
2019 APPENDIX

Center for Biofilm
Engineering

Montana State University
Bozeman

Reporting Period:
June 1, 2018–May 31, 2019

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RESEARCH:

CBE RESEARCH AREAS

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

CBE RESEARCH:

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

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

APPLIED RESEARCH AREAS & PROJECTS

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

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

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

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

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

Standardized methods product claims | regulatory issues | ASTM methods acceptance

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

FUNDAMENTAL TOPICS

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

Cellular/intracellular phenotype | genetics | metabolic pathways | proteomics

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

Ecology/physiology population characterization | spatial and temporal population dynamics

ANALYTICAL TOOLS & TECHNIQUES

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

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

Modeling cellular automata modeling | mathematics | hydrodynamics | cohesive strength

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

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

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RESEARCH:

2018–2019 CBE GRANT-FUNDED RESEARCH ACTIVITY

Current CBE Research Grants for Fiscal Year 2019 (July 1, 2018 to June 30, 2019)			
Research Area	Title	Principal Investigator	Funding Agency
Biofilm Mechanics	Exploring Biofilm Material Properties with Micromechanical Tools	Wilking	NSF
Biofilm Mechanics	Collaborative Research: Modeling Gastric Mucus Layer Physiology with Application to Helicobacter Pylori and Gastric Organoids	Wilking	UTAUNI
Biofilm Mechanics	3D-Printing of Microbial Communities for Optimal Resource Processing	Wilking	ARREOF
Biofilm Mechanics	VIPER: Viral Interdiction through Population Engineering and Restructuring	Chang	NCSU
Biofilm Mechanics	CAREER: Understanding Spatial Heterogeneity in Biofilms Using Colloidal Engineering	Chang	NSF
Biofilms in Nature	SLICE: Spectral Signs of Life in Ice	Foreman	NASA
Biofilms in Nature	Eradication of Microbial Contamination in Metal Working Fluids	Foreman	NSF
Biofilms in Nature	Continued Monitoring of the Bridger Bowl Wetland System	Stein	Bridger Bowl
Energy Solutions	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	Church & Dwight
Environmental Substance Technologies	Cooperative research program on constructed wetland design and implementation	Stein	USFWS
Environmental Substance Technologies	Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep & Extreme Environments	Gerlach	South Dakota School of Mines
Environmental Substance Technologies	Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment*	Stewart	University of Maryland
Environmental Substance Technologies	Sulfate reducer biofilm transcriptomics and thermodynamics under transient conditions	Fields	EXXMOB002
Environmental Substance Technologies	Developing Biomineralization Technology for Ensuring Wellbore Integrity	Gerlach	Montana Emergent Technologies Inc
Environmental Substance Technologies	Bio-cement Coating of Waste Ores and Tailings	Lauchnor	Pegasus Technical Services
Environmental Substance Technologies	Permeability Control for Enhanced Oil and Gas Recovery in Unconventional Reservoirs Using Advanced Mineral Precipitation Technologies	Phillips	Montana Emergent Technologies Inc

Environmental Substance Technologies	A comprehensive strategy for stable, high productivity cultivation of microalgae with controllable biomass composition	Gerlach	University of Toledo
Medical Biofilms	Resensitization of Bacteria in Biofilms to Antibiotics	Stewart	DOD (USAMRAA)
Medical Biofilms	Synergy between omics, symptoms, and healing trajectories of venous ulcers	Stewart	University of Florida
Medical Biofilms	Designing Immunomodulatory Antibiofilm Biomaterials	Stewart	University of Copenhagen
Methods Development	Methods to assess biofilm prevention on medical devices	Goeres	Burroughs Wellcome Fund
Methods Development	Antimicrobial Test Method - Statistical Support & Consultation	Goeres	EPA
Methods Development	Biofilm and Biomineralization Methods Development in Support of CRC 1313 Projects C04 and C05	Cunningham	Deutsche Forschungsgemeinschaft
Modeling	Predictive Multiscale Modeling of Microbial Consortia Biofilms	Carlson	NIH
Modeling	Development of Robust Microbial Communities through Engineered Biofilms	Carlson	ARREOF
Modeling	A Robust Biofilm-Biomat Reactor for Conversion of Mission-Relevant Feedstocks to Products	Carlson	Sustainable Bioproducts
Physiology & Ecology	Environmental Networks Integrated with Genomes and Molecular Assemblies	Fields	Lawrence Berkley National Laboratory
Physiology & Ecology	Mineral Recovery from Urine - An Alternative Approach for Providing Nutrient for Primary Production in a Controlled Ecological Life Support System for Long-Term Space Missions ¹	Gerlach	NASA
Water Systems	Strengthening Little Big Horn College Research Capacity through Improving Rural Families' Access to Safe Drinking Water, Crow Reservation, Montana	Eggers	Little Bighorn College
¹ NASA EPSCOR			

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FY19 New CBE Research Grants (July 1, 2018 to June 30, 2019)

New CBE Research Grants Awarded in Fiscal Year 2019 (July 1, 2018 to June 30, 2019)				
Sponsor	Title	PI	Period	Award Amount
University of Maryland	Application of Biofilm Covered Carbon Particles as a Microbial Inoculum Delivery System in Weathered PCB Contaminated Sediment*	Phil Stewart	1 Yr	\$4,992
Bridger Bowl	Continued Monitoring of the Bridger Bowl Wetland System*	Otto Stein	3 Yr	\$92,288
Pegasus Technical Services	Bio-cement Coating of Waste Ores and Tailings*	Ellen Lauchnor	10 months	\$22,800
Montana Emergent Technologies	Permeability Control for Enhanced Oil and Gas Recovery in Unconventional Reservoirs Using Advanced Mineral Precipitation Technologies	Adie Phillips	6 months	\$40,000
National Science Foundation	Eradication of Microbial Contamination in Metal Working Fluids	Christine Foreman	3 Yr	\$316,495
University of Utah	Collaborative Research: Modeling Gastric Mucus Layer Physiology with Application to Helicobacter Pylori and Gastric Organoids	James Wilking	3.5 Yr	\$104,356
University of Toledo	A comprehensive strategy for stable, high productivity cultivation of microalgae with controllable biomass composition	Robin Gerlach	3.5 Yr	\$1,156,293
Arreventus Inc	Development of a predictive moderate throughput assay to screen novel Designer Proline-rich antimicrobial peptide Chaperone protein inhibitors (DPCs) against multi-drug resistant pathogens	Garth James	1 Yr	\$89,834
Sustainable Bioproducts	A Robust Biofilm-Biomat Reactor for Conversion of Mission-Relevant Feedstocks to Products	Ross Carlson	1 Yr	\$37,500
US Army Research Office	3D-Printing of Microbial Communities for Optimal Resource Processing	James Wilking	2 yr	\$679,072
	Total Grant Awards to CBE in Fiscal Year 2019			\$2,543,630
	<i>*Additional funding awarded to existing grants in FY19 (budget increased by the amount listed)</i>			

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RESEARCH:

PUBLICATIONS

June 2018–May 2019

2018 Publications

NOTE:

2018-001 through 2018-018 are listed in 2018 Appendix

2018 Publications

Smith HJ, Dieser M, McKnight DM, SanClements MD, Foreman CM, "Relationship between dissolved organic matter quality and microbial community composition across polar glacial environments," *FEMS Microbiology Ecology*, July 2018; 94(7):1-10. 2018-019

Simkins JW, Stewart PS, Seymour JD, "Spatiotemporal mapping of oxygen in a microbially-impacted packed bed using 19F nuclear magnetic resonance oximetry," *J Magnetic Resonance*, August 2018; 293:123-133. 2018-020

Phillips A, Troyer E, Hiebert R, Kirkland C, Gerlach R, Cunningham AB, Spangler L, Kirksey J, Esposito R, "Enhancing wellbore cement integrity with microbially induced calcite precipitation (MICP): A field scale demonstration," *J Petroleum Science and Engineering*, December 2018; 171: 1141-1148. 2018-025

Tan LC*, Nancharaiah YB, **Lu S**, Hullebusch ED, **Gerlach R**, Lens PNL, "Biological treatment of selenium-laden wastewater containing nitrate and sulfate in an upflow anaerobic sludge bed reactor at pH 5.0," *Chemosphere*, November 2018; 211: 684-693. 2018-026

Parker AE, Pitts B, Lorenz L, Stewart PS, "Polynomial accelerated solutions to a LARGE Gaussian model for imaging biofilms: In theory and finite precision," *J Am Stat Assoc*, June 2018; 113(524): 1431-1442. 2018-028

Field EK, Blaskovich JP, **Peyton BM, Gerlach R**, "Carbon-dependent chromate toxicity mechanism in an environmental *Arthrobacter* isolate," *J Hazard Mater*, August 2018; 355:162-169. 2018-029

Parker AE, Hamilton MA, **Goeres DM**, "Reproducibility of antimicrobial test methods," *Scientific Reports*, August 2018; 8(1):12531. 2018-030

Richards CL, Broadaway SC, **Eggers MJ, Doyle J**, Pyle BH, **Camper AK**, Ford TE, "Detection of pathogenic and non-pathogenic bacteria in drinking water and associated biofilms on the Crow Reservation," *Microbial Ecology*, July 2018;76(1):52-63. 2018-031

Akiyama T, Williamson KS, Franklin MJ, "Expression and regulation of the *Pseudomonas aeruginosa* hibernation promoting factor," *Molecular Microbiology*, October 2018; 110(2): 161-175. 2018-032

Thrane LW, **Berglund EA^**, **Wilking JN**, Vodak D, **Seymour JD**, "NMR relaxometry to characterize the drug structural phase in a porous construct," *Molecular Pharmaceutics*, June 2018; 15(7): 2614-2620. 2018-033

Cattò C*, **James GA, Villa F**, Villa S, Cappitelli F, "Zosteric acid and salicylic acid bound to a low-density polyethylene surface successfully control bacterial biofilm formation," *Biofouling*, May 2018, 34:4: 440-452. 2018-034

Bell TA, Sen-Kilic E, Felföldi T, Vasas G, **Fields MW, Peyton BM**, "Microbial community changes during a toxic cyanobacterial bloom in an alkaline Hungarian lake," *Antonie van Leeuwenhoek*, 111(12): 2425-2440. 2018-036

Smith HJ, Zelaya AJ, De León KB, Chakraborty R, Elias DA, Hazen TC, Arkin AP, **Cunningham AB, Fields MW**, "Impact of hydrologic boundaries on microbial planktonic and biofilm communities in shallow terrestrial subsurface environments," *FEMS Microbiol Ecology*, December 2018, 94(12): 1-16. 2018-037

Markwardt SD, Ronnie N, **Camper AK**, "Non-destructive approaches for assessing biofouling of household reverse osmosis membranes," *Biofouling*, September 2018, 34(7): 740-752. 2018-038

Shelobolina ES±, **Walker DK, Parker AE**, Lust DV, Schultz JM, **Dickerman GE^**, "Inactivation of *Pseudomonas aeruginosa* biofilms formed under high shear stress on various hydrophilic and hydrophobic surfaces by a continuous flow of ozonated water," *Biofouling*, October 2018, 34(7): 826-234. 2018-039

Espinosa-Ortiz EJ, Eisner BH, Lange D, **Gerlach R**, "Current insights into the mechanisms and management of infection stones," *Nat Rev Urol*, November 2018, 16: 35-53. 2018-040

Cunningham A, Class H, Ebigbo A, **Gerlach R, Phillips AJ**, Hommel J, "Field-scale modeling of microbially induced calcite precipitation," *Computational Geosciences*, November 2018, 1-16. 2018-041

2019 Publications

Schweitzer HD, Ritter D, McIntosh J, **Barnhart EP**, **Cunningham AB**, Vinson D, Orem W, **Fields MW**, "Changes in microbial communities and associated water and gas geochemistry across redox gradients in coal beds: Powder River Basin, US," *Geochim Cosmochim Acta*, January 2019, 245: 495-513. 2019-001

D'Andrilli J, Junker JR, **Smith HJ**, Scholl EA, **Foreman CM**, "DOM composition alters ecosystem function during microbial processing of isolated sources," *Biogeochemistry*, January 2019, 142(2): 281-298. 2019-002

Cattò C*, Francesco S, **James GA**, **Villa F**, Cappitelli F, "α-Chymotrypsin immobilized on a low-density polyethylene surface successfully weakens *Escherichia coli* biofilm formation," *Int J Molecular Sciences*, December 2018, 19(12):4003. 2019-003

Silverstein DM, Trerotola SO, Clark TC, **James G**, Ng W, Dwyer A, Florescu MC, Shingarev R, Ash SR, "Clinical and regulatory considerations for central venous catheters for hemodialysis," *Clinical J American Society of Nephrology*, December 2018, 13(12):1924-1932. 2019-004

Schuhmann S, **Simkins JW**, Schork N, **Codd SL**, **Seymour JD**, Heijnen M, Saravia F, Horn H, Nirschl H, Guthausen G, "Characterization and Quantification of Structure and Flow in Multichannel Polymer Membranes by MRI," *J Membrane Sci*, January 2019, 570-571:472-480. 2019-005

Frattarelli D, Powers L, Doshi D, Vargo K, Patel B, Gallagher M, Monticello R, **Goeres DM**, **Lorenz L**, **Buckingham-Meyer K**, "Holistic management of textile odor using novel silver-polymeric complexes," *AATCC J Research*, 2018 August; 5(4):7-10. 2019-006

Wu Y, **Klapper I#**, **Stewart PS**, "Hypoxia arising from concerted oxygen consumption by neutrophils and microorganisms in biofilms," *Pathogens and Disease*, 2018 June, 76(4):fty043. 2019-007

Ferrer-Espada R*, Shahrour H, **Pitts B**, **Stewart PS**, Sanchez-Gomez S, Martinez de Tejada G, "A permeability-increasing drug synergizes with bacterial efflux pump inhibitors and restores susceptibility to antibiotics in multi-drug resistant *Pseudomonas aeruginosa* strains," *Scientific Reports*, 2019 March, 9(1):3452. 2019-008

Hunt KA, Jennings RM, Inskeep WP, **Carlson RP**, "Multiscale analysis of autotroph-heterotroph interactions in a high-temperature microbial community," *PLOS Computational*, 2018 September, 14(9):1-21. 2019-009

Borrel G, Adam PS, **McKay LJ**, Chen L-X, Sierra-García N, Sieber CMK, Letourneur Q, Ghoulane A, Andersen GL, Li W-J, Hallam SJ, Muyzer G, de Oliveira VM, Inskeep WP, Banfield JF, Gribaldo S, "Wide diversity of methane and short-chain alkane metabolisms in uncultured archaea," *Nature Microbiology*, 2019 March, 4:603-613. 2019-010

Hamner S, Brown BL, Hasan NA, **Franklin MJ**, **Doyle J**, **Eggers MJ**, Colwell RR, Ford TE, "Metagenomic profiling of microbial populations including human pathogens in Montana's Little Bighorn River," *Environmental Research and Public Health*, 2019 March, 16(7):1097. 2019-011

McKay LJ, Dlakić M, **Fields MW**, Delmont TO, Eren AM, **Jay ZJ**, **Klingel-Smith KB^**, Rusch DB, Inskeep WP, "Co-occurring genomic capacity for anaerobic methane and dissimilatory sulfur metabolisms discovered in the Korarchaeota," *Nature Microbiology*, 2019 March, 4:614-622. 2019-012

Swain S, Roe MM, Sebrell TA, **Sidar B**, Dankoff J, VanAusdol R, Smythies LE, Smith PD, Bimczok D, "CD103 (αE Integrin) undergoes endosomal trafficking in human dendritic cells, but does not mediate epithelial adhesion," *Front Immunol.*, 2018 December, 9:2989. 2019-013

James GA, **Boegli L**, Hancock J, **Bowersock L**, **Parker A**, Kinney BM, "Bacterial adhesion and biofilm formation on textured breast implant shell materials," *Aesthetic Plast Surg.*, 2019 April, 43(2):490-497. 2019-014

Bell TAS, **Doig L**, **Gerlach R**, **Peyton BM**, **Fields MW**, "Contributions of the microbial community to algal biomass and biofuel productivity in a wastewater treatment lagoon system," *Algal Research*, 2019 May, 39:101461. 2019-015

Arbogast JW[±], Moore L, Clark Tracy, Thompson M, Wagner P, Young E, **Parker AE**, "Who goes in and out of patient rooms? An observational study of room entries and exits in the acute care setting," *Am J Infect Control*, 2019 May, 47(5): 585-587. 2019-016

Stewart PS, **Parker AE**, "Measuring antimicrobial efficacy against biofilms: A meta-analysis," *Antimicrob Agents Chemother.*, 2019 May, 63(5):1-11. 2019-017

Benjamin AD^, **Abbasi R**, **Owens M^**, **Walsh DJ**, **LeFevre TB**, **Wilking JN**, "Light-based 3D printing of hydrogels with high-resolution channels," *Biomed Phys Eng Express*, 2019 January, 5(2):025035:1-11. 2019-018

Kirkland CM, **Norton D**, Firth O, **Eldring J**, **Cunningham AB**, **Gerlach R**, **Phillips AJ**, "Visualizing MICP with X-ray μ-CT to enhance cement defect sealing," *Int J of Greenh Gas Con*, 2019 July, 86:93-100. 2019-019

Arbogast JW[±], **Bowersock L**, **Parker AE**, Macinga DR, "Randomized controlled trial evaluating the antimicrobial

efficacy of chlorhexidine gluconate and para-chloro-meta-xyleneol handwash formulations in real-world doses", *Am J Infect Control*, 2019 June, 47(6):726-728. 2019-020

Zambare NM, Lauchnor EG, Gerlach R, "Controlling the distribution of microbially precipitated calcium carbonate in radial flow environments," *Environ Sci Technol*, 2019 June, 53(10):5916-5925. 2019-021

Mitchell AC, **Espinosa-Ortiz EJ**, Parks SL, **Phillips JC, Cunningham AB, Gerlach R**, "Kinetics of calcite precipitation by ureolytic bacteria under aerobic and anaerobic conditions," *Biogeosciences*, 2019 May, 16:2147-2161. 2019-022

Sebrell TA, Hashimi M, **Sidar B**, Wilkinson RA, Kipotina L, Quinn MT, Taylor PJ, Wilking JN, Bimczok D, "A novel gastric spheroid co-culture model reveals chemokine-dependent recruitment of human dendritic cells to the gastric epithelium," *Cell Mol Gastroenterol Hepatol*, 2019, 8(1):157-171.e3. 2019-023

Espinosa-Ortiz EJ, Gerlach R, "Struvite stone formation by ureolytic biofilms," *The Role of Bacteria in Urology*, 2019, Eds: Lange, D. and Scotland, K. *Springer Nature*, 2019, 61-70. 2019-024

Özcan SS, Dieser M, Parker AE, Balasubramanian N, **Foreman CM**, "Quorum sensing inhibition as a promising method to control biofilm growth in metalworking fluids," *J Ind Microbiol Biotechnol*, 2019, 1-9. 2019-025

^Undergraduate student

± Industrial or Federal Agency co-author

*Previous Visiting Researcher

Previous staff/faculty

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RESEARCH:
PRESENTATIONS
June 2018–May 2019

The following CBE faculty presented research at the ASM Microbe 2018 Conference, June 7–11, 2018, in Atlanta, GA:

Christine Foreman, associate professor, chemical and biological engineering, as an invited plenary speaker presented “Microbes, carbon and climate: Exploring the impacts of a changing cryosphere.”

Darla Goeres, associate research professor, chemical & biological engineering, as an invited speaker presented “Standard methods and public health: Review and evaluation of case study data through an academic, regulatory, and public health perspective.”

John Doyle, project coordinator, microbiology & immunology, **Mari Eggers**, CBE research engineer, presented “Climate Adaptation and Waterborne Disease Prevention, Crow Reservation in Montana,” at the Tribal Environmental Health Summit, June 25–26, 2018, Corvallis, OR.

Diane Walker, CBE research engineer, **Kelli Buckingham-Meyer**, CBE Research Assistant III, and **Albert Parker**, CBE statistician, conducted a workshop “Standardized Biofilm Methods for Laboratory Studies of Biofilms,” at the International Association for Food Protection (IAFP), July 6–8, 2018, Salt Lake City, UT.

Neerja Zambare, PhD student, chemical & biological engineering, presented “Multi-scale microscopy of microbially induced calcium carbonate precipitation,” at the Microscopy & Microanalysis 2018 Meeting, August 5–9, 2018, Baltimore, MD.

The following CBE researchers presented their work at the 17th International Symposium on Microbial Ecology in Leipzig, Germany from August 13–16, 2018:

Roland Hatzenpichler, assistant professor, chemistry & biochemistry, as a keynote speaker presented “In situ activity and metabolism of uncultured thermophiles experimentally determined at single cell resolution through Next Generation Physiology.”

Luke McKay, assistant research professor, land resources & environment science, presented “Genomic potential for anaerobic methane and dissimilatory sulfur metabolism discovered in the Korarchaeota.”

Gregory Krantz, PhD student, microbiology & immunology, presented “Large extracellular novel proteins essential to *Desulfovibrio vulgaris* Hildenborough biofilm formation,” at the Society for Microbiology and Biotechnology Conference, August 13–15, 2018, Chicago, IL.

Neerja Zambare presented “Controlling strontium partitioning during MICP under continuous flow,” at the Goldschmidt Conference, August 13–16, 2018, Boston, MA.

Matthew Fields, CBE director, professor, microbiology & immunology, presented “Metabolisms of bacteria involved in MIC” at the EUROCORR conference, September 8–12, 2018, Krakow, Poland.

Darla Goeres presented “Biofilms in draught beer lines: Besting the bacteria in beer,” Draught Quality Summit, September 20–21, 2018, Denver, CO.

Al Parker presented “Bayesian analysis and design of experiments of biofilms over space and time,” Applied Math Seminar at MSU, Bozeman, MT, September 27, 2018.

Mari Eggers, CBE research scientist and **John Doyle**, project coordinator, microbiology & immunology, presented “Merging science and technology with culture and tradition: A panel discussion,” Water Environment Federation, September 30–October 1, 2018, New Orleans, LA.

Phil Stewart, professor, chemical & biological engineering, presented “Critical parameters for neutrophil control of nascent biofilm,” at the 7th Thesinge Biofilm Meeting, Groeningen, The Netherlands, October 1–2, 2018.

Heidi Smith, assistant research professor, microbiology & immunology, presented “ENIGMA Pilot Project: Summary, assessment, and future recommendations,” at the SAC Strategic Planning Sessions, Berkeley, CA, October 8–11, 2018.

Garth James, associate research professor, chemical & biological engineering, presented “Bacterial adhesion and biofilm formation on textured breast implant shell materials, at the 4th World Symposium on Ergonomic Implants, October 8–9, 2018, Gardone, Lago di Garda, Italy.

The following CBE researchers participated in the 8th ASM Conference on Biofilms, Washington DC, October 10–11, 2018:

Presenters:

Kelli Buckingham-Meyer, Darla Goeres, Al Parker, and **Diane Walker** hosted a workshop “Standardized Biofilm Methods.”

Mike Franklin, professor, microbiology & immunology, presented “Ribosome hibernation in dormant *Pseudomonas aeruginosa* biofilm cells.”

Brian Pettygrove, PhD student, microbiology & immunology, presented “Neutrophil clearance of nascent *Staphylococcus aureus* biofilm.”

Phil Stewart served as a session chair and program committee member. He also presented “Oxygen limitation, starvation stress responses,” and “Extracellular polysaccharide synthesis contribute to Ciprofloxacin tolerance in a *Pseudomonas aeruginosa* biofilm.”

Poster:

Danica Walsh, PhD student, chemistry & biochemistry, presented “The design synthesis and evaluation of prodrug antimicrobials to control biofilms.”

The following CBE researchers presented their work at the Algae Biomass Summit, Houston TX, Oct. 15–16, 2018:

Speakers:

Robin Gerlach, professor, chemical & biological engineering, “Maximizing the benefits of combined algae cultivation and wastewater treatment through a better understanding of

organic carbon utilization by three green algae species.”

Matthew Jackson, PhD student, chemical & biological engineering, presented “Improved productivity during combined wastewater treatment and algae cultivation: Understanding nitrogen assimilation under low and high alkalinity conditions.”

Nickolas Avila, undergraduate, chemical & biological engineering, presented “Quantifying enhanced mass transfer of CO₂ into high alkalinity algae culture medium.”

Poster Presenters:

Nickolas Avila presented “Thermophilic, high alkalinity microalgal enrichment from a Yellowstone National Park hot spring outflow cyanobacterial mat.”

Berrak Erturk, masters student, chemical & biological engineering, presented “Sodium bicarbonate amendment for enhanced astaxanthin production from *Haematococcus pluvialis*.”

Calvin Cicha, PhD student, microbiology & immunology, presented “Genome annotation of coal bed methane production water isolate PW95.”

Hannah Goemann, PhD student, microbiology & immunology, presented “Impact of a cyanobacterial biofertilizer on switchgrass production and the soil microbiome.”

Matthew Jackson presented “Bicarbonate amendment at nitrogen depletion for enhanced lipid accumulation under different nitrogen and carbon regimes.”

Paul Sturman, CBE industrial coordinator, presented “Biofilms and the microbiome,” at the Recent Advances in Microbial Control Conference, Clearwater Beach, FL, November 4–6, 2018.

Roland Hatzenpichler’s research into the Guaymas deep sea basin was covered in a one-minute radio segment by the Northern News Network and NPR on January 17, 2019. The project is funded by NSF.

Phil Stewart was invited to present two talks at Nanyang Technological University (NTU) in Singapore: “How bacteria persist in biofilms,” Jan. 23, 2019.

“Strategies for preventing biofilm infections on medical devices,” Jan. 25, 2019.

Matthew Fields presented “Novel bio-signatures and activity in fractionated groundwater from uncontaminated and contaminated sites,” at the Genomic Sciences Workshop, Washington, D.C., February 25–26, 2019.

Elinor Pulcini, assistant research professor, chemical & biological engineering, presented “Proposed standard method for testing the efficacy of antimicrobial urinary catheters,” at the Catheter Associated Urinary Tract Infection Workshop, Bethesda, MD, March 10–13, 2019.

Roland Hatzenpichler was invited to present “Next generation physiology: Determining in situ metabolisms of uncultured microbes at single cell resolution and high through-put,” at the John Lawrence Seminar, Lawrence Berkeley National Laboratory, Berkeley, CA, March 19, 2019.

Phil Stewart presented “Strategies for preventing biofilm infections on medical devices,” at the University of Calgary, Canada, March 22, 2019.

Matthew Fields “Novel bio-signatures and genomes in geothermal features of Yellowstone National Park: Implications for CO₂/CH₄ metabolism,” at the University of Puerto Rico, San Juan, Puerto Rico, March 14, 2019.

Roland Hatzenpichler presented the poster “Linking identity and in situ metabolism of uncultured microbes via next generation physiology,” at the New Lineages of Life workshop, DOE Joint Genome Institute, San Francisco, CA, April 2–5, 2019.

Al Parker presented “Interlaboratory study design for antimicrobial test methods,” at ASTM Committee E35 Meeting, Denver, CO, April 2, 2019.

Matthew Fields presented “Biofilms, surface disinfection, & standardization,” at the AMICI/PRINT-AID training, Amsterdam, The Netherlands, April 10–14, 2019.

The following CBE researchers participated in InterPore 2019, Valencia, Spain, May 6–10, 2019.

Al Cunningham, professor emeritus in civil engineering, **Adie Phillips**, assistant professor in civil engineering, and **Robin Gerlach** were part of the organizing committee for the mini symposia “Biochemical processes and biofilms in porous media.”

Invited presentations:

Catherine Kirkland, assistant research professor, civil engineering: “MICP in the field: Continuous injection to reduce permeability and enhance wellbore integrity.”

Brent Peyton, professor, chemical & biological engineering: “In situ bioremediation of selenium and nitrate for mine waste management in the Elk Valley, British Columbia.”

Neerja Zambare*: “Improved understanding of microbe-mineral interactions using droplet-based microfluidics.” *Neerja won an MSU Graduate School travel grant to present at this meeting.

Poster Presentations:

Arda Akyel, PhD student, chemical & biological engineering, “Thermal stability of urease produced by *Sporosarcina pasteurii*.”

Dalton Albers, masters student, chemical & biological engineering, “Thermally induced calcium carbonate precipitation in the Bakken oilfields.”

Sobia Anjum, PhD student, chemical & biological engineering, “Relating mechanical properties of biofilm-mineral composites to bulk porous media properties.”

Zachary Frieling, masters student, chemical & biological engineering, “Urease immobilization for advancing enzyme-induced calcium carbonate precipitation applications.”

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RESEARCH:

CBE Affiliated Faculty and Their Specialties, 2018–2019

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

Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Dana Skorupa	Chemical & Biological Engineering	Microbes in extreme environments
Otto Stein	Civil Engineering	Engineered waste remediation
Heidi Smith	Microbiology & Immunology	Biology, imaging
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Sturman	Civil Engineering	Biofilms in waste remediation, industrial systems
Stephan Warnat	Mechanical & Industrial Engineering	MEMS, sensors and actuators
James Wilking	Chemical & Biological Engineering	Physical and material biofilm properties
Tianyu Zhang	Mathematical Sciences	Mathematical modeling

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RESEARCH:

NEWS HIGHLIGHTS

CBE recognized by MSU as leader in research activity

CBE was recognized as a top contributor to MSU's research expenditures for fiscal year 2018, according to MSU's Office of Research and Economic Development. The university reported expenditures totaling \$126.5 million, marking one of its strongest years for research. The Norm Asbjornson College of Engineering was one of the top three colleges for expenditures, led by the CBE, the Department of Electrical Engineering, and Western Transportation Institute. The article "[MSU records yet another strong year for research](#)," published by MSU News and featured in the *Bozeman Daily Chronicle*, also highlights the research activity of several MSU researchers including CBE affiliated faculty members **Connie Chang** and **Darla Goeres**.

CBE faculty member awarded grant to study how deep-microorganisms break down carbon

CBE affiliated faculty member **Roland Hatzenpichler**, assistant professor in chemistry and biochemistry, was featured by MSU News for his receipt of a \$1 million award from NSF to collect microbe-rich sediments from the floor of Guaymas Basin, located in the Gulf of California. "[MSU biochemist awarded grant to study how deep-sea microorganisms break down carbon](#)"

CBE researchers explain how life-threatening bacterium can withstand antibiotics

At the CBE's summer 2018 Montana Biofilm Meeting, **Phil Stewart** shared findings about how a bacterium that causes serious wound infections can tolerate common medical treatments. "[MSU biofilm researchers explain how life-threatening bacterium can withstand antibiotics](#)"

MSU algae research could make biofuel production more economical

In an effort to improve the feasibility of a renewable energy source, Montana State University researchers are exploring a potential breakthrough in producing biofuel from algae. Four CBE affiliated faculty members are PIs on the project. [Read the full article at MSU News.](#)

Two scientific journals featured CBE images on their covers

The separate works of a faculty member and a PhD student at the Center for Biofilm Engineering have been featured on the covers of prominent scientific journals.

Garth James, associate research professor in chemical and biological engineering and the principal investigator of CBE's Medical Biofilms Laboratory, took part in an expert panel that recommended in 2017 that physicians adopt an aggressive treatment protocol for chronic wounds. The expert panel's recommendation was featured on the cover of the September 2017 issue of *Wound Repair and Regeneration* for the article "Consensus guidelines for the identification and treatment of biofilms in chronic nonhealing wounds."

Jeffrey Simkins, a CBE PhD student in chemical and biological engineering, created the cover image for the August 2018 issue of the *Journal of Magnetic Resonance*. Simkins is also the first author of the feature article that details a study that pioneers a new, MRI-based technique to measure oxygen distribution in biofilms that exploits the sensitivity of fluorocarbons to local oxygen concentration. [Read](#)

[full article on the research behind the covers](#)

Stewart, James part of NIH grant addressing chronic wounds

Phil Stewart and **Garth James**, both CBE affiliate faculty in chemical and biological engineering, are collaborating with nursing and medical investigators at the University of Florida on the NIH-funded project “Biobehavioral mechanisms underlying symptoms and healing outcomes in older individuals with chronic venous leg ulcers.” The research program aims to enhance the health outcomes of older individuals with chronic non-healing wounds by elucidating the complex biobehavioral factors that influence the trajectory of healing and patient-oriented symptoms, including distressing pain, fatigue, and depression. A longitudinal analysis of clinical wound debridement specimens for the presence of biofilm and characterization of their microbial communities by DNA sequencing is an integral component of the project.

CBE researchers use 3-D printing to push knowledge of microbial communities

CBE faculty member **Jim Wilking**, assistant professor in chemical and biological engineering, was featured by MSU News [for innovative work he and his students are doing with 3-D printing](#). Wilking is part of a team that received a grant from the US Army to use 3-D printing to push the knowledge of how microbial communities assemble and interact in biofilms.

MSU researcher co-authors paper that raises awareness of microbes' importance to climate change

CBE affiliated faculty member **Christine Foreman**, associate professor in chemical and biological engineering, was featured by MSU News for her paper in Nature Reviews Microbiology that [calls for greater attention to microbes when studying global climate change](#).

CBE postdoc first author on *Nature Microbiology* article

Zack Jay, CBE postdoctoral researcher, was first author on the article “Marsarchaeota are an aerobic archaeal lineage abundant in geothermal iron oxide microbial mats,” published in [Nature Microbiology](#) in May 2018. According to an article in [MSU News](#), the research team found a new lineage of microbes living in Yellowstone National Park’s thermal features that sheds light on the origin of life and the evolutionary history of the Earth. Jay joined the CBE as a postdoc in 2016.

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CBE Affiliated Faculty & Staff Awards & Appointments

2019 MSU Faculty and Staff Honors

Joe Seymour, Center for Biofilm Engineering faculty and professor in MSU’s Department of Chemical and Biological Engineering, was honored as one of Montana State University top faculty at the university’s 2019 Spring Convocation ceremony Jan. 8. The annual awards recognize and honor achievement in faculty and staff research, teaching, outreach, and creative projects. Seymour received the Provost’s Award for Graduate Research/Creative Mentoring, which recognizes a faculty member who engages graduate students in this valuable learning process.

Matthew Fields, CBE director and professor in MSU's Department of Microbiology and Immunology, won the award last year. To read more about Seymour and other distinguished faculty and staff to be honored during the Spring Convocation ceremony, [visit MSU News](#).

2019 College of Engineering Awards

Sarah Codd, **Robin Gerlach**, and **Darla Goeres**, each a faculty member affiliated with the Center for Biofilm Engineering, were among the honorees at the annual Norm Asbjornson College of Engineering awards luncheon held April 30. Codd, professor of mechanical and industrial engineering, received the Distinguished Professor award. Gerlach, professor of chemical and biological engineering, was honored with the Lloyd Berg Faculty Mentorship award. Goeres, associate research professor of chemical and biological engineering, received the Excellence in Outreach award. [Learn about each award recipient](#).

Faculty Appointments

Luke McKay, former CBE postdoctoral researcher, was appointed to an assistant research professor position in MSU's Department of Land Resources and Environmental Sciences. Luke earned his master's and doctorate degrees from the Department of Marine Sciences at the University of North Carolina at Chapel Hill. He joined MSU in 2015 as a NASA postdoctoral fellow through the NASA Astrobiology Institute, studying primitive microbial processes in Yellowstone National Park. His research focuses on metagenomics, metatranscriptomics, stable isotope probing enrichments, and cultivation techniques to examine the distribution, functional capacity, and substrate utilization of novel archaea and bacteria in geothermal ecosystems. He will continue his CBE affiliation as a research professor.

Catherine Kirkland, former post-doctoral researcher with the CBE was recently appointed to assistant professor in MSU's Department of Civil Engineering. Cat received her PhD in civil and environmental engineering from Montana State University. Her research focuses on a type of granular sludge that is able to break down environmental contaminants, including sources of carbon, nitrogen, and phosphorus, from wastewater. Dozens of wastewater treatment plants, primarily in Europe, currently use this emerging technology. Cat will continue her affiliated status with the CBE.

2019 CBE Outstanding Faculty Award

Robin Gerlach, professor of chemical and biological engineering, was awarded the 2019 CBE Outstanding Faculty award. Gerlach was recognized for his research activity that commands international respect, as well as his high level of industrial interaction, and work as a gifted educator. Gerlach's activity in disseminating his findings is similarly commendable, as is his unrivaled contributions to the extraordinary growth of the field of biomineralization technology.

2019 Outstanding Researcher Award

Erika Espinosa-Ortiz, CBE postdoctoral researcher, received the CBE Outstanding Staff Award. Espinosa-Ortiz was acknowledged for her ongoing contributions to the center and outstanding work with the Industrial Associates program. She was recognized as an exemplary team player and communicator, and success as a mentor to undergraduate and graduate students alike.

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New Staff

Connie Chang, assistant professor in chemical and biological engineering, welcomed two postdoctoral researchers to her lab in fall 2018. **Dimitri Bikos** joins the lab from UCLA where he earned his PhD and studied experimental colloidal soft matter physical chemistry specifically electrophoresis, rheology, and nanoemulsions. In Connie's lab, he is investigating the influenza virus using single-cell drop-based microfluidic platforms. Dimitri was born in Australia, lived in Argentina until he was 6 years-old and then moved to Virginia. He enjoys studying genetic anthropology, European history and political movements, and car maintenance and repair (now we know who to talk to when our cars break down). **Emma Loveday** earned her PhD in microbiology and immunology from the University of British Columbia. She is researching Influenza A virus evolution, replication, and transcription at the single cell level using drop-based microfluidics. Though Emma grew up in the beach town of San Diego, snowboarding is one of her biggest passions. She has snowboarded in six different countries, in both hemispheres. Emma is also a community leader, volunteering her time with the Bozeman 500 Women Scientists Pod, an organization committed to building an inclusive scientific community and standing up for women and science. CBE and knows it will be the perfect place to explore the magical biofilm turf.

Huyen Bui joined Dr. Robin Gerlach's lab as a research scientist in April 2018. Huyen was born and raised in Vietnam. She came to the US in 2006 to pursue a PhD in molecular biology at the University of Utah. Huyen's previous research experience includes postdoc trainings at the Cold Spring Harbor Laboratory and University of Utah, where she used genetics and genomics approaches to understand plant development and plant-herbivore interactions. In Robin's lab, Huyen will explore the microbial community associated with algal culture and develop a molecular toolkit to improve algal fermentation for biofuel production. When not working in the lab, Huyen enjoys gardening, baking, and hiking.

In January 2019, **Skip Anderson** joined the CBE as a full-time communications specialist. Skip is an award-winning journalist with more than 20 years of experience in the industry, including serving nine years as a writer and editor at Vanderbilt University. Over the last two years, Skip has written more than 20 stories for MSU News including stories on several CBE affiliated faculty and researchers. He earned his BA in journalism from Belmont University in Nashville, Tennessee. At the CBE, Skip is responsible for proofing, story ideas, and all creative communications. When he's not writing, Skip enjoys wandering the mountains and rivers in and around Bozeman with his wife and daughter.

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EDUCATION:

Undergraduate Students: Summer 2018, Fall 2019, Spring 2019

*Graduating

‡Native American

1. *Abdelgaid, Mona (Peyton)	F	Chemical & Biological Engineering	Mansoura, Egypt
2. Anderson, Rebekah (Foreman)	F	Chemical & Biological Engineering	Golden, CO
3. Arachchige Suraweera, Thilini (Goeres)	F	Chemical & Biological Engineering	Anuradhapuri, Sri Lanka
4. *Avila, Nickolas (Gerlach)	M	Chemical & Biological Engineering	Richland, WA
5. *Baybali, Begum (Peyton)	F	Chemical & Biological Engineering	Istanbul, Turkey
6. Bedwell, Sierra (Fields)	F	Chemistry & Biochemistry	S. Lake Tahoe, CA
7. Betil, Ülkem (Peyton)	M	Chemical & Biological Engineering	Mugula, Turkey
8. *Boise, Noelani (Peyton)	F	Chemical & Biological Engineering	Livingston, MT
9. Brasier, Whitney (Goeres)	F	Cell Biology & Neuroscience	Erie, CO
10. Burr, Mary (Lauchnor)	F	Civil Engineering	Anchorage, AK
11. Carmody, Caitlin (Wilking)	F	Mechanical & Industrial Engineering	Butte, MT
12. Cuthbertson, Isabelle (Chang)	F	Chemical & Biological Engineering	Kalispell, MT
13. *Dispinar, Ipek (Fields)	F	Chemical & Biological Engineering	Kocoeli, Turkey
14. Du, Martina (Carlson)	F	Chemical & Biological Engineering	Kent, WA
15. DuBois, Camryn (Gerlach)	F	Mechanical & Industrial Engineering	Lake Stevens, WA
16. *Erdogan, Ayten Ebru (Fields)	F	Chemical & Biological Engineering	Istanbul, Turkey
17. Espinal, Michael (Phillips)	M	Mechanical & Industrial Engineering	Vacaville, CA
18. Frische, Lora (Wilking)	F	Chemical & Biological Engineering	Beaverton, OR
19. Gulyavskaya, Anastasia (Peyton)	F	Chemical & Biological Engineering	Cleveland, OH
20. Gurney, James (Gerlach)	M	Chemical & Biological Engineering	Pleasanton, CA
21. *Haller, Gregory (Gerlach)	F	Chemical & Biological Engineering	Lakewood, CO
22. Haider, Olivia (Chang)	F	Chemical & Biological Engineering	Helena, MT
23. Hamilton, Josiah (Foreman)	M	Mechanical & Industrial Engineering	Billings, MT
24. Hemmah, Ashlyn (Peyton)	F	Civil Engineering	Leads, SD
25. *Jarvis, Jacob (Chang)	M	Chemical & Biological Engineering	Redmond, OR
26. John, Ethan (Wilking)	M	Chemical & Biological Engineering	Essex, VT
27. *Kieffer, Whitney (Lauchnor)	F	Chemical & Biological Engineering	Richland, WA
28. King, Felicia (Foreman)	F	Chemical & Biological Engineering	Santa Cruz, CA
29. Lewis, Christian (Peyton)	M	Chemical & Biological Engineering	Gig Harbor, WA
30. Martinson, Anna (Phillips)	F	Chemical & Biological Engineering	Gig Harbor, WA
31. *Massey, KaeLee (Fields)	F	Chemical & Biological Engineering	Billings, MT
32. Mettler, Madelyn (Goeres)	M	Chemical & Biological Engineering	Littleton, CO
33. ‡Meier, Kelsey (Goeres)	F	Microbiology & Immunology	Billings, MT
34. McCoy, Quintin (Foreman)	M	Chemical & Biological Engineering	Bend, OR
35. Morris, Kate (Stein)	F	Civil Engineering	Kansas City, KS
36. *Naser, Nada (Chang/Gerlach)	F	Chemical & Biological Engineering	Assuit, Egypt
37. *Park, Rita (Phillips)	F	Microbiology & Immunology	Butte, MT
38. Parks, Kendall (Gerlach)	F	Chemical & Biological Engineering	Vancouver, WA
39. *Parrett, Brian (James)	M	Plant Sciences & Plant Pathology	Rochester, MN
40. Olsen, Timothy (Wilking)	M	Chemical & Biological Engineering	Deer Lodge, MT
41. Rotert, Jacob (Stewart/Wilking)	M	Chemical & Biological Engineering	Everett, WA
42. Russell, Petria (Chang)	F	Chemical & Biological Engineering	Lake Tapps, WA
43. *Snyder, Derek (Stein)	M	Civil Engineering	San Jose, CA
44. Steinberg, David (Gerlach)	M	Chemical & Biological Engineering	Tenafly, NJ
45. *Stonebraker, Alison (Lauchnor)	F	Civil Engineering	Red Lodge, MT
46. *Tunby, Paige (Gerlach/Phillips)	F	Civil Engineering	Bozeman, MT
47. Trudgeon, Benjamin (Foreman)	M	Chemical & Biological Engineering	Grand Rapids, MI
48. Udeck, Megan (Peyton)	F	Microbiology & Immunology	Missoula, MT
49. *Zeng, Jason (Wilking)	M	Chemical & Biological Engineering	Novato, CA

Undergraduates Summary: 2018–2019

Department (Program)	Male	Female	Total
Cell Biology & Neuroscience		1F	1
Chemical & Biological Engineering	13M	20F	33
Chemistry & Biochemistry		1F	1
Civil Engineering	1M	5F	6
Mechanical & Industrial Engineering	2M	2F	4
Microbiology & Immunology		3F	3
Plant Science & Plant Pathology	1M		1
Totals	17M	32F	49

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EDUCATION:

Graduate Students: Summer 2018, Fall 2019, Spring 2019

‡ Native American *Received degree

Masters Candidates

1.	*Albers, Dalton (Gerlach/Phillips)	M	Chemical & Biological Engineering	Great Falls, MT
2.	Bowersock, Lisa (Parker)	F	Mathematical Sciences	Rochester Hills, MI
3.	Daily, Rynne (Phillips)	F	Civil Engineering	Great Falls, MT
4.	Erturk, Berrak (Peyton)	F	Chemical & Biological Engineering	Istanbul, Turkey
5.	*Frieling, Zachary (Gerlach/Phillips)	M	Chemical & Biological Engineering	Gallatin Gateway, MT
6.	Messmer, Mitch (Foreman)	M	Chemical & Biological Engineering	Hillsboro, OR
7.	Paine, Kyle (Lauchnor)	M	Civil Engineering	Ludington, MI
8.	Panighetti, Robert (Stein)	M	Civil Engineering	Cedarburg, WI
9.	Platt, George (Fields/Gerlach)	M	Chemical & Biological Engineering	Eagle River, AK
10.	Proudfoot, Dylan (Lauchnor)	M	Civil Engineering	Fairmont, WV
11.	*Raeside, Emma (Lauchnor)	F	Civil Engineering	Rochester, NY
12.	*Summers, Jennifer (Goeres)	F	Chemical & Biological Engineering	Conowingo, MD
13.	Sykes, Jordan (Lauchnor)	M	Civil Engineering	Brevard, NC
14.	Thompson, Luke (Lauchnor)	M	Civil Engineering	Littleton, CO

PhD Candidates

1.	Abbasi, Reha (Wilking)	M	Chemical & Biological Engineering	Istanbul, Turkey
2.	Akyel, Arda (Gerlach)	M	Chemical & Biological Engineering	Istanbul, Turkey
3.	Anjum, Sobia (Gerlach)	F	Chemical & Biological Engineering	Punjab, Pakistan
4.	Arnold, Adrienne (Carlson)	F	Microbiology & Immunology	Charleston, WV
5.	Brame, Keenan (Camper)	M	Chemical & Biological Engineering	Livingston, MT
6.	*Camilleri, Laura (Fields)	F	Microbiology & Immunology	Ukiah, CA
7.	Carter, Hoffman (Chang)	M	Chemical & Biological Engineering	Carlsbad, CA
8.	Cicha, Calvin (Gerlach/Wiedenheft)	M	Microbiology & Immunology	Isanti, MN
9.	Corredor-Arias, Luisa (Fields)	F	Microbiology & Immunology	Pereira, Colombia
10.	Fredrickson, Jacob (Chang)	M	Chemical & Biological Engineering	Puyallup, WA
11.	Goemann, Hannah (Peyton)	F	Microbiology & Immunology	Wells, MN
12.	Jackson, Matthew (Gerlach)	M	Chemical & Biological Engineering	Naples, FL
13.	Kilic, Ayse Bengisu (Lauchnor)	F	Chemical & Biological Engineering	Istanbul, Turkey
14.	Koepnick, Hannah (Peyton)	F	Chemical & Biological Engineering	Sherman, TX
15.	Krantz, Gregory (Fields)	M	Microbiology & Immunology	Tinmouth, VT
16.	LeFevre, Thomas (Wilking)	M	Chemical & Biological Engineering	Escanaba, MI
17.	Lynes, Mackenzie (Hatzenpichler)	F	Chemistry & Biochemistry	Cleveland, OH
18.	McGill, Stacy (Carlson)	M	Microbiology & Immunology	Minor Hill, TN
19.	Miller, Isaac (Fields)	M	Microbiology & Immunology	East Helena, MT
20.	Moll, Karen (Peyton)	F	Microbiology & Immunology	Fairport, NY
21.	Payne, Devon (Fields)	M	Microbiology & Immunology	Henderson, NV
22.	Pettygrove, Brian (Stewart)	M	Microbiology & Immunology	Leesburg, VA
23.	Pratt, Shawna (Chang)	F	Chemical & Biological Engineering	Miles City, MT
24.	Rathore, Muneeb (Peyton)	M	Chemical & Biological Engineering	Punjab, Pakistan
25.	Reichart, Nicholas (Hatzenpichler)	M	Chemistry & Biochemistry	Bel Air, MD
26.	Sanchez, Humberto (Chang)	M	Chemical & Biological Engineering	Corona, CA
27.	*Schweitzer, Hannah (Fields)	F	Microbiology & Immunology	Chester, MT
28.	*Sidar, Barkan (Wilking)	M	Chemical & Biological Engineering	Istanbul, Turkey
29.	*Simkins, Jeffrey (Stewart/Seymour)	M	Chemical & Biological Engineering	Bozeman, MT
30.	Thornton, Isaak (Wilking)	M	Mechanical & Industrial Engineering	Great Falls, MT
31.	Walsh, Danica (Stewart/Livinghouse)	F	Chemistry & Biochemistry	Olympia, WA
32.	Zambare, Neerja (Gerlach)	F	Chemical & Biological Engineering	Maharaswra, India
33.	Zath, Geoffrey (Chang)	M	Chemical & Biological Engineering	Bend, OR
34.	*Zelaya, Anna (Fields)	F	Microbiology & Immunology	Russellville, AR
35.	Zeng, Jason (Wilking)	M	Chemical & Biological Engineering	Novato, CA

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EDUCATION:

Graduate Students, 2018–2019

24: Chemical & Biological Engineering

MS: 7

5 M Albers, Dalton: MS, *Gerlach*
 Frieling, Zachary: MS, *Gerlach*
 LeFevre, Thomas: MS, *Wilking*
 Messmer, Mitch: MS, *Foreman*
 Platt, George: MS, *Fields*

2 F Erturk, Berrak: MS, *Peyton*
 Summers, Jennifer: MS, *Goeres*

PhD: 17

12 M Abbasi, Reha: PhD, *Wilking*
 Akyel, Arda: PhD, *Gerlach*
 Brame, Keenan: PhD, *Camper*
 Carter, Hoffman: PhD, *Chang*
 Fredrickson, Jacob: PhD, *Chang*
 Jackson, Matthew: PhD, *Gerlach*
 Rathore, Muneeb: PhD, *Peyton*
 Sanchez, Humberto: PhD, *Chang*
 Sidar, Barkan: PhD, *Wilking*
 Simkins, Jeffrey: PhD, *Stewart*
 Zath, Geoffrey: PhD, *Chang*
 Zeng, Jason: PhD, *Wilking*

5 F Anjum, Sobia: PhD, *Gerlach*
 Kilic, Ayse Bengisu: PhD, *Lauchnor*
 Koepnick, Hannah: PhD, *Peyton*
 Pratt, Shawna: PhD, *Chang*
 Zambare, Neerja: PhD, *Gerlach*

3: Chemistry & Biochemistry

PhD: 3

2 F Lynes, Mackenzie: PhD, *Hatzenpichler*
 Walsh, Danica: PhD, *Stewart*

1 M Reichart, Nicholas: PhD, *Hatzenpichler*

7: Civil / Environmental Engineering

MS: 7

5 M Paine, Kyle: MS, *Lauchnor*
 Panighetti, Robert: MS, *Stein*
 Proudfoot, Dylan: MS, *Lauchnor*
 Sykes, Jordan: MS, *Lauchnor*
 Thompson, Luke: MS, *Lauchnor*

2 F Daily, Ryanne: MS, *Phillips*
 Raeside, Emma: MS, *Stein*

1: Mathematical Sciences

MS: 1

1 F Bowersock, Lisa: MS, *Parker*

1: Mechanical & Industrial Engineering

PhD: 1

1 M Thornton, Isaak: PhD, *Wilking*

13: Microbiology & Immunology

PhD: 13

6 M Cicha, Calvin: PhD, *Gerlach*
 Krantz, Gregory: PhD, *Fields*
 McGill, Stacy: PhD, *Carlson*
 Miller, Isaac: PhD, *Fields*
 Payne, Devon: PhD, *Fields*
 Pettygrove, Brian: PhD, *Stewart*

7 F Arnold, Adrienne: PhD, *Carlson*
 Camilleri, Laura: PhD, *Fields*
 Corredor-Arias, Luisa: PhD, *Fields*
 Goemann, Hannah: PhD, *Peyton*
 Moll, Karen: PhD, *Peyton*
 Schweitzer, Hannah: PhD, *Fields*
 Zelaya, Anna: PhD, *Fields*

TOTALS

Total Grads: 49

Total MS: 14 9 M / 5 F
 Total PhD: 35 21 M / 14 F

Total Male: 30
 Total Female: 19

EDUCATION:

Graduating with advanced degrees: June 2018–June 2019

Jennifer Summers, MS, Chemical and Biological Engineering, December 2018

The development and validation of a standard In vitro method to evaluate the efficacy of surface modified urinary catheters

Barkan Sidar, PhD, Chemical and Biological Engineering, March 2019

Gastrointestinal organoid structure and transport

Anna Zelaya, PhD, Microbiology and Immunology, April 2019

Bacterial Community Dynamics and Variability in Shallow Aquifers

Jeffrey Simkins, PhD, Chemical and Biological Engineering, April 2019

Spatiotemporal Mapping of Oxygen in Model Porous Media Biofilms Using ¹⁹F Nuclear Magnetic Resonance Oximetry

Hannah Schweitzer, PhD, Microbiology and Immunology, April 2019

Bacterial and Archaeal Community Dynamics in Relation to Organic Consumption and Sulfate Gradients in the Powder River Basin

Laura Camilleri, PhD, Microbiology and Immunology, April 2019

Metabolic interactions and activity partitioning in a methanogenic, interdomain biofilm

Zachary Frieling, MS, Chemical and Biological Engineering, May 2019

Urease immobilization for advancing enzyme-induced calcium carbonate precipitation applications

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EDUCATION:

Student News and Awards

CBE undergrad discusses her ‘chickensplash’ research in radio interview

If you’re someone who bucks the FDA recommendation of not rinsing raw chicken before cooking it, you might at least want to consider thwarting the advisory with as little risk to human health as possible. Cati Carmody, an MSU junior and CBE researcher, recently told Bozeman radio station KGVM (95.9 FM) that rinsing raw chicken in a bowl prefilled with water can help avoid spreading harmful microbes to nearby surfaces – such as countertops, plates and utensils, and other foods – through airborne water droplets she calls “chickensplash.” The junior mechanical and industrial engineering major recently featured her research in a scientific poster titled “Chickensplash! Exploring the health concerns of washing raw chicken.” [Listen to Cati’s insightful interview.](#)

Volunteering leads to friendship for CBE student

Bekah Anderson, a CBE undergrad in chemical and biological engineering, sought a meaningful use of her time outside of college life. What she found was a new friend – a retired piano teacher living at a care facility. [Read about Bekah's experience with the non-profit Befrienders in the Bozeman Daily Chronicle.](#)

CBE researchers, lab featured in women in engineering commercial

An advertisement highlighting MSU’s efforts to increase the number of women in the male-dominated fields of engineering and computer science features four female CBE-affiliated faculty members and a student researcher from the CBE. The 60-second advertisement also features one of CBE’s labs.

MSU News article: [“MSU releases TV ad featuring women in engineering”](#)

Video: [“Think Outside Expectations: MSU's Women in Engineering”](#)

In the Media

CBE PhD Student **Jeffrey Simkins**, chemical and biological engineering, earned the cover image and feature article in the August 2018 issue of the *Journal of Magnetic Resonance*. The article details a study that pioneers a new, MRI-based technique for the measurement of oxygen distribution in biofilms which exploits the sensitivity of fluorocarbons to local oxygen concentration. Oxygen gradients are a critical determinant of biofilm behavior, regardless of whether the context is medical, industrial, or environmental, but they are notoriously difficult to measure using conventional approaches. The MRI method is both noninvasive and allows for measurement of oxygen distribution in multiple dimensions simultaneously, and these unique advantages allow novel insights to be made about bacterial oxygen usage under different conditions. Read the article in the August issue of [Journal of Magnetic Resonance, August 2018; 293:123–133.](#)

Two CBE PhD students collaborate on polymer research

Two PhD students working in separate labs at the CBE traveled to Germany to gain insights into nontoxic substances for potential use in their research projects involving living microbes. [Read more](#)

High school intern tackles limitations of algae as a biofuel

In February, Emily Gan, 17, was reading a publication dedicated to biofuels. When she wanted to learn more about a particular strain of algae used in research at the Center for Biofilm Engineering, she called up the lead author of the study cited in the industry publication. [Read more](#)

CBE Student Awards

CBE PhD student takes top prize in chemical engineering competition

Shawna Pratt, a PhD student in chemical engineering in Montana State University's Center for Biofilm Engineering, won first place in the Graduate Student Competition in the Microbes at Biomedical Interfaces session at the American Institute for Chemical Engineering's annual meeting held in Pittsburgh Oct. 28–Nov. 2, 2018. Her 20-minute presentation, titled "Just to Watch You Grow," focused on her collaborative work on *Pseudomonas aeruginosa* biofilms in the laboratories of CBE faculty Connie Chang, an assistant professor in chemical and biological engineering, and Michael Franklin, a professor in microbiology and immunology. [Read more about Pratt's research](#)

CBE undergrads receive honors, spotlight on research

Bekah Anderson, Honors College undergraduate student in chemical and biological engineering, won the Outstanding Poster Award at the Western Region Honors Conference held on MSU's campus March 29–31. Bekah presented "Characterization of microplastics in precipitation," at the annual conference that promotes the advancement of undergraduate honors education. Bekah also received an Honorable Mention at the National Council of Undergraduate Research (NCUR) Posters on the Hill event and participated at the NCUR National Conference held April 10–13 in Atlanta, Georgia.

Nada Naser, undergraduate scholar in chemical and biological engineering, also participated in the NCUR National Conference earlier this month. Nada was invited to deliver a platform presentation of her research "Visualization of microbially induced calcium carbonate precipitation on the single-cell scale using droplet-based microfluidics."

CBE PhD student earns Judges Prize at Three Minute Thesis competition

Reha Abbasi, MSU PhD student in chemical and biological engineering, earned the Judges Prize for his presentation "3D printing of microorganisms for a better future," during the Three Minute Thesis competition held on MSU's campus February 28. Reha has worked at the CBE for three years under the supervision of Dr. Jim Wilking. His research focuses on developing new ways of structuring microbial biofilms in three dimensions using stereolithography-based 3D printers.

For a fifth straight year, graduate students from Montana State University gave the public a chance to hear an 80,000-word thesis distilled into 180 seconds. MSU hosted the Three Minute Thesis event at Inspiration Hall in the Norm Asbjornson College of Engineering building.

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

College of Engineering Awards

MSU-CBE PhD students **Matt Jackson** and **Geoff Zath**, both in chemical and biological engineering, were awarded the Raymond E. and Erin S. Schultz Emerging Fellows Award at the department's banquet held at MSU on April 23. The award is given to chemical and biological engineering graduate students in recognition of their high academic performance in coursework and grades, and history of receiving awards, grants, and scholarships. The award also recognizes research accomplishments evidenced by publications and presentations. Jackson and Zath will split the \$18,000 award, using it to fund their research. Jackson's work focuses optimizing algae

nutrients for bioproduct synthesis and wastewater remediation. Zath is investigating cell diversity of the flu virus using drop-based microfluidics.

2019 W.G. Characklis Outstanding Graduate Student Award

CBE awarded the 2019 W.G Characklis Outstanding Graduate Student Award to Ms. Neerja Zambare, PhD candidate in chemical and biological engineering. Neerja was recognized for the quality and productivity of her work at the CBE, especially in the field of biomineralization. She has demonstrated a true passion for biofilm research, which has fueled her drive to overcome any barriers to advance the science. Neerja was also recognized for her exceptional leadership skills and active participation on numerous committees at the CBE, MSU, and professional organizations.

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 Lab Citizen Award

George Platt, masters student in chemical and biological engineering, received CBE's Student Lab Citizen Award. Platt was recognized for of his outstanding work in the Fields Lab, as well as his willingness to help others troubleshoot instruments and data analysis, especially with gas chromatography. The CBE also commended Platt's volunteer efforts, including serving as a 2018-19 committee member of the CBE Seminar Series. Platt's willingness to get on board with shenanigans was also appreciated, including the 90-degree day you wore hockey breezers to play in the CBE kickball tournament.

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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2019 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration Thursday, April 18, 2019. Among the more than 200 students presenting their research, numerous students were connected with the Center for Biofilm Engineering.

POSTERS

Tillie Stewart: Microbiology & Immunology

Mentors: Ellen Lauchnor, Margaret Eggers – Civil Engineering, Microbiology & Immunology, Center for Biofilm Engineering
 "Characterization of Arsenic Distribution on the Crow Reservation"

Bekah Anderson: Chemical & Biological Engineering

Mentors: Christine Foreman, Markus Dieser – Chemical & Biological Engineering, Center for Biofilm Engineering
 "Characterization of Microplastics in Precipitation"

Petria Russell: Chemical & Biological Engineering

Mentor: **Connie Chang** – Chemical & Biological Engineering, Center for Biofilm Engineering
 "Encapsulation of Single Bacterial Cells in Alginate Hydrogels"

Anna Martinson: Chemical & Biological Engineering

Mentors: **Adrienne Phillips, Arda Akyel** – Civil Engineering, Chemical & Biological Engineering, Center for Biofilm Engineering

“pH Controlled UICP”

Mary Burr: Civil Engineering

Mentor: **Ellen Lauchnor** – Civil Engineering, Center for Biofilm Engineering

“Characterizing Unique Methanotrophs from the Deep Subsurface”

Jacob Rotert: Chemical & Biological Engineering

Mentors: **James Wilking, Phil Stewart** – Chemical & Biological Engineering, Center for Biofilm Engineering “Fabrication of Custom Microfluidics for Biofilm Investigation in Crevices”

Nickolas Avila: Chemical & Biological Engineering

Mentor: **Robin Gerlach** – Chemical & Biological Engineering, Center for Biofilm Engineering

“A model to quantify the enhanced mass transfer of CO₂ into high alkalinity algae culture medium”

Martina Du: Chemical & Biological Engineering

Mentor: **Ross Carlson** – Chemical & Biological Engineering, Center for Biofilm Engineering

“Applying Synthetic Biology Techniques to Engineer Microbial Ecology Systems”

Christian Lewis: Chemical & Biological Engineering

Mentor: **Brent Peyton** – Chemical & Biological Engineering, Center for Biofilm Engineering

“Nutrient-induced accelerated growth of microalgae”

Whitney Kieffer: Chemical & Biological Engineering

Mentor: **Ellen Lauchnor** – Civil Engineering, Center for Biofilm Engineering

“Remediation of mine tailings using microbially induced calcite precipitation”

Caitlin Carmody: Mechanical & Industrial Engineering

Mentors: **Jim Wilking, Scott McCalla** – Chemical & Biological Engineering, Mathematical Sciences, Center for Biofilm Engineering

“Chickensplash! Exploring the Health Concerns of Washing Raw Chicken”

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EDUCATION:

CBE Seminar Series: Fall 2018

Montana State University, Roberts Hall, 321 4:10 p.m.

Date	Speaker	Affiliation	Title/Topic
Aug 30	Karen Maegaard	PhD Student, Section of Microbiology, Aarhus University, Denmark	Application of H ₂ microsensors in environments ranging from microbial mats to anaerobic digesters
Sept 6	Neerja Zambare	PhD Student, Dept. of Chemical & Biological Engineering, MSU, CBE	Multi-scale microscopy of microbially induced calcium carbonate precipitation
Sept 13	No Seminar		
Sept 20	Dr. Mike Franklin	Professor, Dept. of Microbiology & Immunology, MSU, CBE	Ribosome hibernation in dormant <i>Pseudomonas aeruginosa</i> biofilm cells
	Brian Pettygrove	PhD Student, Dept. of Microbiology & Immunology, MSU, CBE	Neutrophil clearance of nascent <i>Staphylococcus aureus</i> biofilm
Sept 27	Dr. Seth Pincus	Professor, Dept. of Chemistry & Biochemistry, MSU	Can HIV infection be cured?
Oct 4	No Seminar		
Oct 11	Dr. Ross Carlson	Professor, Dept. of Chemical & Biological Engineering, MSU, CBE	Multiscale analysis of resource allocation in chronic wound biofilms
Oct 18	Dr. Carl Yeoman	Associate Professor, Dept. of Animal & Range Sciences, MSU	Unraveling the role of biogenic amines in vaginal dysbiosis and disease
Oct 25	No Seminar		
Nov 1	Dr. Diane Bimczok	Assistant Professor, Dept. of Microbiology & Immunology, MSU	How gastric epithelial cells control the immune response to <i>H. pylori</i> infection
Nov 8	Dr. Alexander Hoover	Assistant Professor, Dept. of Mathematics, University of Akron, Akron, OH	Modeling microbial swimming and interactions in viscoelastic environments
Nov 15	No Seminar		
Nov 22	No Seminar- Thanksgiving Day		
Nov 29	Dr. Amy Mathers	Associate Professor, Medicine & Pathology, Div. of Infectious Diseases & Int'l. Health, University of Virginia School of Medicine, Charlottesville, VA	Down the drain: The exploration of multidrug resistant bacteria in hospital plumbing
Dec 6	No Seminar- Last Week of Classes		

EDUCATION:

CBE Seminar Series: Spring 2019

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

Date	Speaker	Affiliation	Title/Topic
Jan 10	No Seminar		
Jan 17	No Seminar		
Jan 24	No Seminar		
Jan 31	No Seminar		
Feb 7	Dr. Sreekala Bajwa	Vice President, Agriculture, MSU	Value addition to agriculture through bio-based products
Feb 14	Dr. Garth James	Assoc. Research Professor, Chemical & Biological Engineering, MSU; PI, Medical Biofilms Laboratory, CBE	Influence of breast implant textures on bacterial attachment and biofilm formation
Feb 21	Anna Zelaya	PhD Student, Microbiology & Immunology, MSU, CBE	Microbial community assembly processes in an uncontaminated subsurface aquifer
Feb 28	No seminar - 3-Minute Thesis Competition		
Mar 1	Dr. Mark Lund	Associate Professor, Environmental Management, Edith Cowan University, Joondalup, Western Australia	Using microbial assemblages as part of an environmental assessment of a mine pit lake closure using a river flow-through
Mar 5	Dr. Jennifer Macalady	Professor, Geosciences, Pennsylvania State University, State College, PA	Frasassi dark and deep: A biofilm factory in the terrestrial subsurface
Mar 7	Dr. Kara De Leon	Postdoctoral Research Fellow, University of Missouri, Colombia, MO	Genetic requirements for <i>Desulfovibrio vulgaris</i> Hildenborough biofilm formation in bioreactors and the rat colon
Mar 14	Dr. Chelsea Heveran	Assistant Professor, Mechanical and Industrial Engineering, MSU	Bone-inspired design of tough infrastructure materials
Mar 21	No Seminar- Spring Break		
Mar 28	Stephanie Dodson	PhD Student, Applied Mathematics, Brown University, Providence, RI	Geometry dependent instabilities of waves in excitable media
Apr 4	Dr. Roland Hatzenpichler	Assistant Professor, Chemistry & Biochemistry, MSU, CBE	A new Confocal Raman microscope with cell-sorting ability at MSU: What to do with it and how to get seed funding for using it
Apr 11	Undergraduate Research Day	Cati Carmody, Chemical & Biological Engineering, MSU, CBE	Chickensplash! Exploring the health concerns of washing raw chicken
		Whitney Kieffer, Chemical & Biological Engineering, MSU, CBE	Bacterially influenced leaching of metals from mine tailings
		Nick Avila, Chemical & Biological Engineering, MSU, CBE	A model to quantify the enhanced mass transfer of CO ₂ into high alkalinity algae culture medium
Apr 18	No Seminar		
Apr 26	No Seminar- Last Week of Classes		

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TECHNOLOGY TRANSFER:

Industrial Associates, 2018–19

Bold, new *Small business member

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

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**TECHNOLOGY TRANSFER:
 Montana Biofilm Meeting
 July 17–19, 2018**

Monday

July 16

6:00–8:30 pm

Registration & welcome reception
 Larkspur Foyer, Hilton Garden Inn
 Bozeman

Tuesday

July 17

7:30–8:00 am

Registration & continental
 breakfast

Larkspur Foyer, Hilton Garden Inn

8:00–8:10

Introductory remarks, Larkspur
 Ballroom

Matthew Fields, CBE Director
 Paul Sturman, CBE Industrial
 Coord.

Laura Wahlen, Research Scientist,
 Baxter Healthcare, Round Lake, IL

SESSION 1:

Biofilm Methods

8:10–8:35

Biofilm removal and control issues
 in food processing: Biofilm reactor
 and drain models
 Charles Giambone, Vice President,
 Technical Services, Rochester
 Midland Corp., Rochester, NY

8:35–9:05

Novel methods to study
 multispecies biofilms
 Nuno Filipe Azevedo, Assistant
 Professor, Chemical Engineering,
 University of Porto, Porto, Portugal

9:05–9:35

Advances in 3D hydrogel printing
 for biofilm engineering
 Jim Wilking, Assistant Professor,
 Chemical & Biological Eng., MSU,
 CBE

9:35–10:05 Networking Break

10:05–10:30

Shear stress mediates metabolism
 and growth in electroactive
 biofilms

Andrew Jones, Postdoctoral
 Researcher, Mechanical &
 Industrial Eng., Northeastern
 University, Boston, MA; CBE Young
 Investigator Awardee

10:30–11:00

The versatility of shockwaves in
 destroying biofilms
 Iulian Cioanta, Vice President,
 Research & Development,
 SANUWAVE Health, Suwanee, GA

SESSION 2:

Bacteriophage and Biofilm

11:00–11:30

A bacteriophage integrase
 regulates virulence factor
 production by *Pseudomonas*
aeruginosa

Pat Secor, Assistant Professor,
 Biological Sciences, University of
 Montana; CBE Young Investigator
 Awardee

11:30–12:00

A potential biocontrol strategy for
 healthcare facilities using a
 surfactant-supplemented
 bacteriophage cocktail for the
 control of carbapenemase-
 producing *Klebsiella pneumoniae*
 biofilms

Ariel Santiago, ORISE Research
 Fellow, Biofilm Laboratory, Centers
 for Disease Control, Atlanta, GA;
 CBE Young Investigator Awardee

12:00–1:00 pm

Catered lunch, Hilton Garden Inn

Special Presentation:

1:00–1:30

Life in the human gut microbiome
 Seth Walk, Assistant Professor,
 Microbiology & Immunology, MSU

SESSION 3:

**Strategic Communication and
 Data Resources**

1:30–2:00

BRaID: Biofilm data fusion
 Dave Millman, Assistant Professor,
 Gianforte School of Computing,
 MSU

2:00–2:30

Fostering a common vision to
 mobilize innovation across
 government, industry and
 academic partnerships
 Jayne Morrow, Sr. Science Policy
 Advisor, NIST, Gaithersburg, MD

CBE Open House:

**Poster session and lab
 demonstrations**

3:00–5:00

3rd Floor Barnard Hall, MSU
 Schedule available onsite

Wednesday

July 18

7:30–8:00 am

Registration & continental
 breakfast
 Larkspur Foyer, Hilton Garden Inn

SESSION 4:

Medical Biofilms

8:00–8:05

Session introduction
 Garth James, Associate Research
 Professor, Chem. & Biological Eng.,
 MSU; PI, Medical Biofilms
 Laboratory, CBE

8:05–8:15
 Clinical efficacy of biofilm disruption technology developed with testing at the CBE
 Alicia Tetlak, Microbiologist, Next Science LLC, Jacksonville, FL

8:15–8:45
 Diabetic wound care in our veteran population
 MaryCloud Ammons Anderson, Research Scientist, Idaho Veterans Research and Education Foundation, Boise VA Medical Center, Boise, ID

8:45–9:15
 How bacteria in biofilms withstand antibiotics
 Phil Stewart, Distinguished Professor, Chem. & Bio. Eng., MSU, CBE

9:15–9:45
 Microplate hydrogel assay for antibiofilm testing
 Kenneth Scott Phillips, Biofilms Research Group Leader, Center for Devices & Radiological Health, US FDA, Silver Spring, MD

9:45–10:15 Networking Break

10:15–10:45
 Biofilm: The clinical dilemma
 Eric Johnson, MD, Bozeman Health Wound and Hyperbaric Center, Bozeman, MT

10:45–11:15
 Characterization of Mycobacterium chimaera biofilms on medical device materials
 Archana Siddam, Commissioner's Fellow, Winchester Engineering & Analytical Center, US FDA, Winchester, MA

11:15–11:45
 Design, synthesis, and evaluation of prodrug antimicrobials to control biofilms
 Danica Walsh, PhD Student, Chemistry & Biochemistry, MSU, CBE

11:45–12:00
 Presentation of CBE awards
 Matthew Fields

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

**SESSION 5:
 Biofilm Physiology**

1:00–1:30
 Investigating single cell growth using drop-based microfluidic incubation
 Shawna Pratt, PhD Student, Chemical & Biological Engineering, MSU, CBE

1:30–2:00
 Heterogeneity in Pseudomonas aeruginosa populations
 Tatsuya Akiyama, Postdoctoral Researcher, Microbiology & Immunology, MSU

2:00–2:30
 Spatiotemporal mapping of oxygen in a microbially-impacted packed bed using 19F nuclear magnetic resonance oximetry
 Jeffrey Simkins, PhD Student, Chemical & Biological Engineering, MSU, CBE

2:30–3:00
 CRISPR-mediated defense and bacteriophage counter-defense in P. aeruginosa
 MaryClare Rollins, Research Associate, Microbiology & Immunology, MSU

3:00–3:15
 State of the CBE Address
 Matthew Fields

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

Thursday

July 19
 7:30–8:00 am
 Registration & continental breakfast

Larkspur Foyer, Hilton Garden Inn

**SESSION 6:
 Biofilm Imaging**

8:00–8:30
 CBE imaging capabilities: An overview
 Heidi Smith, Postdoctoral Researcher, CBE

8:30–9:00
 Quantification of biofilm characteristics from images with error bars
 Al Parker, Biostatistician, CBE; Assistant Research Professor, Mathematical Sciences, MSU

9:00–9:30
 Characterizing biofilms using centrifuge force microscopy
 Tom LeFevre, PhD Student, Chem. & Bio. Eng., MSU, CBE

9:30–10:00 Networking Break

**SESSION 7:
 Industrial Biofilms**

10:00–10:30
 Biofilms in industrial water handling systems: An overview of real-time biomonitoring and system performance
 David Vela, Senior Research Scientist; Angela Delegard, Research Scientist, Chem-Aqua, Irving, TX

10:30–11:00
 Microbial defacement of building materials
 Erika Espinosa-Ortiz, Postdoctoral Researcher, CBE

11:00–11:30
 Scale in water systems: A biomineral?
 Adrienne Phillips, Assistant Professor, Civil Eng., MSU, CBE

11:30–11:40
 Meeting wrap up

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WORKSHOP:

**A Two-Part MBM Advanced Biofilms Workshop
 July 16, 2018**

Part I: Imaging Biofilms with Optical Coherence Tomography (OCT)

8:00 – 8:15	Welcome – <i>Matthew Fields, CBE Director</i> Group introductions	323 BH
8:15 – 8:30	An overview to today’s workshop – <i>Paul Sturman</i>	323 BH
8:30 – 9:30	Imaging biofilms with OCT – <i>Jim Wilking</i>	323 BH
9:30 – 9:45	<i>Morning Refreshments</i>	323 BH
9:45 – 11:50	<i>Hands-On!</i> OCT Training – <i>Jim Wilking</i>	TBD BH
11:50 - 12:00	Group Photos	Outside (weather permitting)
12:00 - 1:15	LUNCH	407 JABS

Part II: Developing Ontology for Biofilm Researchers

1:15 – 2:00	An introduction to BRaID – <i>Thiru Ramaraj</i>	323 BH
2:00 - 2:15	<i>Afternoon Refreshments</i>	
2:15 – 4:30	<i>Hands-On!</i> Protégé orientation – <i>Thiru Ramaraj & Karen Moll</i>	134 BH
4:30 – 5:00	Wrap-Up/Discussion	323 BH

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TECHNOLOGY TRANSFER:

**Biofilm Technologies: Pathways to Product Development
 February 5-6, 2019 Arlington, VA**

Tuesday

February 5

7:30-8:00 am

Registration & Cont. Breakfast,
 Commonwealth Foyer
 Meeting, Williamsburg/Yorktown
 Ballroom

8:00-8:15 am

Introductory remarks
 Matthew Fields, CBE Director
 Paul Sturman, CBE Industrial
 Coord.

Keynote

8:15-8:50 am

Biofilm tolerance favors rapid
 emergence of antibiotic resistance
 Christophe Beloin, Associate
 Professor; Co-Director, Institut
 Pasteur Microbiology Course,
 Institut Pasteur

SESSION 1

Food-Related Biofilms

8:50-9:25 am

Biofilms in beer
 Diane Walker, Research Engineer,
 CBE

9:25-10:00 am

Trending topics in food protection:
 A review from the 2018 food
 conferences
 Diane Walker

10:00-10:30 am

Break

10:30-11:05 am

Biofilms, sanitizers, and meat
 safety
 Rong Wang, Research
 Microbiologist, Meat Safety &
 Quality Research, US Meat Animal
 Research Center

11:05-11:40 am

Biofilm management in food and
 beverage processing
 Erin Mertz, Area Technical Support
 Coordinator, Food & Beverage,
 Ecolab

12:00-1:00 pm

Lunch, Richmond/Roanoke

SESSION 2

Biofilm Detection

1:00-1:30 pm

Tracking antimicrobial resistance
 from sink drain biofilms
 Amy Mathers, MD, Associat
 Director, Clinical Microbiology,
 University of Virginia

1:30-2:00 pm

Different techniques to visualize,
 quantify, and investigate biofilms
 Matthew Fields

2:00-2:30 pm

Electrochemical sensing of quorum
 sensing molecules and virulence
 factors
 Edgar Goluch, Associate Professor,
 Chemical Engineering,
 Northeastern University

2:30-3:00 pm

Break
 Sponsored by Decon7 Systems

SESSION 3

Antimicrobials and Regulation

3:00-3:30 pm

Global regulatory impediments and
 their effect on trade
 Adrian Krygsman, Director, Troy
 Corporation

3:30-4:00 pm

Biofilm claims and product
 development
 Dan Klein, Senior Manager, R&D
 Microbiology, STERIS Corporation

4:00-4:30 pm

Antimicrobial pesticides:
 Regulatory update and methods
 development initiatives
 Steve Tomasino, Senior Scientist,
 Office of Pesticide Programs, US
 EPA

Wednesday

February 6

7:30-8:00 am

Continental Breakfast, Richmond/
 Roanoke
 Meeting, Williamsburg/Yorktown
 Ballroom

SESSION 4

Breast Implant Biofilms

8:00-8:05 am

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

8:05-8:40 am

Controversies in biofilm and breast
 implants
 Roger Wixtrom, President, LSCI

8:40-9:10 am

Influence of breast implant
 textures on bacterial attachment
 and biofilm formation
 Garth James, Associate Research
 Professor, Chemical & Biological
 Engineering, MSU; PI, Medical
 Biofilms Laboratory, CBE

9:10-9:45 am

Mechanical factors that may
 contribute to the involvement of
 surface texture on the
 pathogenesis of soft tissue implant
 associated complications
 Hainsworth Shin, Fellow,
 Biomedical Engineer, Center for
 Device & Radiological Health, US
 FDA

9:45-10:15 am
Breast implant surface texture
impacts tissue response
TracyAnn Perry, Vice President,
Science & Research, Establishment
Labs

Break

2:45-3:45 pm
Round Table Discussion

10:15-10:45 am
Break

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SESSION 5

Medical Device

Cleaning/Reprocessing

10:45-11:00 am
Reusable medical devices:
Understanding the challenges and
presenting a path forward
Paul Sturman

11:00-11:35 am
Overview of biofilms in flexible
endoscopes
Kaumudi Kulkarni, R&D Manager,
Healthmark Industries Company

11:35-12:10 pm
Fluorescence microscopy-based
SOP for detecting cellular
contamination of endoscopes
Scott Phillips, Regulatory Research
Scientist, Center for Device &
Radiological Health, US FDA

12:10 pm–1:10 pm
Lunch, Richmond/Roanoke

1:10-1:45 pm
Growth of *Mycobacterium*
chimaera in heater-coolers
Joe Falkinham, Professor,
Microbiology, Virginia
Technological Institute

1:45-2:15 pm
Ultrasound device disinfection: A
patient safety risk
Marcia Ryder, Research Scientist,
Ryder Science, Inc.

2:15-2:45 pm

TECHNOLOGY TRANSFER:

NEWS HIGHLIGHTS**STERIS earns first biofilm claim from EPA using testing standard developed by CBE**

An Industrial Associate of the Center for Biofilm Engineering received the first biofilm claim to be authorized under U.S. EPA regulations using Method MB-19 and/or MB-20 (dated July 2017). Ohio-based STERIS Corporation earned the claim for its ProKlenz® ONE alkaline detergent in July 2018. The CBE was part of the team that developed the standard testing method that the U.S. EPA requires products meet or exceed for the company to use the biofilm claim in the marketing of the product. Since its founding at Montana State University in 1990, the CBE has worked closely with private and governmental agencies through its membership-based Industrial Associates Program. Please see STERIS Corporation's [press release](#) for more information about earning the country's first biofilm removal claim.

CBE welcomed new members to its Industrial Associates Program:

[Advanced Sterilization Products](#) (ASP) is a Johnson & Johnson company that makes a variety of sterilization and high-level disinfection products. They're a leader in infection prevention, helping facilities prevent healthcare-associated infections by designing and delivering best-in-class medical device processing products and equipment. **Keyvan Nowruzi** is the CBE designated representative.

[Clorox](#) has been bringing the cleaning and disinfecting power of bleach to the world for almost 100 years. Today, an estimated eight out of ten American households use Clorox brand bleach. Clorox brand laundry and home cleaning products are sold in more than 100 countries in North America, South America, Europe, Africa, and Asia. This cleaning agent, derived almost 100 years ago from a salt pond in the San Francisco area, is now a cleaning essential used in homes throughout the world. **Bill King** is the CBE designated representative.

[Olympus](#) is a Japanese manufacturer of optics and reprography products. It was established in 1919, initially specializing in microscopes and thermometers. Today, Olympus holds roughly a 70-percent share of the global endoscope market. Their medical business division works with healthcare professionals delivering the diagnostic and therapeutic technologies they need to treat their patients. **Jason Ashraf**, director of reprocessing strategy, will be the CBE designated representative.

[PureLine Systems](#) specializes in the generation and application of chlorine dioxide aimed at improving the quality of water supplies used in "various markets, including oil and gas production, municipal water, hospital and healthcare facility secondary disinfection, food and beverage, district energy, and manufacturing industries." Established in 1995 as ElectroSci, the company expanded three years later and changed its name to PureLine. **Bob Sullivan** is the designated representative to the CBE.

Founded in 1886, [S.C. Johnson](#) is a family-owned company and one of the world's leading producers of household brands. Their product portfolio is vast and includes global brands that help every household with cleaning, pest control, storage, shoe and auto care, and home fragrance.

[CBE Industrial Associates](#)

[CBE membership](#)

CBE launches third methods training video

CBE, in collaboration with MSU's Department of Visual Media and BioSurface Technologies, launched the Single Tube Method training video. It covers ASTM Method E2871, disinfection and neutralization, and biofilm removal and disaggregation. The video also provides a link to calculate log reduction and helpful tips on conical vials, splash guards, neutralization, sonication, and filtration. View all of the [methods training videos](#)

NASA seeks ideas for biofilm problem

The International Space Station has a biofilm problem in its wastewater plumbing. Biofilm can grow in the water recycling system, and while it poses no immediate threat to the astronaut scientists orbiting some 220 miles above earth, it's a problem that needs a solution nonetheless. Without one, NASA's biofilm problem is sure to follow tomorrow's astronauts on missions to the moon, Mars, and possibly other destinations where maintenance shuttles will be impractical to come by.

In the same week as the 50th anniversary of man first walking on the moon, NASA engineers convened in Bozeman to brainstorm potential solutions with scientists from the Center for Biofilm Engineering and attendees of its Montana Biofilm Meeting shortly after the annual meeting wrapped up July 18.

"We plan to use these ideas to design concepts that we'll develop into a trade study," says Layne Carter, manager of the water subsystem on the International Space Station. "If it goes as planned, we'll do a technology demonstration on the ISS. Will that be in two years? Three years? I do not know. But it will be as fast as we can do it."

Carter also offered a carrot: "There is plenty of opportunity for funding here."

The wastewater on the ISS is comprised by two primary waste streams: crew urine and humidity condensate from respiration and perspiration, according to information provided by NASA. None of these liquids have a biocide to inhibit microbial growth. As a result, biofilm forms in the wastewater plumbing.

Carter and other NASA personnel briefed the group on the problem and what the solution needs to accomplish. He also stated an obvious — but important — caveat: while the long-term solution for future spaceships will be installed on earth, the solution that will be tested on the ISS needs to be able to be implemented in microgravity.

Ideas discussed in the freeform meeting included biocides, antimicrobial coatings, redesigned storage receptacles, and using the sun's ultraviolet rays as a disinfectant.

"I'm thrilled by the feedback we've gotten from the people in this group," Carter said. "I'm ecstatic about that."

VIDEO: Documentary examines biofilms, CBE

Biofilms have profoundly shaped the world almost since the dawn of life on earth. These communities of self-organized microbes are remarkably resilient, and they wreak havoc on human health and societal infrastructure every day. Governments and industries in the U.S. alone spend a half-trillion dollars each year fighting biofilm-related corrosion. As this 6-minute documentary shows, researchers at the CBE — the world's first, largest, and best-known biofilm research center — are on the front lines of this critical battle, seeking real-world solutions to real-world problems by peeling back the mysteries of these fascinating — and devastating — microbial communities. [VIDEO](#)

Bozeman reactor company celebrates 25 years of supporting biofilm research

CBE congratulates [BioSurface Technologies](#) on 25 years in the business of providing laboratory bioreactors for biofilm study. BioSurface Technologies reactors are used in ASTM biofilm growth and treatment methods, as well as by many academic and industry laboratories around the world. The company is based in Bozeman, Montana.

TECHNOLOGY TRANSFER:

Industry and Agency Interactions

Industry Visits to CBE

Paul Sturman, CBE industrial coordinator, hosted **Mason Nagasaki**, **Takashi Abe**, **Jason Ashraf**, and **Takashi Kinebuchi** from Olympus. The group met with **Darla Goeres** and **Garth James** to discuss projects related to their endoscope division. October 31, 2018

Denis Bendejacq, **Richard Jacobinas**, and **Gilda Lizarraga** from Solvay, a CBE industrial member for several years, visited the center to discuss potential projects. November 13, 2018.

Paul Sturman, CBE industrial coordinator, presented “Biofilm growth and response to antimicrobial treatment,” at PureLine System’s technical symposium in Chicago, Illinois. PureLine is a member of the CBE Industrial Associates Program. They specialize in the application of chlorine dioxide to improve the quality of water supplies used in various markets. December 11, 2018

Early this year, **Todd Roper** and **Mike Marotz** from Carboceramics visited the CBE to discuss potential testing projects and membership. Carboceramics sells a variety of products and services related to oil and gas industrial processes, and environmental applications. They were hosted by affiliated faculty **Robin Gerlach**, professor in chemical and biological engineering and **Adrienne Phillips**, assistant professor in civil engineering. January 22, 2019.

CBE’s Standardized Biofilm Methods Lab (SBML) hosted the following industrial visitors:

Jillian Vocke and **Tyler Zanon** from Medline visited the center to learn about the drip flow reactor in preparation for their participation in the ASTM interlaboratory study. February 2019

Sasha Zavgorodnya from Solvay worked with SBML researchers on a project using a new cooling tower reactor currently in development at BioSurface Technologies. April 2019

Sailaja Chandrapati from 3M visited the SBML to work on biofilm sampling methods. April 2019

CBE Visits to Industry

Matthew Fields attended an invite-only tour of the Argonne National Laboratory in Chicago, IL. August 28–30, 2018.

Paul Sturman, as an invited speaker presented “Biofilm growth and response to antimicrobial treatment,” at L’Oreal in Newark, New Jersey. Paul was also invited to present a poster “CBE helps industry solve biofilm problems,” at L’Oreal’s industry partners poster session. September 12, 2018.

Jim Wilking, assistant professor in chemical & biological engineering, was invited to present at STERIS Corporation’s Scientific Conference October 10–12 in St. Louis, MO. Jim presented “Biofilms as soft materials.” STERIS is a leading provider of infection prevention and other procedural products and services, focusing primarily on healthcare, pharmaceutical and medical device customers. They have been a member of the CBE’s Industrial Associates Program since 2011. October 10–12, 2018.

OUTREACH:

News Highlights

Standardized Biofilm Methods Lab hosting workshop at IAFP Annual Meeting

The CBE Standardized Biofilm Methods Lab conducted [a workshop](#) at the annual meeting of the International Association for Food Protection in Salt Lake City July 8–11, 2018. The workshop was designed for anyone interested in standard methods, growing relevant biofilms, and those wanting to test surfaces, agents, or fabrics for antimicrobial efficacy against biofilms.

8th ASM Biofilms Conference

CBE researchers took an active role at the 8th ASM Conference on Biofilms October 10–11, 2018 in Washington, D.C. **Phil Stewart** was part of the program committee and served as chair of the session on biofilm antimicrobial tolerance. **Mike Franklin**, professor in microbiology & immunology, presented “Ribosome hibernation in dormant *Pseudomonas aeruginosa* biofilm cells,” and **Brian Pettygrove**, PhD student in microbiology & immunology, received a travel award to present his research on neutrophil clearance of nascent *Staphylococcus aureus* biofilm.

CBE's Standardized Biofilm Methods Lab (SBML) was invited to present a workshop on methods for biofilm laboratory studies. The full-day workshop was one of three pre-meeting workshops offered by the conference. It was designed for researchers interested in standard methods, growing relevant biofilms, and testing surfaces, agents, or fabrics for antimicrobial efficacy against biofilms. The SBML also hosted this workshop in July at the International Association for Food Protection meeting in Salt Lake City, UT. Read [workshop abstract](#)

Nikon High Resolution Imaging Workshop

CBE hosted Nikon for a presentation on recent advances in high resolution imaging April 19. Technicians from Nikon spoke about hyperspectral imaging, super resolution microscopy, data analysis, and advances in confocal laser scanning microscopy. Instrument demos were also available based on attendee interest. The event was organized by **Heidi Smith**, CBE Microscopy Facility manager. Heidi assumed the role as head of the million-dollar microscopy facility in September 2018. [Read about the state-of-the-art facility](#)

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OUTREACH:

Visiting Researchers

Visiting Faculty

Bastiaan Krom, faculty from University of Amsterdam, The Netherlands

Area of study: Oral biofilms, host interactions

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

Visiting June 2018–August 2018

Ayrat Ziganshin, faculty from Kazan Federal University, Kazan, Russia

Home department: Microbiology

Area of study: Fungi

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

Visiting June 2018–September 2018

Elvira Ziganshin, faculty from Kazan Federal University, Kazan, Russia

Home department: Microbiology

Area of study: Urinary tract stone formation

CBE host: Robin Gerlach

Visiting June 2018–September 2018

Nicolas Forquet, faculty from the National Institute for Environmental and Agricultural Science and Research in Lyon, France

Area of study: Root biofilm interactions in treatment wetlands

CBE host: **Otto Stein**, professor, civil engineering, and **Ellen Lauchnor**, assistant professor, civil engineering

Visiting August 2018–January 2019

Scott Wade, associate professor, Swinburne University, Melbourne, Australia

Home department: Telecommunications, Electrical, Robotics, and Biomedical Engineering

Area of study: Corrosion and investigating microbially influenced corrosion (MIC) and the development of new sensing systems.

CBE host: Matthew Fields, CBE director

Visiting July 2019–December 2019

CBE hosted six visiting researchers from the University of Stuttgart, Germany for a week-long biofilm and biomineralization workshop February 25–28, 2019. Visitors included: Dr. **Johannes Hommel**, **Felix Weinhardt**, Prof. **Holger Class**, **Joseph Piotrowski**, Prof. **Holger Steeb**, and Dr. **Nikos Karadimitriou**. CBE hosts were **Al Cunningham**, professor emeritus in civil engineering, **Robin Gerlach**, professor in chemical and biological engineering, and **Adie Phillips**, assistant professor in civil engineering.

Visiting Student Researchers

Lenno van den Berg, PhD student

Home university: Delft University of Technology, The Netherlands

Area of study: Wastewater treatment

CBE hosts: Sarah Codd, professor, mechanical and industrial engineering; Cat Kirkland, associate research professor, civil engineering

Visiting May 2018–August 2018

Rachel Kleiman, Masters student

Home university: University of North Carolina, Chapel Hill

Area of study: Algal biofuels

CBE host: Robin Gerlach

Visiting June 2018–August 2018

Elizabeth Lee, High School student

Hometown: Bozeman, MT

CBE Project: Growth and use of algae as a biofertilizer

CBE host: Matthew Fields, CBE director; professor, microbiology and immunology

Visiting June 2018–August 2018

Hannah Sylvester, Undergraduate student

Home university: Carroll College, Helena, MT

Area of study: Biology and health sciences

CBE host: Connie Chang, assistant professor, chemical and biological engineering

Visiting May 2018–August 2018

Albert Tafur, PhD student

Home university: Universidad de Los Andes, Bogota, Colombia

Area of study: Metabolic pathways

CBE hosts: Ross Carlson, professor, chemical & biological engineering

Visiting August 2018–November 2018

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OUTREACH:

Web image library use 2018-2019

Total image downloads: **298**

Requests for CBE graphics were submitted from **29** of the U.S. states:

Arizona	Indiana	Missouri	Nevada	Tennessee
California	Louisiana	Montana	North Carolina	Texas
Connecticut	Maryland	New Hampshire	Ohio	Virginia
Florida	Massachusetts	New Jersey	Oregon	Washington
Georgia	Michigan	New Mexico	Pennsylvania	Wisconsin
Illinois	Minnesota	New York	South Carolina	

There were requests from an additional **29** countries:

Argentina	Hungary	Poland
Australia	India	Portugal
Belgium	Indonesia	Qatar
Brazil	Ireland	Serbia
Canada	Italy	South Africa
Chile	Japan	Spain
Denmark	Kazakhstan	Switzerland
France	Mexico	Turkey
Germany	Netherlands	United Kingdom
Greece	New Zealand	

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FACILITIES:

Center for Biofilm Engineering Facilities Overview

Located in [Barnard Hall](#) next to the [Strand Union Building](#), the Center for Biofilm Engineering comprises more than 20,000 square feet, and includes offices and conference rooms for faculty, staff, and students; a computer lab; and 13 fully equipped research laboratories. General use areas include an analytical instrument lab, a microbiology lab with media preparation area and autoclaves, and a general molecular area with two thermocyclers, a gel running and imaging station, and spectrophotometers for nucleic acid quantification, as well as an isolated radioactive isotope lab. See below for a comprehensive list of shared equipment available.

Microscope Facilities

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

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

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

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

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

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

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

- The **Chemical Imaging Lab** contains a Horiba **Confocal Raman Microscope**. Raman is a vibrational spectroscopic method that provides a fingerprint of the molecular, and to some extent the isotopic composition of a sample. The Horiba LabRam HR Evolution NIR is dedicated to studying the molecular composition of a sample. This is a fully integrated high resolution Raman microscope for confocal Raman analysis, optimized for the visible to IR range (400nm-2500nm) microscope. It includes a confocal Raman microscope with an automated xyz-stage with fast-mapping capabilities, transfer optics, stigmatic spectrometer equipped with two gratings (600 and 1800 l/mm gratings), multichannel air-cooled CCD detector, and computer package with the latest version of the LabSpec6 software and the KnowItAll Raman spectra library, Horiba edition. It is equipped with 532nm 100mW laser, HeNe 633nm laser, 785nm 90mW laser, and 10x, 50x, 100x, 20xLWD and 50xLWD objectives.
- The **Microscope Resource Room / Digital Imaging Lab** is where CBE researchers examine and reconstruct the stacks of image data they have collected using our image analysis software. For quantitative analysis, such as intensity or particle-size measurements, we use Universal Imaging Corporation's MetaMorph software. We use Bitplane's *Imaris* software for computer-intensive data analysis like particle tracking and for qualitative analysis—for example, putting together a stack of 200 red and green flat images to get a 3-dimensional image of a biofilm microcolony that can be rotated in space and examined from every angle. The lab consists of three dedicated computers, a server for storing large files, CD and DVD burners and readers, and a color printer. In addition to providing CBE students, staff, and researchers with an imaging workplace, the resource room gives us a place to hold group tutorials and WebEx group software training sessions.

Mass Spectrometry Facility

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

Specialized CBE Laboratories

Ecology/Physiology Laboratory

The Ecology/Physiology Laboratory headed by Dr. Matthew Fields has general microbiology equipment, anaerobic gassing stations in two lab spaces, Shimadzu UV-VIS spectrophotometer, Ultra-Centrifuge, Anaerobic Chamber, biofilm reactors, protein and DNA electrophoresis, Qubit fluorometer, two Eppendorf Mastercylcers, incubators, laminar/fume hoods, microcentrifuges, table-top centrifuges, and a microcapillary gas chromatograph with dual TCDs. The lab has two light-cycle controlled photo-incubators as well as photo-bioreactors for the cultivation of algae and diatoms, and maintains two -20°C freezers and three -70°C freezers for sample storage. Additionally, the lab has a large capacity refrigerated incubator (5-70°C) for temperature critical studies.

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

Medical Biofilm Laboratory

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

Currently, twelve companies, including CBE Industrial Associates, sponsor MBL projects. These projects include evaluating antimicrobial wound dressings, biofilm formation on biomedical polymers, testing novel toothpaste ingredients, and testing biofilm prevention and removal agents. The MBL is also researching the role of biofilms in Lyme disease with funding from a private foundation. The MBL is a prime example of integration at the CBE, bringing together applied biomedical science, industrial interaction, and student educational opportunities.

Standardized Biofilm Methods Laboratory

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

Microbial Ecology and Biogeochemistry Laboratory

Research in the Microbial Ecology and Biogeochemistry Laboratory (www.foremanresearchgroup.com) lies at the intersection of microbial and ecosystem ecology and uses a combination of field and laboratory studies, as well as approaches ranging from the single-cell to the community level. Staff in this lab are interested in understanding how the environment controls the composition of microbial communities and how, in turn, those microbes regulate whole ecosystem processes such as nutrient and organic matter cycling. Ongoing research examines carbon flux through microbial communities, with the long-term goal of improving predictions of carbon fate (metabolism to CO₂, sequestration into biomass, long-term storage in ice) in the context of a changing environment. Additionally, they are interested in physiological adaptations to life in extreme environments, as extremophiles are natural resources for the discovery of pigments, biosurfactants, novel enzymes and other bioactive compounds of industrial relevance.

Microfluidics Laboratory

Dr. Connie Chang runs a soft materials and microfluidics laboratory to study microbes (bacteria, biofilms, and viruses). Dr. Chang is applying drop-based microfluidics—the creation and manipulation of picoliter-sized drops of fluid—for high-throughput screening and assaying in biology. Her lab is developing novel tools for quantifying the behavior of individuals and how they can collectively contribute to large-scale population dynamics. Ongoing projects within her group include the screening of persister and dormant bacteria cells in biofilms and the study of influenza evolution and population dynamics. Dr. Chang has shared laboratory space in the CBE and an individual laboratory space in the Chemistry and Biochemistry Building (CBB) at MSU. The laboratory spaces include common space for equipment, chemical storage, freezers and reagents. The lab is outfitted with a qPCR machine and also includes a dedicated a room for epifluorescence microscopy and a custom built microscope stand (200 square feet). The lab contains all the equipment and instrumentation necessary for fabrication of new devices, microfluidics handling, PCR, and cell culture.

Microsensor Laboratory

The Microsensor Laboratory provides the capability of measuring microscale chemical and physical parameters within biofilms, microbial mats and other compatible environments. The Microsensor Laboratory has the capability to measure spatial concentration profiles using sensors for oxygen, pH, hydrogen sulfide, nitrous oxide and some custom-made electrodes. All electrodes are used in conjunction with computer-controlled micromanipulators for depth profiling. A Leica

stereoscope is used to visualize the sensors while positioning them on the biofilm surface. The laboratory has experience with diverse microsensors applications including biofilms in wastewater, catheters and hollow fiber membrane systems in addition to algal and fungal biofilms.

OTHER Montana State University facilities available for collaborative research

Montana Nanotechnology (MONT) Facility

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

MSU Nuclear Magnetic Resonance (NMR) Facility

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

MSU Magnetic Resonance Microscopy (MRM) Facility

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

MSU ICAL Laboratory

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

A new critical point dryer—jointly purchased in 2007 by the CBE and the Image & Chemical Analysis Laboratory—has been set up in the ICAL lab for the processing of biological samples for electron microscopy. This equipment allows our researchers to remove water from soft samples without distorting the sample.

The ICAL currently contains eleven complementary microanalytical systems:

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

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

CBE Computer Facilities

The CBE maintains several dedicated computational and data storage computer systems including 10 high performance data and image analysis workstations and servers in addition to three large storage servers. The CBE maintains a small to mid-scale computational cluster for modeling and analysis. The center provides personal workstations for staff and graduate students that are connected to the MSU computer network. A student computer laboratory offers nine state-of-the-art PCs along with scanning and printing services. Additionally, CBE staff and students have access to the centrally maintained computational cluster for data manipulation, analysis, and mathematical modeling. This cluster consists of 77 nodes with a total of 1300 hyper-threaded cores and 22 teraflops of computing power.

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