Johnson Space Ctr.
9:30 a.m.–10:00 a.m.	BREAK	
Session 2: Regulatory Perspectives		
10:00 a.m.–10:30 a.m.	Beneficial colonization: A researcher's perspective on medical devices	Eva Wang, ORISE Research Fellow, Center for Devices & Radiological Health, FDA
10:30 a.m.–11:00 a.m.	Microbial pesticide ecological risk assessment	Mike Mendelsohn, Senior Regulatory Specialist, Biopesticides and Pollution Prevention Division, Office of Pesticide Programs, EPA
Session 3: Academic Perspectives		
11:00 a.m.–11:30 a.m.	Beneficial bacteria associated with the human body	Garth James, Manager, Medical Biofilms Laboratory, CBE; Assistant Research Professor, Chemical & Biological Engineering, MSU
11:30 a.m.–12:00 p.m.	Altering oral biofilm communities to maintain dental health	Alexander H. Rickard, Assistant Professor, Epidemiology, School of Public Health, University of Michigan
12:00 p.m.–1:00 p.m.	Catered Lunch, Studio F	
Academic Perspectives <i>continued</i>		
1:00 p.m.–1:30 p.m.	Energy-related biofilms	Matthew Fields
1:30 p.m.–2:00 p.m.	Biofilms in biomineralization, bioremediation, and biocorrosion	Brent Peyton, Professor, Chemical & Biological Engineering, MSU, CBE
2:00 p.m.–2:30 p.m.	Energy recovery in wastewater using electrogenic biofilms in microbial fuel cells	Birthe Venø Kjellerup, Assistant Professor, Civil & Environmental Engineering, University of Maryland
2:30 p.m.–3:00 p.m.	Break	
3:00 p.m.–4:00 p.m.	Discussion & Brainstorming Session	

TECHNOLOGY TRANSFER: NEWS HIGHLIGHTS

CBE welcomed new members to its Industrial Associates Program:

Lonza Specialty Products

Lonza is one of the world's leading suppliers to the pharma, biotech, and specialty ingredient markets. Their products and services range from active pharmaceutical ingredients and stem-cell therapies to drinking water sanitizers; industrial preservatives to microbial control solutions that combat dangerous viruses, bacteria and other pathogens; and manufacturing of vitamin B compounds and organic personal care ingredients to agricultural services and products.

Denise Taylor is the CBE designated representative. Read more about Lonza at: <http://www.lonza.com>

PPG Industries

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

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

Read about [CBE membership](#)

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

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

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

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

ASTM International, formerly known as the American Society for Testing and Materials (ASTM), is a globally recognized leader in the development and delivery of international voluntary consensus standards. Committee E35 is responsible for the development of standard definitions, classifications, appropriate test methods, and recommended practices relating to efficacy, safety, quality, and impact in appropriate environments of pesticides, antiseptic and antimicrobial agents, biological agents, devices, and equipment.

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TECHNOLOGY TRANSFER: Industry and Agency Interactions

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

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

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

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

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

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

- “What is a biofilm?” M. Fields
- The value of CBE’s industrial membership*, M. Fields
- Standard methods and disinfectant efficacy testing*, D. Goeres
- Microscopy and treatment flow cell*, A. Parker & K. Buckingham-Meyer

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

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

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

Matthew Fields, Darla Goeres, Al Parker, and Garth James visited **Procter and Gamble** in Cincinnati, OH, on March 7, 2016.

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

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

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

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

Matthew Fields hosted **Cliff Bradley**, President, **Montana BioAgriculture, Inc.** Missoula, MT, on May 5, 2016.

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

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

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

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

Meet with fungal researcher **Andrea Stierle** at **University of Montana**.

Phil Stewart visited **3M** and presented “The Science of Biofilm Control with Antimicrobial Agents,” in St. Paul, MN on May 19, 2016.

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

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OUTREACH: News Highlights

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

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

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

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

To view the cover image and the entire *PNAS* issue go to: ["CBE collaboration earns PNAS cover image"](#)

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

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

To view the workshop agenda, go to: <http://bit.ly/1L6QBRz>

7th ASM Conference on Biofilms, October 2015: <http://conferences.asm.org/index.php/upcoming-conferences/7th-asm-conference-on-biofilms>

MSU's NanoDays Event

CBE faculty and researchers participated in MSU's 2016 NanoDays on February 29, 2016. **Connie Chang**, assistant research professor in chemical and biological engineering, presented "Tiny test tubes created using the magic of microfluidics," to fifth graders from local elementary schools. Chang was assisted by **Amy Fox**, MSU-CBE undergraduate student in chemical and biological engineering, and **Robert Schaefer**, MSU-CBE master's student in chemical and biological engineering.

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Nanoscience is the study of extremely small particles. Nanoscientists work with particles and devices between one and 100 nanometers in size (the head of a pin is 1,000,000 nanometers across). Through nanoscience, scientists have developed disease-fighting drugs, computer components, transparent sunscreen, ultra-strong sports equipment and many other applications.

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

Phil Stewart explains biofilm on radio show

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

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

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

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OUTREACH:

Visiting Researchers

Visiting Student Researchers

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

Adam Hise, PhD student, environmental sciences & engineering, University of North Carolina at Chapel Hill
 Area of study: Algal biofuels
 CBE host: **Robin Gerlach**, professor, chemical & biological engineering

Adam successfully defended his PhD thesis, "Interdependence of financing parameters and processing improvements in the design of economically competitive algal biofuel production pathways" while working at the CBE (July 30, 2016).

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

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

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

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

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

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

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Visiting Research Faculty

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

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

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

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CBE Tours

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

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

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

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OUTREACH:

Web image library use 2015–2016

Total image downloads: **321**

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

Arizona	Illinois	Michigan	Ohio	Vermont
California	Indiana	Minnesota	Oklahoma	Washington
Colorado	Iowa	Montana	Oregon	Wisconsin
Connecticut	Kansas	Nevada	Pennsylvania	
Delaware	Kentucky	New Jersey	Rhode Island	
Florida	Louisiana	New Mexico	South Carolina	
Georgia	Maryland	New York	Texas	
Idaho	Massachusetts	North Carolina	Utah	

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

Argentina	
Austria	
Australia	Japan
Belgium	Korea
Brazil	Malaysia
Canada	Mexico
Chile	Netherlands
Cuba	New Zealand
Czech Republic	Nigeria
Denmark	Portugal
Finland	Saudi Arabia
France	Serbia
Germany	Singapore
Greece	South Africa
Hungary	Spain
India	Sweden
Iran	Thailand
Ireland	United Kingdom
Italy	United Arab Emirates

FACILITIES:

Center for Biofilm Engineering Facilities Overview

The CBE moved into MSU's Engineering and Physical Sciences Building when it was built in 1997. The >20,000 ft² facility includes offices and conference rooms for faculty, staff, and students; a computer lab; and thirteen fully equipped research laboratories. The full-time CBE Technical Operations Manager oversees the research laboratories, provides one-on-one training for students, ensures safe laboratory practices, and maintains equipment. State-of-the-art instruments and equipment are available for use by all CBE faculty, staff, and students. General use areas include an analytical instrument lab, a microbiology lab with media preparation area and autoclaves, an incubator room, and a general molecular area with two thermocyclers, a gel running and imaging station, and NanoDrop for nucleic acid quantification, as well as an isolated radioactive isotope lab. Facilities of particular note are described below. In spring 2016 the Engineering and Physical Sciences Building was renamed Barnard Hall in honor of Tim and Mary Barnard, MSU-College of Engineering donors and founders of the Bozeman-based company Barnard Construction.

Mass Spectrometry Facility

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

Microsensor Laboratory

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

Microscope Facilities

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

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

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

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

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

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

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

Computer Facilities

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

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

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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, two technicians, and three undergraduate research assistants.

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

Standardized Biofilm Methods Laboratory

The Standardized Biofilm Methods Laboratory (SBML) was designed to meet research and industry needs for standard analytical methods to evaluate innovative biofilm control technologies. SBML staff and students develop, refine, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBML members work with international standard setting organizations (AOAC International, ASTM International, IBRG, and OECD) on the approval of biofilm methods by the standard setting community. Under a contract with the U.S. Environmental Protection Agency (EPA), the SBML provides statistical services related to the EPA's Office of Pesticide Programs Antimicrobial Testing Program to assess the performance of antimicrobial test methods—including those for biofilm bacteria. Most recently, the SBML received funding from the Burroughs Wellcome Foundation to develop a method for assessing the prevention of biofilm on surface modified urinary catheters. In addition, they conduct applied and fundamental research experiments and develop testing protocols for product specific applications. Methods include: design of reactor systems to simulate industrial/medical systems; growing biofilm and quantifying microbial abundances and activity; testing the efficacy of chemical constituents against biofilms; and microscopy and image analysis of biofilms. SBML staff offer customized biofilm methods training workshops for CBE students, collaborators, and industry clients.

Microbial Ecology and Biogeochemistry Laboratory

Research in the Microbial Ecology and Biogeochemistry Laboratory lies at the intersection of microbial and ecosystem ecology and uses a combination of field and laboratory studies, as well as approaches ranging from the single-cell to the community level. Staff in this lab are interested in understanding how the environment controls the composition of microbial communities and how, in turn, those microbes regulate whole ecosystem processes such as nutrient and organic matter cycling. Ongoing research examines carbon flux through microbial communities, with the long-term goal of improving predictions of carbon fate (metabolism to CO₂, sequestration into biomass, long-term storage in ice) in the context of a changing environment. Additionally, they are interested in physiological adaptations to life in icy environments. Regardless of the environment, the group employs microbiological, limnological, biochemical and molecular biology approaches to investigate fundamental processes carried out by microbes.

Microfluidics Laboratory

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

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

OTHER Montana State University facilities available for collaborative research

Montana Nanotechnology (MONT) Facility

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

Montana Microfabrication Facility (MMF)

The Montana Microfabrication Facility is a cleanroom user facility located at MSU-Bozeman. As part of the NSF NNCI consortium MMF is a user facility open to university students and faculty as well as extramural users from industry and academia. The MMF facility comprises three separate areas: the Barnard Hall cleanroom, the Cobleigh process cleanroom and the Cobleigh packaging room. The Barnard Hall facility is a 1500 sq. ft. lab consisting of a class 1000 lithography area and a class 1000 general processing area. The Cobleigh process facility is a 500 sq. ft. class 10,000 lab that is home to MMF's PVD deposition tools and the packaging room is a 200 sq. ft., class 10,000 softwall cleanroom. The labs are located in adjacent, connected buildings. MMF supports education, research, and development work in nano and microfabrication areas. **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 Barnard Hall, adjacent to the Center for Biofilm Engineering. ICAL is a core user facility that fosters interdisciplinary collaboration and supports basic and applied research and education in all science and engineering disciplines at MSU and in the surrounding area. The laboratory provides users from academic and government institutions and the private sector with access to state-of-the-art equipment, professional expertise, and individual training. ICAL instrumentation is dedicated to the characterization of materials through high-resolution imaging and spectroscopy. The recent addition of a state-of-the-art Auger nanoprobe with EBSD and EDX opens up *unique* and transformative material characterization capabilities. This system will enable the simultaneous submicron analysis of surface and bulk composition, identification of crystal phase and crystallographic orientation, and measurement of strain on precisely the same spot at nearly the same time, which will elevate the capabilities of the research groups in the region to the next level.

Current Instrumentation

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

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

MSU Proteomics, Metabolomics, Mass Spectrometry Facility

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

Facility Coordinator: Dr. Jonathan Hilmer jkhilmer@montana.edu

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

MSU Magnetic Resonance Microscopy (MRM) Facility

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

MSU High Field Nuclear Magnetic Resonance (NMR) Facility

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

The 600 MHz NMR was upgraded in 2011 from a DRX to an AVANCE III spectrometer, and is equipped with a helium-cooled ^1H -optimized, inverse detection, (^1H , ^{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, is being used for broadly based untargeted NMR metabolomic analyses.

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

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

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

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