
2014 APPENDIX

**Center for
Biofilm
Engineering**

Montana State University
Bozeman

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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:
 2013–2014 CBE GRANT-FUNDED RESEARCH ACTIVITY

Research Area	Title	Principal Investigator	Funding Agency
Biofilms in Nature	Heidi Smith's NASA fellowship	Foreman	NASA
Education	Improving Montana community health through graduate education	Camper	NIH
Energy Solutions	Environmental responses to geologic CO ₂ sequestrations	Cunningham	DOE EPSCoR
Energy Solutions	Basic science of retention issues, risk assessment & measurement, monitoring & verification for geologic CO ₂ sequestrations	Cunningham	DOE
Energy Solutions	EFRI-HyBi: Fungal processes for bioconversion	Peyton	NSF-ARRA
Energy Solutions	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	Church & Dwight
Energy Solutions	SEP collaborative research: Alkaliphilic microalgae-based sustainable & scalable processes for renewable fuels and products	Gerlach, Peyton & Fields	NSF
Energy Solutions	Direct conversion of lignocellulosic feedstocks to lipids and high-value products using a proprietary microbial process	Macur	Sustainable Bioproducts
Energy Solutions	Nutrient and water integration and recycling for sustainable and algal biorefineries	Gerlach, Peyton & Fields	DOE
Energy Solutions	Using biomineralization sealing for leakage mitigation in shale during CO ₂ sequestration	Gerlach	DOE
Energy Solutions	Lipid derived biofuels: Bicarbonate induced microalgae for biofuel and specialty chemicals	Peyton	Church & Dwight
Energy Solutions	Cultivation and characterization of cyanobacteria for a renewable organic fertilizer	Macur	American Indian Higher Education
Energy Solutions	Sustainable coal bed methane (CBM) and biofuel production from algae grown in CBM produced water	Cunningham & Fields	MBRCT
Energy Solutions	Extremophilic fungal enzymes for degradation of lignocellulosic feedstocks	Macur	Sustainable Bioproducts
Environmental Substance Technologies	ZERT II - Cunningham Task II	Cunningham	DOE-ZERT
Environmental Substance Technologies	Plant, season, and microbial controls on complete denitrification in treatment wetlands	Stein	NSF
Environmental Substance Technologies	Microbial activity and precipitation at solution-mixing zones in porous media	Gerlach	DOE-ERSP
Environmental Substance Technologies	Cultivation and characterization of phototrophs for renewable organic fertilizer	Macur	DOE-AIREI
Environmental Substance Technologies	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface	Codd	DOE
Environmental Substance Technologies	Cooperative research program on constructed wetland design and implementation	Stein	USFWS
Environmental Substance Technologies	Design and implementation of pilot vertical flow treatment wetland systems at Bridger Bowl	Stein	MT DEQ
Environmental Substance Technologies	Using biomineralization sealing for leakage mitigation in shale during CO ₂ sequestration	Gerlach	MT Emergent Technologies
Environmental Substance Technologies	MSU selenium biogeochemistry investigation	Peyton	Teck Coal

Research Area	Title	Principal Investigator	Funding Agency
Environmental Substance Technologies	Teck ART/MSU microbial selenium reduction and mining bioprocesses	Peyton	Teck Metals LTD
Medical Biofilms	<i>Staphylococcus aureus</i> biofilms mediate keratinocytes apoptosis	Kirker	NIH
Medical Biofilms	Spatiotemporal distribution of oxygen in biofilm infections	Stewart	NIH
Medical Biofilms	Resensitization of bacteria in biofilms to antibiotics	Stewart	DOD (USAMRAA)
Medical Biofilms	Resuscitation of <i>P. aeruginosa</i> biofilm cells from dormancy ^{*1}	Franklin	NIH
Methods Development	Antimicrobial test methodology	Goeres	EPA
Methods Development	Development and use of standard methods for the growth, treatment, sampling and analysis of biofilm bacteria	Goeres	EPA
Modeling	CMG Research	Klapper	NSF
Physiology & Ecology	Virtual Institute for Microbial Stress & Survival (VIMSS)	Fields	DOE/LBNL
Physiology & Ecology	Role of IbpA in maintaining viability of <i>P. aeruginosa</i> biofilm persister cells ^{*1}	Franklin	NIH
Physiology & Ecology	Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS divide replicate core	Foreman	NSF
Physiology & Ecology	Multidimensional -omics characterization of microbial metabolism and dissolved organic matter	Foreman	NSF
Physiology & Ecology	Phototroph-heterotroph interactions	Carlson	DOE/PNNL
Physiology & Ecology	Collaborative research: Hydrodynamic controls on microbial community dynamics	Cunningham & Fields	NSF

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

¹MSU Department of Microbiology

List of Acronyms

AIREI	American Indian Research and Education Initiative
ARRA	American Recovery and Reinvestment Act
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
EPSCoR	Experimental Program to Stimulate Competitive Research
ERSP	Environmental Remediation Sciences Program
LBNL	Lawrence Berkeley National Laboratory
MBRCT	Montana Board of Research and Commercialization Technology
MT DEQ	Montana Department of Environmental Quality
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NSF	National Science Foundation
PNNL	Pacific Northwest National Laboratories
USAMRAA	U.S.A. Medical Research Acquisition Activity
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
ZERT	Zero Emissions Research and Technology

FY14 New CBE Research Grants (July 1, 2013 to June 30, 2014)

Sponsor	Title	PI	Period	Amount
USFWS	Cooperative research program on constructed wetland design and implementation	Stein	1.5 yrs	\$70,000
MT DEQ	Design and implementation of pilot vertical flow treatment wetland systems at Bridger Bowl	Stein	1.5 yrs	\$61,000
MT Emergent Technologies	Using biomineralization sealing for leakage mitigation in shale during CO ₂ sequestration	Gerlach	.75 yr	\$66,555
NIH	Spatiotemporal distribution of oxygen in biofilm infections	Stewart	3 yrs	\$890,530
Sustainable Bioproducts	Extremophilic fungal enzymes for degradation of lignocellulosic feedstocks	Macur	1 yr	\$21,300
Teck Coal	MSU selenium biogeochemistry investigation	Peyton	1 yr	\$181,000
NSF	Collaborative research: Hydrodynamic controls on microbial community dynamics	Cunningham & Fields	3 yrs	\$202,113
MT Board of Research & Commercialization	Sustainable coal bed methane (CBM) and biofuel production from algae grown in CBM produced water	Cunningham & Fields	1 yr	\$140,866
Teck Metals LTD	Teck ART/MSU microbial selenium reduction and mining bioprocesses	Peyton	1 yr	\$41,992
American Indian Higher Education	Cultivation and characterization of cyanobacteria for a renewable organic fertilizer	Macur	1 yr	\$19,000
US EPA	Development and use of standard methods for the growth, treatment, sampling and analysis of biofilm bacteria	Goeres	1 yr	\$17,000
Church & Dwight	Lipid derived biofuels: Bicarbonate induced microalgae for biofuel and specialty chemicals	Peyton	1 yr	\$198,072
US DOD (USAMRAA)	Resensitization of bacteria in biofilms to antibiotics	Stewart	5 yrs	\$799,917
US DOE w/Vista Clara Inc. (SBIR/STTR)	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface *	Codd	1 yr	\$174,145
NSF	SEP collaborative research: Alkaliphilic microalgae-based sustainable & scalable processes for renewable fuels and products *	Gerlach, Peyton & Fields	2 yrs	\$90,000
US DOE Pacific Northwest Laboratory	Phototroph-heterotroph interactions *	Carlson	1 yr	\$55,179
Total Grant Awards to CBE for FY2014				\$3,028,669
<i>*Additional monies awarded in FY14 (budget increased by the amount listed)</i>				
NIH	Resuscitation of <i>P. aeruginosa</i> biofilm cells from dormancy **	Franklin	5 yrs	\$1,620,000
Total Biofilm Grant Awards for FY2014				\$4,648,669
<i>**Denotes a project running through a different MSU department, but involving collaboration with CBE researchers and/or use of CBE facilities.</i>				

RESEARCH:
PUBLICATIONS
June 2013–May 2014

2013 Publications

NOTE:

2013-001 through 2013-018 are listed in 2013 Appendix

Allen CR, Stein OR, Hook PB, Burr MD, Parker AE, Hafila EC, “Temperature, plant species and residence time effects on nitrogen removal in model treatment wetlands,” *Water Sci & Tech*. 2013; 68(11):2337–2343. 2013-043

Barnhart EP, De León KB, Ramsay BD, Cunningham AB, Fields MW, “Investigation of coal-associated bacterial and archaeal populations from a diffusive microbial sampler (DMS),” *Int J Coal Geology*. 2013;115:64–70. 2013-023

Bernstein HC, Beam JP, Kozubal MA, Carlson RP, Inskeep WP, “In situ analysis of oxygen consumption and diffusive transport in high-temperature acidic iron-oxide microbial mats,” *Environ Microbiol*. 2013;15(8):2360–70. 2013-028

Bhardwaj C, Cui Y, Hofstetter T, Liu SY, **Bernstein HC, Carlson RP,** Ahmed M, Hanley L, “Differentiation of microbial species and strains in coculture biofilms by multivariate analysis of laser desorption post-ionization mass spectra,” *Analyst*. 2013;138(22):6844–51. 2013-054

Bhardwaj C, Moore JF, Cui Y, Gasper GL, **Bernstein HC, Carlson RP,** Hanley L, “Laser desorption VUV postionization MS imaging of a cocultured biofilm,” *Anal Bioanal Chem*. 2013;405(22):6969–77. 2013-030

Brileya KA, Connolly JM, Downey C, Gerlach R, Fields MW, “Taxis toward hydrogen gas by *Methanococcus maripaludis*,” *Sci Rep*. 2013;3:3140. 2013-038

Cawley KM, McKnight DM, Miller P, Cory R, Fimmen RL, Guerard J, **Dieser M,** Jaros C, Chin Y-P, **Foreman C,** “Characterization of fulvic acid fractions of dissolved organic matter during ice-out in a hyper-eutrophic coastal pond in Antarctica,” *Environ Res Letters*. 2013; 8:4. 045015 (10pp). 2013-044

Clingenpeel S, Jinjun K, **Macur RE,** Woyke T, Lovalvo D, Varley J, Inskeep WP, Neelson K, McDermott TR, “Yellowstone Lake nanoarchaeota,” *Front Microbiol*. 2013;4:274. 2013-031

Connolly J, Kaufman M, **Rothman A,** Gupta R, Redden G, Schuster M, Colwell F, **Gerlach R,** “Construction of two ureolytic model organisms for the study of microbially induced calcium carbonate precipitation,” *J Microbiol Methods*. 2013;94(3):290–299. 2013-026

Cui Y, Bhardwaj C, Milasinovic S, **Carlson RP,** Gordon RJ, Hanley L, “Molecular imaging and depth profiling of biomaterials interfaces by femtosecond laser desorption post-ionization mass spectrometry,” *ACS Appl Mater Interfaces*. 2013;5(19):9269–9275. 2013-053

D’Andrilli J, Foreman CM, Marshall AG, McKnight DM, “Characterization of IHSS Pony Lake fulvic acid dissolved organic matter by electrospray ionization Fourier transform ion cyclotron resonance,” *Org Geochem*. 2013;65:19–28. 2013-036

DeLeón KB, Gerlach R, Peyton BM, Fields MW, “Archaeal and bacterial communities in three alkaline hot springs in Heart Lake Geyser Basin, Yellowstone National Park,” *Front Microbiol*. 12 November 2013; 4:330. 00330. 2013-045

Dieser M, Foreman CM, Jaros C, Lisle JT, Greenwood M, Laybourn-Parry J, Miller PL, Chin Y-P, McKnight DM, “Physicochemical and biological dynamics in a coastal Antarctic lake as it transitions from frozen to open water,” *Antarct Sci*. 2013;25(5):663–675. 2013-033

Donovan C, Dewan A*, Heo D, **Lewandowski Z,** Beyenal H[#], “Sediment microbial fuel cell powering a submersible ultrasonic receiver: New approach to remote monitoring,” *J Power Sources*. July 2013;233:79–85. 2013-055

Doyle JT, Redsteer MH, **Eggers MJ,** “Exploring effects of climate change on Northern Plains American Indian health,” *Climatic Change*. 2013;120(3):643–655. 2013-032

Eustance E, Gardner RD, Moll KM, Menicucci J, **Gerlach R, Peyton BM,** “Growth, nitrogen utilization and biodiesel potential for two chlorophytes grown on ammonium, nitrate or urea,” *J Appl Phycol*. 2013;25:1663–1677. 2013-039

Foreman CM, Cory RM, Morris CE*, SanClements MD, **Smith HJ**, Lisle JT, Miller PL, Chin Y-P, McKnight DM, "Microbial growth under humic-free conditions in a supraglacial stream system on the Cotton Glacier, Antarctica," *Environ Res Letters*. (8) Special Focus Issue: *Cryospheric Ecosystems* 2013;1–11.
 2013-029

Gardner RD, Lohman EJ, Cooksey KE, **Gerlach R, Peyton BM**, "Cellular cycling, carbon utilization, and photosynthetic oxygen production during bicarbonate-induced triacylglycerol accumulation in a *Scenedesmus* sp.," *Energies*. 2013;6(11):6060–6076.
 2013-041

Hamilton MA, Hamilton GC, **Goeres DM, Parker AE**, "Guidelines for the statistical analysis of a collaborative study of a laboratory method for testing disinfectant product performance," *J AOAC International*. 2013;96(5):1138–1147.
 2013-034

Khan M[#], Takizawa S, **Lewandowski Z**, Rahman MH[#], Komatsu K, **Nelson SE**, Kurisu F, **Camper AK**, Katayama H, Ohgaki S, "Combined effects of EPS and HRT enhanced biofouling on a submerged and hybrid PAC-MF membrane bioreactor," *Water Research*. 2013;47(2):747–757.
 2013-048

Khilyas IV*, Ziganshin AM*, **Pannier AJ, Gerlach R**, "Effect of ferrihydrite on 2,4,6-trinitrotoluene biotransformation by an aerobic yeast," *Biodegradation*. 2013;24(5):631–644.
 2013-024

Lauchnor EG, Semprini L, "Inhibition of phenol on the rates of ammonia oxidation by *Nitrosomonas europaea* grown under batch, continuous fed, and biofilm conditions," *Wat Res*. Sept 2013;47(13):4692–4700.
 2013-058

Lewandowski Z, Beyenal H[#], Fundamentals of Biofilm Research, Second edition, 2013. Publisher: CRC Press Inc.
 2013-042

Lohman EJ, Gardner RD, Halverson L, Macur RE, Peyton BM, Gerlach R, "An efficient and scalable extraction and quantification method for algal derived biofuel," *J Microbiol Methods*. 2013;94(3):235–244.
 2013-025

Manner S, Skogman M, **Goeres D**, Vuorela P, Fallarero A*, "Systematic exploration of natural and synthetic flavonoids for the inhibition of *Staphylococcus aureus* biofilms," *Int J Mol Sci*. 2013;14(10):19434–19451.
 2013-037

Martinez-Gutierrez F*, Boegli L, Agostinho A, Sánchez EM, Bach H, Ruiz F, **James G**, "Anti-biofilm activity of silver nanoparticles against different microorganisms," *Biofouling*. 2013;29(6):651–60.
 2013-050

Mitchell AC, Lafrenière MJ, Skidmore ML, Boyd ES, "Influence of bedrock mineral composition on microbial diversity in a subglacial environment," *Geology*. August 2013;41:855–858.
 2013-056

Mitchell AC, Phillips A, Schultz L, Parks S, Spangler L, **Cunningham AB, Gerlach R**, "Microbial CaCO₃ mineral formation and stability in an experimentally simulated high pressure saline aquifer with supercritical CO₂," *Int J Greenhouse Gas Control*. 2013;15:86–96.
 2013-019

Momeni B, **Brileya KA, Fields MW**, Shou W, "Strong inter-population cooperation leads to partner intermixing in microbial communities," *Elife*. 2013;22(2):e00230.
 2013-047

Phillips AJ, Gerlach R, Lauchnor E, Mitchell AC, Cunningham AB, Spangler L, "Engineered applications of ureolytic biomineralization: A review," *Biofouling*. 2013;29(6):715–733.
 2013-021

Pines RM, Tomasino SF[†], Cottrill MP, Hamilton GC, **Parker AE**, "Procedural revision to the AOAC germicidal spray products as disinfectants test method: Establishment of minimum and maximum log density values for test microbes on inoculated carriers," *J AOAC International*. 2013;96(3):567–572.
 2013-020

Reeves BD, Young M, Grieco PA, **Suci P**, "Aggregatibacter actinomycetemcomitans biofilm killing by a targeted ciprofloxacin prodrug," *Biofouling*. Sep 2013;29(8):1005–1014.
 2013-057

Ryder M, **James G, deLancey Pulcini E, Parker A**, "An in vitro comparison of intraluminal biofilm bacteria transfer of three peripheral intravenous valved blood control catheters," *AJIC: American J Infection Control*. 2013;41(6) Supplement:S127–S128.
 2013-051

Skorupa DJ, Reeb V, Castenholz RW, Bhattacharya D, McDermott TR, "Cyanidiales diversity in Yellowstone National Park," *Lett App Microbiol*. 2013;57(5):459–466.
 2013-035

Smith H, Akiyama T, Foreman C, Franklin M, Woyke T, Teshima H, Davenport K, Daligault H, Erkkila T, Goodwin L, Gu W, Xu Y, Chain P, "Draft genome sequence and description of *Janthinobacterium* sp. strain CG3, a psychrotolerant Antarctic supraglacial stream bacterium," *Genome Announc.* 2013;1(6):1–2. 2013-040

Valenzuela J, Carlson RP, Gerlach R, Cooksey K, **Peyton BM,** Bothner B, **Fields MW,** "Nutrient resupplementation arrests bio-oil accumulation in *Phaeodactylum tricornutum*," *Appl Microbiol Biotechnol.* 2013;97(15):7049–7059. 2013-022

Yang X, Scheibe TD, Richmond MC, Perkins WA, **Vogt SJ, Codd SL, Seymour JD,** McKinley MI, "Direct numerical simulation of pore-scale flow in a bead pack: Comparison with magnetic resonance imaging observations," *Adv Water Res.* 2013;54:228–241. 2013-049

Zhang T, Pabst B, Klapper I, Stewart PS, "General theory for integrated analysis of growth, gene, and protein expression in biofilms," *PLoS ONE.* 2013;8:12. e83626. 2013-046

Zhao G, Usui ML, Lippman SI, **James GA, Stewart PS,** Fleckman P, Olerud JE, "Biofilms and inflammation in chronic wounds," *Adv Wound Care (New Rochelle).* 2013;2(7):389–399. 2013-052

Ziganshin AM*, **Gerlach R,** "Pathways of 2,4,6-trinitrotoluene transformation by aerobic yeasts," In Singh, SN (Ed): Biological Remediation of Explosive Residues, Springer International Publishing, Switzerland. 2013;14:301-311. 2013-027

2014 Publications

Bernstein HC, Kesaano M, Moll K, Smith T, **Gerlach R, Carlson RP,** Miller CD, **Peyton BM,** Cooksey KE, **Gardner RD,** Sims RC, "Direct measurement and characterization of active photosynthesis zones inside wastewater remediating and biofuel producing microalgal biofilms," *Bioresource Technology.* March 2014;156:206–215. 2014-001

Fox C, **Parker A,** "Convergence in variance of Chebyshev accelerated Gibbs samplers," *SIAM J Sci Comput.* 2014;36(1): A124–A147. 2014-002

Khan M[#], Danielsen S, Johansen K, **Lorenz L, Nelson S, Camper A,** "Enzymatic cleaning of biofouled thin-film composite reverse osmosis (RO) membrane operated in a biofilm membrane reactor," *Biofouling.* 2014;30(2):153–67. 2014-006

Mallette NM, Pankratz E, Parker AE, Strobel GA, Busse SC, **Carlson RP, Peyton BM,** "Evaluation of cellulose as a substrate for hydrocarbon fuel production by *Ascooryne sarcoides* (NRRL 50072)," *J Sus Bioenergy Systems.* March 2014;4(1):33–49. 2014-009

May R, Hoffman M, Sogo M, **Parker A,** O'Toole G, Brennan A, Reddy S, "Micro-patterned surfaces reduce bacterial colonization and biofilm formation in vitro: Potential for enhancing endotracheal tube designs," *Clin Transla Med.* April 2014; 3:8. 2014-010

Mburu N, Rousseau DP, **Stein O,** Lens PN, "Simulation of batch-operated experimental wetland mesocosms in AQUASIM biofilm reactor compartment," *J Environ Manage.* Feb 2014; 134:100–108. 2014-003

Parker A, Hamilton M, Tomasino S[†], "A statistical model for assessing performance standards for quantitative and semi-quantitative disinfectant test methods," *JAOAC International.* 2014;97(1):58–67. 2014-004

Reardon CL, Magnuson TS[#], Boyd ES, Leavitt WD, Reed DW, **Geesey GG,** "Hydrogenase activity of mineral-associated and suspended populations of *Desulfovibrio desulfuricans* Essex 6," *Microb Ecol.* Feb 2014;67(2):318–326. 2014-008

Stewart P, "Biophysics of biofilm infection," *Pathogens and Disease.* 2014;70:212–218. 2014-007

Tomasino S[†], **Parker A, Hamilton M,** "Use of statistical modeling to reassess the performance standard for the AOAC use-dilution methods (955.15 and 964.02)," *JAOAC International.* 2014;97(1):68–77. 2014-005

[†] Industrial or Federal Agency co-author

* Previous Visiting Researcher

[#] Previous Staff/Faculty

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RESEARCH:
 PRESENTATIONS
 June 2013–May 2014

Al Parker, CBE statistician, as invited speaker presented “Using polynomials and matrix splittings to sample from large Gaussians,” Massachusetts Institute of Technology (MIT), Cambridge, MA, June 4, 2013.

Benjamin Jackson, PhD student, mathematics, presented “Biomining using biofilms: Estimating kinetic parameters using a simple flow channel model,” Society for Mathematical Biology 2013 Annual Meeting, Tempe, AZ, June 10–13, 2013.

Heidi Smith, PhD student, land resources & environmental sciences, presented the poster “Single-cell analysis of microbial synthesis and transformation of dissolved organic matter in glacial environments,” Federation of European Microbiological Societies (FEMS), 2013 5th Congress of European Microbiologists, Leipzig, Germany, July 21–25, 2013. Co-authors: Foreman C, Foster R, McKnight D.

Al Parker, CBE statistician, as invited speaker presented the following research at International workshop on Statistical and Computational Methods for Inverse Problems Arising in (O, P or S) Differential Equations, Centro de Investigacion en Matematicas (CIMAT), Guanajuato, Mexico, August 2, 2013:

“Using polynomials and matrix splittings to sample from large Gaussians.”

“Accelerating samplers from high dimensional distributions.”

Chiachi Hwang, CBE industrial research scientist, visited National Center for Genome Resources (NCGR) in Santa Fe, NM, August 8, 2013. Hwang toured the facilities and learned about different next generation DNA sequencing methods.

The following CBE PhD students presented research at the Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA) Annual Meeting and Retreat in Berkeley, California, August 8–9, 2013:

Anna Zelaya, microbiology, as an invited speaker presented “Particle campaign: Lab and field experiments.”

Greg Krantz, microbiology, presented the poster “Distribution and function of Von Willebrand Type A domain containing proteins in *Desulfovibrio vulgaris* Hildenborough.”

Laura Camilleri, microbiology, presented the poster “Investigation into the metabolic dynamics of a syntrophic biofilm.”

Chiachi Hwang, CBE industrial research scientist, as invited speaker presented “Application of molecular ecology for industrial purposes,” Society for Industrial Microbiology (SIMB), San Diego, CA, August 11–14, 2013.

Joe Seymour, professor, chemical and biological engineering, as an invited speaker presented “Mass transport in gels: Water mass transport in alginate hydrogels studied by magnetic resonance measurements of dynamics,” International Symposium on the Properties of Water XII, Fiskebäckskil, Sweden, August 20–23, 2013.

Sarah Codd, professor, mechanical and industrial engineering, as an invited speaker presented “Educational Lecture: Flow and diffusion,” International Conference on Magnetic Resonance Microscopy, Cambridge University, Cambridge, UK, August 25–29, 2013.

Eric Dietrich, CBE research associate, was invited to explain the collaborative project between the Crow Environmental Health Steering Committee, Amway, and MSU Engineers Without Borders chapter at MSU’s University Council Meeting, September 4, 2013. The project explores biofilm filtration units as a means to provide improved drinking water to rural homeowners on the Crow Reservation. Dietrich was invited as part of MSU’s Year of Engaged Leadership, which highlights the university’s events and activities that develop the leadership skills of students, faculty, staff, and community members.

Phil Stewart, CBE director, as the invited opening lecturer presented “Engineering science of biofilm control,” EuroBiofilms 2013, Ghent, Belgium, September 7–13, 2013.

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CBE faculty member **Brent Peyton** presented an overview of the CBE and its biofilm research to the VTT Technical Research Centre of Finland September 11, 2013. VTT conducts research on industrial biofilms and they are interested in student and faculty collaborations with the CBE.

Juliana D'Andrilli, postdoctoral research associate, presented her research "WAIS Divide Ice Core: A microbially derived reservoir of organic carbon," at the following conferences in September:

- 5th International Conference on Polar & Alpine Microbiology, Big Sky, MT, Sept. 8–12, 2013.
- WAIS Divide Meeting, San Diego, CA, September 23–25, 2013.

Ross Carlson, associate professor, chemical and biological engineering, and **Kris Hunt**, PhD student, chemical and biological engineering, presented research at Metabolic Pathway Analysis 2013 at Corpus Christi College in Oxford, England, September 16–20, 2013:

Carlson as an invited speaker presented "In silico and in vitro analysis of interacting microbial consortia."

Hunt presented the poster "Toward multiscale metabolic network analysis of an anaerobic microbial community."

Phil Stewart, CBE director, as an invited speaker presented "Mechanics of biofilm detachment," 5th Symposium on Frontiers in Biomechanics: Mechanics in Infection, Seattle, WA, September 25, 2013.

The following CBE scientists and students participated in the 7th Annual Algae Biomass Summit September 30–October 3, 2013 in Orlando, Florida:

Robert Gardner (postdoctoral research associate) and **Egan Lohman** (PhD candidate in chemical and biological engineering) were co-chairs of the poster exhibit and award presentations.

Karen Moll, PhD student, microbiology, presented the poster "454 Pyrosequencing: A novel approach for determination of unialgal strains."

Robert Gardner, as an invited speaker presented "Characterization of active photosynthesis zones inside biofuel producing and waste-water remediating algal biofilms."

Egan Lohman, as an invited speaker presented "Lipid profiling, carbon partitioning, and inorganic carbon optimization to enhance growth and lipid accumulation in green microalgae." Lohman also presented the poster "Lipid profiling of *Chlamydomonas reinhardtii* grown under three different inorganic carbon regimes."

Tianyu Zhang, assistant professor, mathematical sciences, presented the following research at Temple University in Philadelphia, PA:

"Critical occlusion via biofilm induced calcite precipitation in porous media," Applied Math Seminar, Temple's Department of Mathematics, October 9, 2013.

"General theory for integrated analysis of growth, gene, and protein expression in biofilms," Special Session on Mathematical Biology, Fall Eastern Sectional Meeting of the American Mathematical Society (AMS), October 12–13, 2013.

Chris Allen, PhD student, civil engineering, presented the following research at the WETPOL 2013 5th International Symposium on Wetland Pollutant Dynamics and Control, Nantes, France, October 11–20, 2013:

Breakout session: "Season and plant species influence on the removal of ammonium and nitrate from carbon limited wastewater"

Poster: "Implementation of a two-stage vertical flow treatment wetlands at a ski area"

Co-authors: Stein OR, Davis KJ, Moss JJ, Burr MD, Jones WL.

Darla Goeres, assistant research professor, chemical & biological engineering, attended the ASTM subcommittee E35.15 meeting in Jacksonville, Florida October 23–25, 2013. Goeres was there to discuss various microbial methods under development. ASTM subcommittee E35.15 studies antimicrobial agents and ASTM main committee E35 studies pesticides, antimicrobials, and alternative control agents.

The following CBE master's students presented posters on their research at the National Council on Family Relations annual conference, San Antonio, TX, November 6–9, 2013.

Yanet Eudave, health and human development presented "Coping and depression among frontier migrants: Gender and status matter."

Lidice Tobar Quezada, health and human development, presented "Status, perceived health, and wellbeing among migrants in a new settlement."

Robin Gerlach, associate professor, chemical and biological engineering, presented a poster during the session "Exploring Environmental Impacts of Hydraulic Fracturing in the Subsurface II," at the American Geophysical Union's 46th annual fall meeting and workshops, San Francisco, California, December 8–12, 2013.

The following CBE faculty presented research at the 12th International Bologna Conference on Magnetic Resonance in Porous Media (MRPM12), Wellington, New Zealand, February 9–13, 2014:

Sarah Codd, professor, industrial and mechanical engineering, “Hydrodynamics mediates structure during abiotic growth of a calcite precipitate barrier: A combined MRI/CT study.”

Jennifer Brown, assistant professor, chemical and biological engineering, “Non-Newtonian fluid dynamics in porous media.”

Brent Peyton, professor, chemical and biological engineering, as featured speaker presented “Unknown Yellowstone: Microbial discoveries and biotech applications,” Café Scientifique, Bozeman, MT, February 20, 2014.

The following CBE faculty and researchers participated at the Society for Mining, Metallurgy, and Exploration (SME) 2014 annual meeting, Salt Lake City, UT, February 23–26, 2014:

Lisa Kirk, research scientist, co-chaired the environmental technical program session, “Microbes in mine waste.”

Dana Skorupa, postdoctoral research associate, presented “Spatial analysis of a microbial community in mined waste rock: Activities and signatures.”

Joe Seymour, professor, chemical and biological engineering, as featured speaker presented “Chaos and Randomness: The global climate, technological development and a career in science,” MSU Provost’s Distinguished Lecturer Series, Bozeman, MT, March 4, 2014.

Phil Stewart, CBE director, as an invited seminar speaker presented “Analysis of growth and gene expression in biofilms,” University of Washington, Seattle, Washington, March 4, 2014.

Michelle Tigges, CBE graduate student in chemistry & biochemistry, presented the poster “Understanding the microbially mediated transformation of dissolved organic carbon: An “omics” approach,” 247th ACS National Meeting and Exposition Dallas, Texas, March 16–20, 2014.

Al Parker, CBE statistician, as invited speaker presented “Using polynomials to sample from large Gaussians used to model 3-D confocal microscope images of biofilms,” Society for Industrial and Applied Mathematics (SIAM) Conference on Uncertainty Quantification, Savannah, GA, April 2, 2014.

Emily Bermel, undergraduate in chemical and biological engineering, presented, “The effects of UV light on biofilm formation and pigment production of two Antarctic *Janthinobacterium sp.* strains CG23_2 and CG3,” at an oral presentation session at the National Conference on Undergraduate Research (NCUR) in Lexington, Kentucky, April 3–5, 2014.

Mari Eggers, CBE postdoctoral researcher, and **John Doyle**, CBE project manager, as invited speakers presented “Community-based cumulative risk assessment of well water contamination: A tribal environmental health disparity,” Montana INBRE Network Research and Training Symposium, Bozeman, MT, April 14, 2014.

Phil Stewart, CBE director, as an invited speaker presented “Analysis of growth and gene expression in biofilms,” at the following universities:

Departments of Biology and Mathematics (joint seminar), Temple University, Philadelphia, PA, March 31, 2014;

Depts. of Chemistry and Chemical Engineering (joint seminar), Stanford University, Stanford, CA, April 14, 2014;

Dept. of Microbiology and Environmental Toxicology, Univ. of California Santa Cruz, Santa Cruz, CA, April 15, 2014.

Additionally, **Stewart** presented “Biofilms and their control,” at The Clorox Company, Pleasanton, CA, April 16, 2014.

CBE faculty and researchers presented the following research at Biofilm 6—International Conference on Microbial Biofilms in Vienna, Austria, May 11–13, 2014:

Sara Altenburg, research lab manager, presented the poster, “Biofilm growth and particle size relationships.”

Matthew Fields, associate professor in microbiology, presented the poster, “Biofilm growth mode optimizes carrying capacity in cooperative resource sharing via product inhibition syntrophy.”

Darla Goeres, assistant research professor in chemical and biological engineering, presented the poster, “Validation of standard methods for growing and efficacy testing biofilms.”

Betsey Pitts, research scientist and microscope facilities manager, presented the poster, “Time-lapse confocal microscopy of gel-entrapped bacteria as models of infection.”

Phil Stewart, CBE director, as invited speaker presented, “Reaction-diffusion theory applied to microbial biofilms associated with chronic infections.”

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CBE faculty, researchers, and presented the following research at the Joint Aquatic Sciences Meeting in Portland, Oregon, May 18–23, 2014.

Juliana D’Andrilli, postdoctoral research associate, presenting at an oral concurrent session, “Characterization of IHSS Pony Lake fulvic acid DOM by Fourier transform ion cyclotron resonance mass spectrometry and fluorescence spectroscopy.”

Christine Foreman, associate professor in chemical and biological engineering, presenting at an oral concurrent session, “West Antarctic Ice Sheet (WAIS) Divide Ice Core: A microbially derived reservoir of glacial organic matter.”

Amber Schmit, undergraduate in chemical and biological engineering, presented the poster “Microbial diversity and ecophysiology of cryoconite granules from the Dry Valleys, Antarctica.”

Heidi Smith, PhD candidate in land resources and environmental sciences, presented at an oral concurrent session, “Understanding microbially mediated transformations of dissolved organic matter in a supraglacial stream: A systems approach.”

Mari Eggers, CBE postdoctoral researcher, as an invited speaker presented “The Crow water quality collaboration, a community-based participatory research project, finds elevated uranium in wells on the Crow reservation in south central Montana,” Geological Society of America Rocky Mountain/Cordilleran Annual Meeting, Bozeman, MT May 20, 2014.

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RESEARCH: NEWS HIGHLIGHTS

CBE faculty receive NIH R01 award

CBE director **Phil Stewart** and CBE faculty member **Joe Seymour**, professor in chemical and biological engineering, were awarded an NIH R01 grant to investigate and mathematically model the distribution of oxygen in biofilm infections. The local availability of oxygen is a key parameter in determining the outcome of the battle between bacterial biofilm and the host innate defenses. The team will use innovative NMR-based techniques for non-invasive measurement of oxygen concentrations in biofilms and build new mathematical models that integrate bacterial and host phenomena. Stewart and Seymour will be collaborating with former CBE faculty member **Isaac Klapper**, professor in mathematics, who is now at Temple University in Philadelphia, Pennsylvania.

The NIH R01 grant is the original and historically oldest grant mechanism used by NIH. The R01 provides support for health-related research and development based on the mission of the NIH, which is to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.

Development of innovative methods for biofuels production continues

CBE faculty members **Rich Macur** and **Brent Peyton**, along with Mark Kozubal of Sustainable Bioproducts LLC, received funding from the Montana Board of Research and Commercialization Technology to continue development of innovative methods for biofuels production using extremophilic fungi. Earlier in 2013, the group received an NSF-Small Business Innovation award of \$150,000 for the project "Direct conversion of lignocellulosic feedstocks to lipids and high-value products using a proprietary microbial process." The research will continue to investigate a simple, novel, and economical process for converting lignocellulosic feedstocks, such as wheat straw, to lipids and ethanol using a minimal number of steps compared to current technologies.

The innovative process is enabled by the use of a novel microorganism isolated from Yellowstone National Park, which grows at extreme acidic conditions and is capable of efficiently degrading cellulose, lignin, and hemicellulose. Macur is a research assistant professor and Peyton is a professor in MSU's Department of Chemical and Biological Engineering.

MSU algal biofuel research contributes to larger federal study

CBE faculty members were featured by MSU News for their research into the production of oil-producing algae, as well as the feasibility of commercial-scale biofuel production based on microbes discovered in Yellowstone National Park.

The research is one of many algal biofuel research projects at MSU in the labs of CBE faculty members **Robin Gerlach**, associate professor in chemical and biological engineering, **Matthew Fields**, associate professor in microbiology, and **Brent Peyton**, professor in chemical and biological engineering.

The project, which also includes the University of North Carolina and the University of Toledo, is part of a federal effort to tackle some of the fundamental problems in developing enough biofuels to provide up to 50 percent of the nation's transportation fuel. The U.S. Department of Energy is funding the project.

These MSU scientists are taking the groundbreaking research they have already conducted on algal biofuels and applying it to the bigger question of whether this promising technology can be a major source of sustainable energy.

Read the full story at MSU News: ["MSU research into algal biofuels keys larger study"](#)

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MSU-CBE team report breakthrough in microbe survival strategy

A team of Center for Biofilm Engineering researchers reported a breakthrough achievement in proving a long-suspected microbial survival strategy in the November 5, 2013 issue of *Scientific Reports*, an online journal affiliated with the international journal *Nature*.

The research proved that methanogens—microbes that consume hydrogen and produce methane—are capable of exercising a competitive edge by racing toward hydrogen gas. Methanogens live without oxygen and play a community role in anoxic environments including the human mouth and gut, where positive correlations have been made between their presence and the incidences of periodontitis and colon cancer. Because methanogens are active in a wide range of natural and engineered processes, the research has implications in numerous applications.

The article “Taxis toward hydrogen gas by *Methanococcus maripaludis*,” was authored by CBE faculty and students—**Kristen Brileya**, PhD graduate in microbiology, **James Connolly**, PhD candidate in chemical and biological engineering, **Carey Downey**, undergraduate in microbiology, **Robin Gerlach**, associate professor in chemical and biological engineering, and **Matthew Fields**, associate professor in microbiology.

Read the publication online at nature.com: [“Taxis toward hydrogen gas by *Methanococcus maripaludis*”](#)

Read the related story by *MSU News*: [“MSU team overcomes challenges, proves that microbes swim to hydrogen gas”](#)

Citation: Brileya KA, Connolly JM, Downey C, Gerlach R, Fields MW, “Taxis toward hydrogen gas by *Methanococcus maripaludis*,” *Sci Rep*. 2013;3:3140.

Pathogens and Disease: Mini-review and cover

A mini-review by CBE director **Phil Stewart** in the FEMS journal *Pathogens and Disease* examines the little-discussed role of mechanical clearance in the tenacity of biofilm infections.

The inherently heterogeneous nature of biofilms explains the apparent contradiction that in vivo biofilms both persist in spite of, and are disseminated by, applied mechanical forces. There are also mechanical aspects to the ways that infectious biofilms evade leukocyte phagocytosis. New alternative therapies that reduce biofilm cohesion may hold promise in treating biofilm infections.

Stewart PS, “Biophysics of biofilm infection,” *Pathogens and Disease*. 2014;70:212–218. doi: 10.1111/2049-632X.12118.

<http://onlinelibrary.wiley.com/doi/10.1111/2049-632X.12118/abstract>

This special issue of *Pathogens and Disease*, titled *Biofilms III*, also features a cover illustration collaboratively created by Phil Stewart and **Peg Dirckx**, CBE communications director. The image represents a conceptual model of in vivo biofilm structures. Small microbial aggregates (e.g., 5 to 50 microns in size) are distributed in a gel-like matrix, which may be composed of host extracellular matrix material, dead neutrophils and released neutrophil DNA, and microbial extracellular polymeric substances (EPS).

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RESEARCH:
 CBE Affiliated Faculty and Their Specialties, 2013–2014

NAME	DEPARTMENT	SPECIALTY
Jennifer Brown	Chemical & Biological Engineering	Rheology and biofilm mechanics
Mark Burr	Land Resources & Environ Sciences	Microbial community analysis
Anne Camper	Civil Engineering	Biofilms in environmental systems
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic networks
Connie Chang	Chemical & Biological Engineering	Microfluidics
Sarah Codd	Mechanical & Industrial Engineering	Magnetic resonance imaging
Kevin Cook	Mechanical & Engineering Technology	Tool and machine design
Al Cunningham	Civil Engineering	Subsurface biotechnology and bioremediation
Jack Dockery	Mathematical Science	Mathematical models of biofilms
Matthew Fields	Microbiology	Physiology and ecology
Christine Foreman	Chemical & Biological Engineering	Microbial ecology in cold temperature environments
Michael Franklin	Microbiology	Molecular genetics, gene expression, alginate
Gill Geesey	Microbiology	Molecular and cellular interactions at interfaces
Robin Gerlach	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Darla Goeres	Chemical & Biological Engineering	Standardized biofilm methods
Marty Hamilton	Statistics	Applied biostatistical thinking
Jeff Heys	Chemical & Biological Engineering	Fluid-structure interactions
Garth James	Chemical & Biological Engineering	Medical biofilms
Erick Johnson	Mechanical & Industrial Engineering	Fluid mechanics
Isaac Klapper	Mathematical Science	Mathematical modeling
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
Richard Macur	Chemical & Biological Engineering	Biofuels, geochemistry, geomicrobiology
Aurélien Mazurie	Microbiology	Bioinformatics
Bruce McLeod	Electrical & Computer Engineering	Bioelectric effect
Andy Mitchell	Civil Engineering	Geomicrobiology
Al Parker	Statistics	Statistical models in biofilm systems
Brent Peyton	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Elinor Pulcini	Chemical & Biological Engineering	Medical Biofilms
Abbie Richards	Chemical & Biological Engineering	Environmental biotechnology
Rocky Ross	Computer Science	Web-based, active learning education
Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Otto Stein	Civil Engineering	Engineered waste remediation
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Sturman	Civil Engineering	Biofilms in waste remediation and industrial systems
James Wilking	Chemical & Biological Engineering	Physical and material biofilm properties
Tianyu Zhang	Mathematics	Mathematical modeling

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CBE Affiliated Faculty Awards & News

CBE faculty member named Regents Professor

The Montana University System (MUS) Board of Regents unanimously approved the appointment of **Dr. Anne Camper** to Regents Professor at their meeting in Bozeman on Thursday, November 21, 2013. Regents Professor is the system's top honor for faculty of distinction.

Dr. Camper is a professor of civil engineering at MSU-Bozeman and has been an exemplary researcher, faculty member, mentor and administrator at MSU for more than 40 years. She is a national expert in biofilm growth and control in drinking and industrial water systems. Dr. Camper has been instrumental in advancing the careers of almost 40 graduate students, and she has been actively involved in advancing Native American nations. A native of Montana, she is also a graduate of MSU and a wonderful example of how an education at the state's first land-grant university can change the world. Dr. Camper is currently serving as MSU's Interim Vice President of Research, Creativity and Technology Transfer.

When she is conferred on Thursday, Dr. Camper will be the first woman and first engineer to be appointed Regents Professor in the Montana University System. Dr. Camper's career accomplishments were recently featured by *MSU News*. Read the [full article](#)

Dr. Camper was also inducted into the 2013 Montana BioScience Alliance Hall of Fame. [Read more](#)

CBE faculty member honored by ASTM International

CBE faculty member Darla Goeres, assistant research professor in chemical and biological engineering, was recently honored by the American Society for Testing and Materials (ASTM International) for her contributions to the ASTM committee on pesticides, antimicrobials, and alternative control agents.

Goeres was awarded ASTM's Chip Collins Award which was established in 2010 to recognize and honor individuals who have made exemplary technical, practical, or administrative contributions to Committee E35 over a continuous period of time. Goeres was honored for her innovation and contributions to the development of E35 biofilm standards. She has been a member of ASTM International since 2000 and currently serves as E35 recording secretary.

ASTM International is one of the largest international standards development and delivery systems in the world. ASTM International meets the World Trade Organization (WTO) principles for the development of international standards: coherence, consensus, development dimension, effectiveness, impartiality, openness, relevance and transparency. ASTM standards are accepted and used in research and development, product testing, quality systems and commercial transactions.

Formed in 1973, ASTM Committee E35 on Pesticides is responsible for developing standardized test methods and recommending practices relating to efficacy, safety, quality, and impact in appropriate environments of pesticides, antiseptic and antimicrobial agents, biological agents, devices, and equipment. The committee has a membership of about 230 people from industry, academia, and government. It currently has five technical subcommittees that have jurisdiction of over 80 standards.

Earlier this year, Goeres was awarded a Fulbright Scholarship, the US government's flagship program in international educational exchange. Goeres will head to Finland in February 2014 for a six-month exchange working in a pharmacy sciences laboratory at Åbo Akademi University in Turku, Finland. As a Fulbright scholar, Goeres' research will be identifying and eliminating biofilms as they pertain to pharmaceuticals.

Read more about Goeres and her ASTM award at MSU News Service: ["MSU professor honored for work with international standards group"](#)

Read about Goeres' Fulbright scholarship at MSU News Service: ["Engineering professor wins Fulbright Scholarship to Finland"](#)

MSU 2014 Faculty Awards and Recognition

CBE faculty member **Brent Peyton**, professor, chemical and biological engineering, was among the winners of the top Montana State University 2014 faculty awards announced Tuesday, January 7th at the 4th annual MSU Spring Convocation on the MSU Campus. The annual awards honor achievement in faculty research, teaching, outreach, and creative projects.

Peyton received the Vice President for Research's Meritorious Technology/Science Award. It carries a \$2,500 honorarium and recognizes MSU faculty members who have made at least one significant technological or scientific contribution that could be transferred or already has been transferred to the private sector.

Peyton researches chemical and biological processes that cover a range of fields with significant potential impacts on industrial and environment processes. One of them transforms selenium into an insoluble form, improving mining operations in British Columbia and significantly reducing downstream pollution. Another uses baking soda to enhance biodiesel production from algae. That technology is currently being licensed to a company that has committed more than \$300,000 in the last two years to advance its use in a variety of commercial uses. A third technology, applied by the Center for Biofilm Engineering, employs a bacterial species that thrives in high salt environments.

To read more about Peyton's research and related news go to: <http://www.biofilm.montana.edu/people/faculty/peyton-brent.html>

To read about all MSU faculty award recipients go to:

<http://www.montana.edu/news/12351/msu-honors-top-faculty-and-staff>

CBE faculty member part of MSU's program to enhance science education on Montana's Crow reservation

CBE faculty member **Christine Foreman**, associate professor, chemical and biological engineering, was part of a team of MSU polar scientists, graduate students, and outreach personnel that collaborated with students and teachers on the Crow Reservation in South Central Montana. The partnership provided science enrichment activities for 10 fourth-grade classrooms in three different schools on or near the reservation, and professional development for their teachers. The Crow Education Partnership includes monthly hands-on science activities, field experiences and video conferencing technology to increase students' excitement about science.

New MSU faculty join CBE

The CBE welcomed two new faculty members in November 2013: **Jim Wilking**, assistant professor, and **Connie Chang**, assistant research professor, both in MSU's Department of Chemical and Biological Engineering. Wilking and Chang come to MSU from postdoctoral positions in the David Weitz laboratory at the School of Engineering and Applied Sciences, Harvard University.

Wilking's research specialties include physical and material biofilm properties, biophysics, and colloidal and nanomaterials synthesis with specific applications in pharmaceutical formulations. Chang's research interest is in droplet-based microfluidics, which is the creation and manipulation of tiny drops of fluid that range from picoliters to nanoliters in volume. These drops are created at rates of thousands per second and can be used in applications such as biomaterials, ultra high-throughput screening of bacterial biofilm formation, single cell genomics, and directed evolution in biology.

Both new faculty members have offices and labs in the CBE.

CBE 2013 Outstanding Researcher Award

Kerry Williamson, research assistant, received the CBE Outstanding Researcher Award. Williamson was recognized for her commitment to research excellence, work ethic, and collaborative skills. Williamson is selfless with her time, training investigators on protocols for RNA extraction, transcriptomics methods, and data analyses.

The outstanding researcher award is open to any CBE researcher or faculty member. The criteria for selection for the Outstanding Researcher Award are research quality, teamwork, willingness to mentor others and willingness to contribute to CBE outreach efforts through the Montana Biofilm Meetings and workshops.

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EDUCATION:

Undergraduate Students: Summer 2013, Fall 2013, Spring 2014

*Graduating ‡ Native American †Post-baccalaureate

1. Avera, Erika (James)	F	Cell Bio & Neurosci	Grass Valley, CA
2. Bender, Andrew (Codd)	M	Mech & Indust Eng	Moscow, ID
3. Bermel, Emily (Foreman)	F	Chem & Bio Eng (McNair Scholar)	Big Fork, MT
4. Berninghaus, Ashley (Gerlach)	F	Chem & Bio Eng (USP)	Poulsbo, WA
5. *Bleem, Alissa (Carlson)	F	Chem & Bio Eng (USP/Hughes/Goldwater)	Fort Collins, CO
6. *Bodle, Kylie (Walker)	F	Chem & Bio Eng	Camano Island, WA
7. Boucher, Logan (Macur)	M	Chem & Bio Eng	Laurel, MT
8. Brindle, Joseph (Macur)	M	Chem & Bio Eng (USP)	Castle Rock, CO
9. Bronec, Hallie (Franklin)	F	Microbiology & Immunology	Geraldine, MT
10. Click, Randall (Gerlach)	M	Chem & Bio Eng (USP)	Lone Tree, CO
11. Dankworth, Piper (Fields)	F	Microbiology & Immunology	Carlsbad, CA
12. *‡Davis, Steven (Carlson)	M	Chem & Bio Eng (McNair Scholar)	Billings, MT
13. †Doig, Lakotah (Fields)	F	Microbiology & Immunology	Gypsum, CO
14. *Durch, Amanda (James)	F	Chem & Bio Eng (USP)	Newell, SD
15. Eickelberg, Makayla (James)	F	Chem & Bio Eng	Belgrade, MT
16. Everly, Dylan (Macur)	M	Chem & Bio Eng	Butte, MT
17. *Fritz, Blaine (Walker)	M	Chem/Biochem (USP)	Billings, MT
18. *Gamero, Edgar (Macur)	M	Chem & Bio Eng	Colombia
19. *Goveia (Orr), Danielle (Walker)	F	Microbiology & Immunology	Bozeman, MT
20. Gray, James (Carlson)	M	Chem & Bio Eng	Helena, MT
21. Haug, Shelley (Seymour/Codd)	F	Chem & Bio Eng	Livingston, MT
22. Hobbs, Trace (Gerlach)	M	Chemistry (Hughes)	Kalispell, MT
23. *Kennedy, Jordan (Brown)	F	Chem & Bio Eng	Cutbank, MT
24. Lamm, Kaitlyn (Carlson)	F	Chem & Bio Eng (Hughes)	Bigfork, MT
25. Lewis, Julia (Pulcini)	F	Microbiology & Immunology	Tiffin, OH
26. Maier, Bailey (Gerlach)	F	Chem & Bio Eng	Boise, ID
27. McDonald, Daniel (Peyton)	M	Chem & Bio Eng	Tumwater, WA
28. Meagher, Michelle (Peyton/Skorupa)	F	Chem & Bio Eng	Idaho Falls, ID
29. Miller, Isaac (Fields)	M	Ecology	Helena, MT
30. *Murphy, Nathan (Peyton)	M	Chem & Bio Eng (USP)	Hardin, MT
31. *Newhouse, Hannah (Peyton)	F	Chem & Bio Eng (USP)	Pocatello, ID
32. Oeschger, Taylor (Seymour)	F	Chem & Bio Eng	Sacramento, CA
33. *Pabst, Breanna (Stewart)	F	Chem & Bio Eng	Great Falls, MT
34. *Pedersen, Todd (Peyton)	M	Chem & Bio Eng (USP)	Poulsbo, WA
35. Rao, Varsha (Codd/Seymour)	F	Chem & Bio Eng	Canada
36. Rehbein, Steven (Fields)	M	Chem/Biochem	Missoula, MT
37. Richards, Amanda (Franklin)	F	Microbiology & Immunology	Salt Lake City, UT
38. Santana, Edrey (Carlson)	M	Chem & Bio Eng	Brazil
39. *Schmit, Amber (Foreman)	F	Chem & Bio Eng (USP)	Sheridan, WY
40. Sherick, Matthew (Codd/Seymour)	M	Chem & Bio Eng (INBRE, Goldwater)	Hudson, WI
41. Solomon, Benjamin (Peyton)	M	Chem & Bio Eng	Lone Tree, CO
42. *Stabio, Katie (Fields)	F	Microbiology & Immunology	Billings, MT
43. Steinbeisser, Sadie (Fields)	F	Microbiology & Immunology	Sidney, MT
44. Summers, Jennifer (Walker)	F	Chem & Bio Eng	Conowingo, MD
45. Swain, Kyle (Walker)	M	Chem & Bio Eng	Burien, WA
46. TeSelle, Jake (Wilking)	M	Mech & Indust Eng	Bozeman, MT
47. *Morris Topp, Dayla (Gerlach)	F	Chem & Bio Eng (USP)	Stockett, MT
48. Troyer, Eric (Gerlach)	M	Chem & Bio Eng	Hardin, MT
49. Warthen, Katherine (Gerlach)	F	Chem & Bio Eng (USP)	Laurel, MT
50. Westerhoff, Lilly (Macur/Richards)	F	Chem & Bio Eng	Worden, MT
51. †Whitney, Erika (Fields)	F	Microbiology & Immunology	Issaquah, WA
52. Yanardag, Sila (Franklin)	F	Chem & Bio Eng	Turkey
53. Ying Wee, Shu (Foreman)	F	Chem & Bio Eng	Malaysia
54. *Zambare, Neerja (Lauchnor)	F	Chem & Bio Eng	India
55. Zhu, Sophie (Fields)	F	Microbiology & Immunology	Bozeman, MT

Undergraduates Summary: 2013–2014

Department (Program)	Male	Female	Total
Cell Biology & Neuroscience		1F	1
Chemical & Biological Engineering	15M	23F	38
Chemistry & Biochemistry	3M		3
Ecology	1M		1
Mechanical & Industrial Engineering	2M		2
Microbiology & Immunology		10F	10
Totals	21 M	34 F	55

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EDUCATION:

Graduate Students: Summer 2013, Fall 2013, Spring 2014

‡ Native American *Received degree

Masters Candidates

1. *Blaskovich, John (Gerlach)	M	Chem & Bio Eng	Butte, MT
2. *Davis, Katie (Cunningham)	F	Civil Engineering	Green Creek, NC
3. *Eudave, Yanet (Camper)	F	Health & Human Dev	Phoenix, AZ
4. Halverson, Luke (Gerlach)	M	Chem & Bio Eng	Lansing, IA
5. Hodgskiss, Logan (Cunningham/Fields)	M	Civil Engineering	Choteau, MT
6. Markwardt, Stephen (Camper)	M	Civil Engineering	Ely, MN
7. Moss, Jefferson (Stein)	M	Civil Engineering	Colorado Springs, CO
8. *Olson, Andrew (Camper)	M	Civil Engineering	Hill City, ID
9. Qzay, Burcu (Peyton)	M	Chem & Bio Eng	Istanbul, Turkey
10. ‡Realbird, Sloane (Camper)	F	Health & Human Dev	Hardin, MT
11. *Sanderlin, Alexis (Codd/Seymour)	F	Chem & Bio Eng	Atlanta, GA
12. Schaefer, Robert (Chang)	M	Chem & Bio Eng	Bothell, WA
13. Schoen, Heidi (Peyton)	F	Chem & Bio Eng	Geneva, IL
14. Spengler, Justin (Carlson/Camper)	M	Chem & Bio Eng	Jacksonville, FL
15. *Taffs, Reed (Carlson)	M	Chem & Bio Eng	Helena, MT
16. *Tobar-Quezada, Lidice (Camper)	F	Health & Human Dev	Livingston, MT
17. *‡Tucker, Nathaniel (Camper)	M	Health & Human Dev	Lodgegrass, MT
18. *Weeks, Lisa (Peyton)	F	Chem & Bio Eng	Fort Fairfield, ME

PhD Candidates

1. Akiyama, Tatsuya (Franklin)	M	Microbiology	Japan
2. Allen, Chris (Stein)	M	Civil Engineering	Eldorado Hills, CA
3. Corredor Arias, Luisa (Fields)	F	Micro & Immun (Fulbright)	Colombia
4. Barnhart, Elliott (Fields)	M	Micro & Immunology	Broadus, MT
5. Beck, Ashley (Carlson)	F	Micro & Immunology	Corning, IA
6. Bell, Tisza (Fields/Peyton)	F	Micro & Immunology	Littleton, CO
7. Burbank, Katherine (Peyton)	F	Chemistry	Bozeman, MT
8. Camilleri, Laura (Fields)	F	Micro & Immunology	Ukiah, CA
9. Connolly, James (Gerlach)	M	Chem & Bio Eng	Post Falls, ID
10. Davis, Katie (Gerlach)	F	Chem & Bio Eng	Green Creek, NC
11. *Eggers, Margaret (Camper)	F	Micro & Immunology	California
12. Serrano Figueroa, Luis (Richards)	M	Micro & Immunology	Puerto Rico
13. Franco, Lauren (Fields)	F	Micro & Immunology	Moorpark, CA
14. Hunt, Kristopher (Carlson)	M	Chem & Bio Eng	Thorp, WI
15. Jackson, Benjamin (Klapper)	M	Mathematics	Sheridan, OR
16. Jennings, Ryan (Carlson)	M	LRES	Lexington, SC
17. Kirkland, Catherine (Codd)	F	Civil Engineering	Bozeman, MT
18. Krantz, Gregory (Fields)	M	Micro & Immunology	Tinmouth, UT
19. ‡LaVeaux, Deb (Camper)	F	Health & Human Dev	Ronan, MT
20. *Lohman, Egan (Gerlach)	M	Chem & Bio Eng	Pine, CO
21. Mailhot, Sarah (James)	F	ChBE – Molec BioSci	Oak Forest, IL
22. *Malette, Natasha (Peyton)	F	Chem & Bio Eng	Fayetteville, AR
23. Moll, Karen (Peyton)	F	Micro & Immunology	Fairport, NY
24. *Phillips, Adie (Gerlach)	F	Chem & Bio Eng	Bozeman, MT
25. Plaggemeyer, Sara (Camper)	F	Micro & Immunology	Big Timber, MT
26. Rathore, Muneeb (Peyton)	M	Chem & Bio Eng (Fulbright)	Pakistan
27. Schweitzer, Hannah (Fields)	F	Micro & Immunology	Chester, MT
28. Severson, Grant (James)	M	Micro & Immunology	Claremore, OK
29. ‡Show, Jennifer (Camper)	F	Nursing	Harlem, MT
30. Sidar, Barkan (Wilking)	M	Chem & Bio Eng	Istanbul, Turkey
31. Simkins, Jeffrey (Stewart)	M	Chem & Bio Eng	The Netherlands
32. Smith, Heidi (Foreman)	F	LRES	Westford, VT
33. Tigges, Michelle (Foreman)	F	Chem & Biochem	Battle Lake, MN
34. VanKempfen-Fryling, Rachel (Camper)	F	Micro & Immunology	Grand Rapids, MI
35. White, Benjamin (Franklin/James)	M	Micro & Immunology	Grand Island, NE
36. Zambare, Neerja (Gerlach)	F	Chem & Bio Eng	India
37. Zelaya, Anna (Fields)	F	Micro & Immunology	Russellville, AR

EDUCATION:
 Graduate Students, 2013–2014

20: Chemical & Biological Engineering

MS: 9

- 6 M Blaskovich, John: MS, *Gerlach*
 Halverson, Luke: MS, *Gerlach*
 Qzay, Burcu: MS, *Peyton*
 Schaefer, Robert: MS, *Chang*
 Spengler, Justin: MS, *Carlson/Camper*
 Taffs, Reed: MS, *Carlson*
 3 F Sanderlin, Alexis: MS,
Codd/Seymour
 Schoen, Heidi: MS, *Peyton*
 Weeks, Lisa: MS, *Peyton*

PhD: 11

- 6 M Connolly, James: PhD, *Gerlach*
 Hunt, Kristopher: PhD, *Carlson*
 Lohman, Egan: PhD, *Gerlach*
 Rathore, Muneeb: PhD, *Peyton*
 Sidar, Barkan: PhD, *Wilking*
 Simkins, Jeffrey: PhD, *Stewart*
 5 F Davis, Katie: PhD, *Gerlach*
 Mailhiot, Sarah: PhD, *James*
 Mallette, Natasha: PhD, *Peyton*
 Phillips, Adie: PhD, *Gerlach*
 Zambare, Neerja: PhD, *Gerlach*

2: Chemistry & Biochemistry

PhD: 2

- 2 F Burbank, Katherine: PhD, *Peyton*
 Tigges, Michelle: PhD, *Foreman*

7: Civil / Environmental Engineering

MS: 5

- 4 M Hodgskiss, Logan: MS,
Cunningham/Fields
 Markwardt, Stephen: MS, *Camper*
 Moss, Jefferson: MS, *Stein*
 Olson, Andrew: MS, *Camper*
 1 F Davis, Katie: MS, *Cunningham*

PhD: 2

- 1 M Allen, Chris: PhD, *Stein*
 1 F Kirkland, Catherine: PhD, *Codd*

5: Health & Human Development

MS: 4

- 1 M Tucker, Nathaniel: MS, *Camper*
 3 F Eudave, Yanet: MS, *Camper*
 Realbird, Sloane: MS, *Camper*
 Tobar-Quezada, Lidice: MS, *Camper*

PhD: 1

- 1 F LaVeaux, Deb: PhD, *Camper*

2: Land Resources & Environmental Sciences

PhD: 2

- 1 M Jennings, Ryan: PhD, *Carlson*
 1 F Smith, Heidi: PhD, *Foreman*

1: Mathematical Sciences

PhD: 1

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

17: Microbiology

PhD: 17

- 6 M Akiyama, Tatsuya: PhD, *Franklin*
 Barnhart, Elliott: PhD, *Fields*
 Serrano Figueroa, Luis: PhD, *Richards*
 Krantz, Gregory: PhD, *Fields*
 Severson, Grant: PhD, *James*
 White, Benjamin: PhD, *Franklin/James*
 11 F Corredor Arias, Luisa: PhD, *Fields*
 Beck, Ashley: PhD, *Carlson*
 Bell, Tisza: PhD, *Fields/Peyton*
 Camilleri, Laura: PhD, *Fields*
 Eggers, Margaret: PhD, *Camper*
 Franco, Lauren: PhD, *Fields*
 Moll, Karen: PhD, *Peyton*
 Plaggemeyer, Sara: PhD, *Camper*
 Schweitzer, Hannah: PhD, *Fields*
 VanKempen-Fryling, Rachel: PhD,
Camper
 Zelaya, Anna: PhD, *Fields*

1: Nursing

PhD: 1

- 1 F Show, Jennifer: PhD, *Camper*

TOTALS

Total Grads: 55

Total MS: 18 11 M / 7 F
 Total PhD: 37 15 M / 22 F

Total Male: 26
 Total Female: 29

EDUCATION:

Graduating with advanced degrees: June 2013–May 2014

Alexis Sanderlin, MS, Chemical and Biological Engineering, June 2013

Characterization of biofilm development in model porous media using nuclear magnetic resonance

Natasha D. Mallette, PhD, Chemical and Biological Engineering, August 2013

Volatile fuel & organic compound production by *Ascocoryne sarcoides*

Adrienne Phillips, PhD, Chemical and Biological Engineering, September 2013

Biofilm-Induced calcium carbonate precipitation: Application in the subsurface

John Blaskovich, MS, Chemical and Biological Engineering, October 2013

Biofuel production in a Soap Lake isolate supplemented with sodium bicarbonate and stressed with sodium chloride

Egan Lohman, PhD, Chemical and Biological Engineering, October 2013

Lipid profiling, carbon partitioning, and inorganic carbon optimization to enhance growth and lipid accumulation in microalgae

Lisa Weeks, MS, Chemical and Biological Engineering, November 2013

Response of *Anabaena cylindrica* to variations in growth conditions and its use as a biofertilizer

Reed Taffs, MS, Chemical and Biological Engineering, December 2013

Metabolic network reconstruction in the sulfolobales

Katherine Davis, MS, Civil Engineering, December 2013

Analysis of wastewater treatment in cold climates using a recirculating sand filter

Andy Olson, MS, Civil Engineering, May 2014

Ammonia uptake by a nitrifying community containing novel ammonia-oxidizing archaeon

Margaret Eggers, PhD, Microbiology & Immunology, May 2014

Community based risk assessment of exposure to waterborne contaminants on the Crow Reservation, Montana

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EDUCATION:

2014 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration Tuesday, April 15. Among the 250 students presenting their research, numerous students were connected with the Center for Biofilm Engineering.

Graduate Students (alpha by last name)

Katie Davis: Chemical & Biological Engineering
 "Biogenic coal bed methane enhancement: Methods for field-relevant experiments"

Mentor(s): **Matthew Fields, Al Cunningham, Robin Gerlach** - Microbiology, Civil Engineering, Chemical & Biological Engineering, CBE

Benjamin Jackson: Mathematical Sciences
 "Biofilms and mathematics: Examining urea metabolism in a bacterial community"

Mentor(s): **Isaac Klapper, Robin Gerlach** - Mathematical Sciences, Chemical & Biological Engineering, CBE

Yanet Eudave Marin: Health & Human Development
 "Coping and depression among frontier migrants: Status and gender matter"

Mentor(s): Suzanne Christopher, Bethany Letiecq - Health & Human Development

Hannah Schweitzer: Microbiology
 "Investigation of coal-associated microbial community from a diffusive microbial sampler (DMS)"

Mentor(s): **Matthew Fields** - Microbiology, CBE

Lidice Tobar: Health & Human Development
 "Legal status, perceived health, and wellbeing among migrants in a new settlement"

Mentor: Suzanne Christopher, Bethany Letiecq—Health & Human Development

Benjamin White: Microbiology
 "The development of chronic wound exudate media"
 Mentor(s): **Michael Franklin, Garth James, Phil Stewart** - Microbiology, Chemical & Biological Engineering, CBE

Undergraduate Students (alpha by last name)

Andrew Bender: Mechanical & Industrial Engineering
 "Variables affecting the growth of biofilm in porous media"

Mentor(s): **Sarah Codd** - Mechanical & Industrial Engineering, CBE

Emily Bermel: Chemical & Biological Engineering
 "The effects of ultraviolet light on biofilm formation and pigment production of *Janthinobacterium sp.* strain CG23_2"

Mentor(s): **Christine Foreman** - Chemical & Biological Engineering, CBE

Ashley Berninghaus: Chemical & Biological Engineering
 "Growth of two alkaliphilic microalgal isolates in recycled harvest water supplemented with anaerobic digestate"

Mentor(s): **Robin Gerlach** - Chemical & Biological Engineering, CBE

Alissa Bleem: Chemical & Biological Engineering
 "A survey of acetic acid substrate and product inhibition kinetics for *Escherichia coli* K-12 MG1655 wild-type and select gene deletion mutants"

Mentor(s): **Ross Carlson** - Chemical & Biological Engineering, CBE

Kylie Bodle: Chemical & Biological Engineering
 "Effects of variable oxygen concentrations on microbial reduction of selenate in mining waste and isolation of selenate reducing organisms"

Mentor(s): **Rich Macur** - Center for Biofilm Engineering

Logan Boucher: Chemical & Biological Engineering
 "Lipid and proteomic analysis of a lignocellulosic degrading fungi"

Mentor(s): **Rich Macur** - Center for Biofilm Engineering

Hallie Bronec: Microbiology
 "Effect of anaerobic sulfate reducing bacteria on corrosion of steel"

Mentor(s): **Michael Franklin** - Microbiology, CBE

Edgar Gamero: Chemical & Biological Engineering
 "Lipid production from fungal mixture ENV1"
 Mentor(s): **Rich Macur** - Center for Biofilm Engineering

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James Gray: Chemical & Biological Engineering
 “Synthetic *Escherichia coli* consortia and emergent properties”
 Mentor(s): **Ross Carlson** - Chemical & Biological Engineering, CBE

Trace Hobbs: Chemistry & Biochemistry
 “Development of a clinically relevant model flow system for observing struvite formation by *Proteus mirabilis* biofilms”
 Mentor(s): **Robin Gerlach** - Chemical & Biological Engineering, CBE

Michelle Meagher: Chemical & Biological Engineering
 “Analysis of selenium reducing microbial communities in mine waste rock”
 Mentor(s): **Brent Peyton** - Chemical & Biological Engineering, CBE

Nathan Murphy: Chemical & Biological Engineering
 “Long term cryopreservation of algal cultures”
 Mentor(s): **Brent Peyton** - Chemical & Biological Engineering, CBE

Taylor Oeschger: Chemical & Biological Engineering
 “Growth and isolation of bacterial alginate from *Pseudomonas aeruginosa*”
 Mentor(s): **Joseph Seymour** - Chemical & Biological Engineering, CBE

Todd Pedersen: Chemical & Biological Engineering
 “Investigating culture effects of light irradiance and initial biomass concentration in *Nannochloropsis oceanica* sp. using response surface methodology”
 Mentor(s): **Brent Peyton, Rob Gardner** - Chemical & Biological Engineering, CBE

Varsha Rao: Chemical & Biological Engineering
 “Modeling flow through capillaries formed by heterogeneous gelation of algal alginate”
 Mentor(s): **Sarah Codd, Joseph Seymour** - Mechanical & Industrial Engineering, Chemical & Biological Engineering, CBE

Amanda Richards: Microbiology
 “Fluorescent imaging of *Pseudomonas aeruginosa* biofilms”
 Mentor(s): **Michael Franklin** – Microbiology, CBE

Amber Schmit: Chemical & Biological Engineering
 “Nitrogen cycling in cryoconites from the Canada Glacier in the McMurdo Dry Valleys, Antarctica”
 Mentor(s): **Christine Foreman, Markus Dieser, Heidi Smith** - Chemical & Biological Engineering, CBE, Land Resources & Environmental Sciences

Matthew Sherick: Chemical & Biological Engineering
 “An examination of microcapillary formation and coalescence in diffusive microbial alginate gelation using magnetic resonance”
 Mentor(s): **Joseph Seymour, Sarah Codd, Jennifer Brown** - Chemical & Biological Engineering, Mechanical & Industrial Engineering, Chemical & Biological Engineering, CBE

Jake TeSelle: Mechanical & Industrial Engineering
 “Rheological characterization of biofilm polysaccharides”
 Mentor(s): **James Wilking** - Chemical & Biological Engineering

Eric Troyer: Chemical & Biological Engineering
 “Optimization of media for the hydrolysis of urea and precipitation of calcium carbonate with *S. pasteurii*”
 Mentor(s): **Ellen Lauchnor, Robin Gerlach** - Chemical & Biological Engineering, CBE

Shu Ying Wee: Chemical & Biological Engineering
 “Chemotaxis of Antarctic and Arctic microbial life towards various carbon sources using a capillary motility method”
 Mentor(s): **Christine Foreman** - Chemical & Biological Engineering, CBE

Sila Yanardag: Chemical & Biological Engineering
 “Identification of role of RMF and HPF on cell viability, antibiotic susceptibility and biofilm forming ability of *Pseudomonas aeruginosa* PAO1 strain”
 Mentor(s): **Michael Franklin** - Microbiology, CBE

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EDUCATION: News highlights

2013–2014 MSU Research Awards

The following CBE undergraduate students were awarded funding from MSU’s Undergraduate Scholars program (USP) and Montana’s IDeA Networks of Biomedical Research Excellence program (INBRE) for their research projects in the 2013–2014 academic year.

Montana INBRE Awards

Montana INBRE is a five-year award (2009-2014) by the National Institute of General Medical Sciences (NIGMS) division of the National Institutes of Health (NIH). The program focuses on increasing the biomedical research capacity of Montana by building research infrastructure, supporting faculty and student research, and fostering a state-wide collaborative network. MT INBRE is expanding its research into the field of health disparities, an area of great relevance to the state. INBRE positions Montana as a leader in biomedical research and significantly increases education, research, and, ultimately, employment opportunities in the state.

Trace Hobbs, chemistry and biochemistry

Project: “Association of struvite formation with *Proteus mirabilis* biofilm

Faculty mentor: **Robin Gerlach**, associate professor, chemical and biological engineering

Varsha Rao, chemical and biological engineering

Project: “Modeling flow through capillaries formed by heterogeneous gelation of algal alginate”

Faculty mentor: **Sarah Codd**, professor, mechanical and industrial engineering

Amanda Richards, microbiology

Project: “Fluorescent imaging of *Pseudomonas aeruginosa* biofilms”

Faculty mentor: **Mike Franklin**, associate professor, microbiology

Matt Sherick, chemical and biological engineering

Project: “An examination of microcapillary formation and coalescence in diffusive microbial alginate gelation using magnetic resonance”

Faculty mentor: **Joe Seymour**, professor, chemical and biological engineering

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USP Awards

USP is one of the largest multidisciplinary undergraduate research programs at MSU. The program helps undergraduate students in all disciplines pursue research, scholarship, and creative projects. USP facilitates, supports, and promotes undergraduate research and scholarship by providing funding and logistical support directly to students.

Andrew Bender, mechanical engineering

Project: “Variables affecting the growth of biofilm in porous media”

Faculty mentor: **Sarah Codd**, professor, mechanical and industrial engineering

Emily Bermel, chemical and biological engineering

Project: “The effects of ultraviolet light on biofilm formation and pigment production of *Janthinobacterium sp.*”

Faculty mentor: **Christine Foreman**, associate professor, chemical and biological engineering

Ashley Berninghaus, chemical and biological engineering

Project: “Nutrient recycling through anaerobic digestate supplementation to enhance growth and lipid accumulation in microalgae for biofuel production”

Faculty mentor: **Robin Gerlach**, associate professor, chemical and biological engineering

Alissa Bleem, chemical and biological engineering

Project: "Acetic acid substrate and product inhibition kinetics for *Escherichia coli* K-12 MG1655WT and select gene deletion mutants"

Faculty mentor: **Ross Carlson**, associate professor, chemical and biological engineering

Kylie Bodle, chemical and biological engineering

Project: "Impact of oxygen concentration on selenium reduction"

Faculty mentor: **Rich Macur**, research assistant professor, chemical and biological engineering

Hallie Bronec, microbiology

Project: "Cultivating anaerobic sulfate reducing bacteria on steel coupons"

Faculty mentor: **Mike Franklin**, associate professor, microbiology

Amber Schmit, chemical and biological engineering

Project: "Nitrogen cycling in cryoconites from the Canada Glacier in the McMurdo Dry Valleys, Antarctica"

Faculty mentor: **Christine Foreman**, associate professor, chemical and biological engineering

Eric Troyer, chemical and biological engineering

Project: "Optimization of media for the hydrolysis of urea and precipitation of calcium carbonate with *Sporosarcina pasteurii*"

Faculty mentor: **Robin Gerlach**, associate professor, chemical and biological engineering

Shu-Ying Wee, chemical and biological engineering

Project: "Chemotaxis of Antarctic and Arctic microbial life towards various carbon sources using a capillary motility method"

Faculty mentor: **Christine Foreman**, associate professor, chemical and biological engineering

Sila Yanardag, microbiology

Project: "Mechanisms of antibiotic resistances in *Pseudomonas aeruginosa*"

Faculty mentor: **Mike Franklin**, associate professor, microbiology

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2014 MSU Awards for Excellence

Matthew Sherick, chemical engineering, was one of seven MSU seniors to win a 2014 Torlief Aasheim Community Involvement Award, the university's top award for student service.

The "Torley" award recognizes senior students who, in addition to excelling academically, volunteer on campus and in the community. The award was named for the late MSU alumnus Torlief "Torley" Aasheim, former director of the Montana Cooperative Extension Service and a member of the class of 1937.

Sherick is a member of the American Institute of Chemical Engineers, Sigma Phi Epsilon fraternity and Phi Kappa Phi honor society. Sherick has served as a member of the Honors Program advisory board and as an Advocat and SmartyCats tutor. He has also volunteered for Habitat for Humanity, Can the Griz food drive, Rock Against Rape and as an outreach activity volunteer for MSU's Engineerathon.

Earlier in the week, Sherick was one of 40 MSU students recognized at the university's 32nd annual Awards for Excellence along with his mentor, Joseph Seymour, professor of chemical and biological engineering. Honored students were nominated by faculty in their college or department. Qualified seniors must have at least a 3.5 grade point average on a 4.0 scale, as well as demonstrated campus leadership and community service.

A member of the MSU Honors College, Matt has also received recognition as a 2013 Goldwater Scholar and was inducted into the Septemviri honorary society.

Sherick works in the Magnetic Resonance Microscopy lab under the supervision of CBE faculty members Joe Seymour, Sarah Codd, and Jennifer Brown. His research involves gels that may someday benefit people with cystic fibrosis and be used in tissue engineering. Sherick was awarded a Montana INBRE award in 2013 to further his studies on the project: "An examination of microcapillary formation and coalescence in diffusive microbial alginate gelation using magnetic resonance."

Professor [Joe Seymour](#) has previously received a National Science Foundation Career Award and the 2011 College of Engineering Faculty Award for Excellence in Research.

Steven Davis meets challenges, inspires hope

Steven Davis, a recent MSU graduate in chemical and biological engineering and a CBE student since June 2011, shares his story of persistence in the face of adversity. Davis turned a potentially debilitating sports injury into academic success. His story is an inspiration to the MSU community and tribal communities across the region.

Read about Davis' story at *MSU News Service*: <http://www.montana.edu/news/12622/steven-davis-brings-perseverance-tribal-perspective-to-msu-degrees>

ME grad Kennedy is prepared for Harvard

Jordan Kennedy's work in the laboratories of MSU faculty members Jennifer Brown (chemical and biological engineering) and Sarah Codd (mechanical and industrial engineering) prepared her well for her next step: a summer at Harvard.

Read about Jordan's journey to Harvard at *MSU News Service*: <http://www.montana.edu/news/12627/msu-engineering-graduate-heads-off-to-harvard-for-internship>

CBE PhD student receives NSF Graduate Research Fellowship

CBE graduate student Catherine Kirkland, PhD in environmental engineering, was one of seven recipients of a 2013 National Science Foundation (NSF) Graduate Research Fellowship. Kirkland will receive a minimum of \$30,000 to attend graduate school and conduct research. Read more about Kirkland and her research focus at <http://www.biofilm.montana.edu/news/2013-nsf-graduate-research-fellowship.html>

2013 W.G. Characklis Outstanding Student Award

In July 2013, the CBE announced the 2013 W.G. Characklis Outstanding Student Award recipients. **James Connolly**, PhD candidate in chemical and biological engineering, received his award in recognition of his leadership and contributions to multi-disciplinary investigations, the quality and productivity of his research, his gracious willingness to train and assist others, and his unflinching participation in CBE workshops and conferences. **Heidi Smith**, PhD candidate in land resources and environmental sciences, was recognized for her wide-ranging pursuit of skills and knowledge, her productivity in research, and her commitment to the collaborative spirit of the CBE. Smith generously gives her time and expertise with enthusiasm and good humor as a mentor, trainer, seminar organizer, workshop instructor, and social planner.

The W.G. Characklis Award is presented annually to CBE doctoral students for their contributions to research and education. The award honors Center Founder Bill Characklis, who envisioned students working in interdisciplinary teams, participating in innovative educational programs, interacting with industry, and assuming leadership roles.

CBE Student Citizen Award

Adrienne (Adie) Phillips, a PhD candidate in chemical and biological engineering, received the CBE 2013 Student Citizen Award. Phillips received this award in recognition of her commitment to implement proper laboratory procedures, to identify and fix potential hazards, to communicate laboratory safety standards to others, and for her willingness to help others, while successfully conducting her own research.

The Student Citizen Award is open to any CBE student and recognizes a student who exhibits 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.

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EDUCATION:

CBE Seminar Series: Fall 2013

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

Date	Speaker	Affiliation	Topic
Aug 29	No seminar: First week of classes		
Sept 5	Dr. Jill Mikucki	Asst. Professor, Microbiology, University of Tennessee	Recent and pending adventures exploring microbial worlds below Antarctic ice
Sept 12	No seminar		
Sept 19	Dr. Matthew Kirk	Asst. professor, Geology, Kansas State University	A microbial feedback mechanism on CO ₂ trapping
Sept 26	Dr. Josh Bray	Postdoctoral Researcher, Magnetic Resonance Lab, Mechanical & Industrial Engineering, MSU	Imaging complex flows: What is MRI and what can it do for me?
Oct 3	CBE Pls	Dr. Darla Goeres, Asst. Research Professor, ChBE, Standardized Methods Lab, CBE in collaboration with: Sara Altenburg, Research Lab Manager, Physiology and Ecology Lab, CBE Dr. Christine Foreman, Associate Professor, ChBE, Microbial Ecology & Biogeochemistry Lab, CBE Dani Goveia, Undergraduate Student, Standardized Methods Lab Julia Lewis, Undergraduate Student, Medical Biofilms Lab, CBE	Growing biofilm in the CDC biofilm reactor: Methods, modifications, and techniques
Oct 10	Dr. Mary Cloud Ammons	Asst. Research Professor, Chemistry/Biochemistry, MSU	Metabolic fingerprinting of bacterial biofilms
Oct 17	Dr. Parag Vaishampayan	Scientist, Jet Propulsion Laboratory (JPL)	<i>Bacillus pumilus</i> spores hitchhiking to the International Space Station
Oct 24	CBE Mining Group	Dr. Lisa Kirk, Research Scientist, CBE Dr. Rich Macur, Res. Asst. Professor, CBE Dr. Brent Peyton, Professor, ChBE, CBE Dr. Dana Skorupa, Postdoc. Res. Assoc., CBE Dr. Brandy Stewart, Postdoc. Res. Assoc., CBE	Microbial communities and Se reduction in coal waste rock deposits
Oct 31	Dr. Thiru Ramaraj	Senior Bioinformatics Analyst and Team Lead, National Center for Genome Resources (NCGR)	Advanced sequencing technologies & genome informatics to investigate biological systems
Nov 7	Dr. Seth Walk	Asst. Professor, Microbiology & Immunology, MSU	The potential importance of GI tract biofilms in human health and disease
Nov 14	Luis Serrano-Figueroa	CBE PhD student, Microbiology & Immunology, MSU	Characterization of amphiphilic siderophores and vesicle self-assembly from Soap Lake, WA <i>Halomonas</i> sp. isolates
Nov 21	Dr. Blake Wiedenheft	Asst. Professor, Microbiology & Immunology, MSU	RNA-guided adaptive immune system in bacteria
Nov 28	No seminar: Thanksgiving		
Dec 5	No seminar: Last week of classes		

EDUCATION:

CBE Seminar Series: Spring 2014

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

Date	Speaker	Affiliation	Topic
Jan 10	No seminar—First week of classes		
Jan 16	Dr. Phil Stewart Heidi Smith Fernanda Godoy Betsey Pitts	Director, CBE; Professor, ChBE, MSU CBE PhD Candidate, Land Resources & Environmental Sciences Visiting PhD Candidate, Microbiology, Universidade Federal de Vicosá, Brazil Microscope Facilities Manager and Research Scientist, CBE	Review of current confocal microscopy projects
Jan 23	Dr. Ashraf Hassan	Assoc. Professor, Dairy Science, South Dakota State University	Role of exopolysaccharide producing starter cultures in biofilm formation on dairy separation membranes
Jan 30	Dr. Carl Yeoman	Asst. Professor, Animal & Range Sciences, MSU	Investigating the role of the vaginal microbiome in sexual health and reproduction
Feb 6	Dr. Jim Wilking	Asst. Professor, ChBE, MSU CBE	Soft Materials Science & Biofilms
Feb 13	Dr. Mark Rollins, MD	Assoc. Professor, Anesthesia, University of California, San Francisco	The role of oxygen in wound healing and infection prevention
Feb 20	Dr. Dirk Lange	Asst. Professor, Urological Sciences, University of British Columbia	Staghorn stones—Bacterial biomineralization in the kidney
Feb 27	Dr. Connie Chang	Research Asst. Professor, ChBE, MSU, CBE	Drop-based microfluidics for the study of virus evolution and bacterial biofilms
Mar 6	Dr. Phil Stewart Dr. Paul Sturman	Director, CBE; Professor, ChBE, MSU Research Engineer, Industrial Coordinator, CBE	Report on CBE-FDA joint meeting in Washington D.C.
Mar 14	No seminar—Spring break		
Mar 20	No Seminar		
Mar 27	Matt Treballa	Chief Scientific Officer, Lupine Medical	Medical devices and biofilms: Seeing the problem from a patient and company perspective
Apr 3	No Seminar		
Apr 10	Undergraduate Research Day	Breana Pabst, ChBE, MSU, CBE Matthew Sherick, ChBE, MSU, CBE Emily Bermel, ChBE, MSU, CBE	Gel-entrapped <i>Staphylococcus aureus</i> as a model of biofilm infection Modeling formation and flow characteristics of capillaries formed by diffusive gelation of algal alginate The effects of UV light on <i>Janthinobacterium</i> sp. strain CG23_2
Apr 17	Ben Jackson	PhD Candidate, Mathematical Sciences, CBE	Biomineralization and Mathematics: Examining urea metabolism in a bacterial community
Apr 24	No Seminar		

TECHNOLOGY TRANSFER:

Industrial Associates, 2013–14

Bold, new *Small business member

3M
ATS Labs*
Bard Access Systems
BASF
Bausch & Lomb
Baxter Healthcare
BCG Solutions *
Bend Research *
BP
Church & Dwight Company
Colgate-Palmolive
Covidien
Curza*
Dow Corning Corporation
Dow Microbial Control
Ecolab
ExxonMobil
ICU Medical, Inc.
Johnson & Johnson Consumer and Personal Products
Kane Biotech, Inc.*
KCI
Kimberly-Clark
Masco Corporation
NASA
NCH Corporation
Next Science
Novozymes
Procter & Gamble
Reckitt Benckiser
Sample6 Technologies *
Sani-Marc, Inc.
Sealed Air Corporation
Semprus BioSciences *
Sterilex *
STERIS
The Clorox Company
The Sherwin-Williams Company
W.L. Gore & Associates
WuXi AppTec, Inc. *
Zimmer

TECHNOLOGY TRANSFER:
 Montana Biofilm Meeting
 July 16–18, 2013

Monday, July 15

6:00–8:30 p.m.

Pre-registration and welcome reception

Larkspur Foyer, Hilton Garden Inn, Bozeman

Tuesday, July 16

7:30–8:00 a.m.

Registration and continental breakfast

Larkspur Foyer, Hilton Garden Inn

8:00–8:10

Introductory remarks

Larkspur Ballroom

Paul Sturman, CBE Industrial Coordinator

Chuck Pettigrew, IA Vice-Chair, Procter & Gamble

Phil Stewart, CBE Director

SESSION 1:

Oral Biofilms

8:20–9:00

Visualizing the spatial organization of microbes in oral biofilms

Jessica Mark Welch, Assistant Research Scientist, Marine Biological Laboratory, The Josephine Bay Paul Center

9:00–9:30

Evaluating oral biofilm treatments using the CDC biofilm reactor and treatment flow cell

Garth James

9:30–10:00

Survey of emerging approaches for control of oral biofilms

Phil Stewart

10:00–10:30 Break

SESSION 2:

Cyclic di-GMP

10:30–11:00

Cyclic-di-GMP: A signaling molecule during bacterial biofilm formation

Mike Franklin, Associate Professor, Microbiology, CBE

11:00–11:30

Probing second messenger molecules in biofilm formation: c-di-GMP and pGpG inhibitors and chemical probes

William Wuest, Assistant Professor, Chemistry, Temple University

11:30–12:00

Elucidating and targeting cyclic di-GMP signaling

Chris Waters, Assistant Professor, Microbiology and Molecular Genetics, Michigan State University

12:00–1:00

Catered lunch, Hilton Garden Inn

SESSION 3:

Biofuels/Algal Biofilms

1:00–1:10

Session introduction

Matthew Fields, Associate Professor, Microbiology, CBE

1:10–1:40

Biofilm-based sustainable production of wastewater algae for biofuel and other co-products

Ron Sims, Biological Engineering Department Head & Co-Director, Sustainable Waste-to-Bioproducts Engineering, Center, Utah State University

1:40–2:10

Direct measurement and characterization of active photosynthesis zones inside biofuel producing and wastewater remediating microalgal biofilms

Rob Gardner, Postdoctoral Associate, CBE

2:10–2:40

Lipid profiling of *Chlamydomonas reinhardtii* grown under three different inorganic carbon regimes

Egan Lohman, PhD candidate, Civil Engineering, CBE

CBE Open House: Lab

demonstrations and poster session

3:00–5:00

CBE Laboratories, 3rd Floor EPS Building, MSU

Detailed schedule provided at registration

Wednesday, July 17

7:30–8:00 a.m.

Registration and continental breakfast

Larkspur Foyer, Hilton Garden Inn

SESSION 4:

Medical Biofilms

8:00–8:40

Molecular snapshots of pilus biogenesis, UTI pathogenesis and biofilm formation: Blueprint for therapeutics

Scott Hultgren, Professor, Molecular Microbiology; Director, Center for Women's Infectious Disease Research, Washington University Medical School

8:40–9:15

Defining biofilms on intravascular catheters as microbial communities

Rod Donlan, Research Microbiologist/Biofilm Laboratory, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention

9:15–9:50

Catheter-associated urinary tract infection: How pathogenesis affects prevention and management

Rabih Darouiche, MD, VA Distinguished Service Professor, Medicine, Surgery and PM&R; Director, Center for Prostheses Infection, Baylor College of Medicine, Baylor University

9:50–10:20 Break

10:20–10:55

Efficacy of disinfection devices and protocols to remove bacterial spore contamination of needle-free connectors

Elinor Pulcini, Biosafety Manager, CBE; Assistant Research Professor, Chemical & Biological Engineering, MSU

10:55–11:15

Medical Biofilms Panel Discussion

Rod Donlan, CDC
Matt Trebella, Bard Access Systems
Phil Stewart, CBE
Garth James, CBE

11:15–11:50

State of the CBE address

Phil Stewart

11:50–12:00

CBE Award Presentations:

W.G. Characklis
Outstanding Researcher
Student Citizen
 Phil Stewart

12:00–1:00

Catered lunch, Hilton Garden Inn

SESSION 5:

Biofilm-Mineral Interactions

1:20–1:45

Controlling permeability reduction in the subsurface through biofilm-induced mineral precipitation:

A multi scale approach

Adie Phillips, PhD candidate, Chemical & Biological Engineering, CBE

1:45–2:10

Image-based modeling of biofilm-induced calcium carbonate precipitation

James Connolly, PhD student, Chemical & Biological Engineering, CBE

2:10–2:35

Modeling of critical occlusion via biofilm induced calcite precipitation in porous media

Tianyu Zhang, Assistant Professor, Mathematical Sciences, CBE

2:45–3:50

CBE Industrial Associates Business Meeting

6:00–9:00

Banquet Rockin TJ Ranch, Bozeman

Thursday, July 18

7:30–8:00 a.m.

Continental breakfast

Hilton Garden Inn reception area

SESSION 6:

Biomimicry

8:00–8:10

Session introduction

Phil Stewart

8:10–8:40

The art and science of biomimicry

Dayna Baumeister, Co-founder, Biomimicry 3.8

8:40–9:10

Natural product mimetics that inhibit and disperse bacterial biofilms

Christian Melander, Co-founder & Chief Research Officer, Agile Sciences; Associate Professor, Chemistry, North Carolina State University

9:10–9:40

Activity of antimicrobial peptide mimetics against fungal biofilms in vivo

Gill Diamond, Associate Professor, Oral Biology, UMDNJ-New Jersey Dental School

9:40–10:10

Packing them in: Using self-assembled protein cages to direct synthesis and packaging of polymers, minerals, and proteins

Trevor Douglas, Professor, Chemistry/Biochemistry, MSU

10:10–10:40 Break

SESSION 7:

Biofilm Methods

10:40–11:10

Results of a multi-laboratory evaluation of the Single Tube Method (ASTM Method E2871)

Darla Goeres, Assistant Research Professor, Chemical & Biological Engineering, CBE

11:10–11:40

Putting proteomics and metabolomics to work for you

Brian Bothner, Associate Professor, Chemistry/Biochemistry, MSU

11:40–12:10

Biofilms on orbit and on Earth: Current methods, future needs

Leticia Vega, Scientist, Water Recovery Systems Group, NASA-Johnson Space Center

12:00-12:10

Meeting Wrap Up

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WORKSHOP:
 Epifluorescence Microscopy Workshop
 July 15, 2013

8:00 a.m.–8:15 a.m.	Welcome and overview	EPS 323
8:15 a.m.–9:00 a.m.	Intro to bright field and fluorescence microscopy; Basics of the microscope	EPS 323
9:00 a.m.–12:00 p.m.	Group rotations A & B	
	<u>Rotation A, in the lab: Group 1</u>	CBE Labs
	<ul style="list-style-type: none"> • How to stain a biofilm (Walker, Buckingham-Meyer, Orr, Fritz) • Fully-hydrated imaging of stained biofilms and matrix (Pitts, Lorenz, Buckingham-Meyer) • Using a 1.25X objective and epifluorescence microscopy to assess a surface (Lorenz) • Using the Treatment Flowcell to assess removal and generate video data (Pitts) • Tricks for imaging environmental (non-lab grown) samples (Lorenz, Pitts) 	
	<u>Rotation B, application: Group 2</u>	EPS 323/EPS 333
	<ul style="list-style-type: none"> • Quantitative image analysis using NIH Fiji-Image J (Connolly; lecture and hands-on) • How to use microscopy to determine if you are introducing bias in your efficacy testing (Goeres) • Using Power Point to prepare an image for qualitative purposes (Kirker) • Cryo-embedding and cryo-sectioning (Pabst, Rothman) 	
12:00 p.m.– 1:00 p.m.	Lunch and informal panel discussion <i>Panel: Bryan Warwood (BioSurface Technologies); Darla Goeres, Paul Sturman, Phil Stewart, Betsey Pitts (CBE)</i>	COB 429
1:00 p.m.–4:00 p.m.	<u>Rotation A, in the lab: Group 2</u>	CBE Labs
	<ul style="list-style-type: none"> • How to stain a biofilm (Walker, Buckingham-Meyer, Orr, Fritz) • Fully-hydrated imaging of stained biofilms and matrix (Pitts, Lorenz, Buckingham-Meyer) • Using a 1.25X objective and epifluorescence microscopy to assess a surface (Lorenz) • Using the Treatment Flowcell to assess removal and generate video data (Pitts) • Tricks for imaging environmental (non-lab grown) samples (Lorenz, Pitts) 	
	<u>Rotation B, application: Group 1</u>	EPS 323/EPS 333
	<ul style="list-style-type: none"> • Quantitative image analysis using NIH Fiji-Image J (Connolly; lecture and hands-on) • How to use microscopy to determine if you are introducing bias in your efficacy testing (Goeres) • Using Power Point to prepare an image for qualitative purposes (Kirker) • Cryo-embedding and cryo-sectioning (Pabst, Rothman) 	
4:00 p.m.–5:00 p.m.	Wrap up and discussion	EPS 323

TECHNOLOGY TRANSFER:

Biofilms, Medical Devices, and Anti-Biofilm Technology: Challenges and Opportunities

February 20, 2014 Silver Spring, MD

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Time	Subject	Speaker
8:25 – 8:35 am	Welcome and opening remarks – FDA	Dr. Steve Pollack, Director, Office of Science & Engineering Laboratories, CDRH-FDA
8:35 – 8:45 am	Welcome and opening remarks – CBE	Dr. Phil Stewart, Director, CBE, Montana State University
8:45 – 9:15 am	Keynote address	Dr. Javad Parvizi, Director, Clinical Research, Rothman Institute, Professor, Department of Orthopedic Surgery, Jefferson Medical College
9:15 – 9:45 am	Introduction to Biofilms and Medical Device Infections – HAIs and Public Health Impact	Dr. Rodney Donlan, Director, CDC Biofilms Laboratory
9:45 – 10:15 am	Medical Device Biofilms from a Clinician’s Perspective	Dr. Todd Heniford, Chief, Division of Gastrointestinal and Minimally Invasive Surgery, Carolina University Med Center
10:15 – 10:30 am	BREAK	BREAK
10:30 – 11:00 am	Biofilm Explant Analysis	Dr. Chuanwu Xi, Professor, University of Michigan, School of Public Health
11:00 – 11:30 am	Bacterial Interactions with Medical Device Materials	Dr. Matthew Libera, Director, Stevens Laboratory of Multiscale Imaging, Professor, Stevens Institute of Technology
11:30 – 12:00 am	In-vitro Biofilm Reactors: Relation to In-vivo and Clinical Outcomes	Dr. Garth James, CBE Medical Projects Manager
12:00 – 12:20 pm	CDRH/ODE perspectives on adding antibiofilm technology/agents to devices	Ms. Angela Krueger, Policy Advisor – Product Jurisdiction Officer, CDRH/ODE
12:20 – 12:30 pm	Wrap-up	Dr. K. Scott Phillips, LCDR, USPHS, Regulatory Research Scientist, CDRH/OSEL
Morning presentations moderator		Dr. Geetha Jayan, Senior Science Health Advisor - CDRH/OCD
12:30–1:15 pm	NETWORKING LUNCH – ON SITE	
1:15–1:45 pm	EPA Development of a Biofilm Model for Pesticides	Dr. Stephen Tomasino, Senior Scientist, EPA Environmental Center, Microbiology Laboratory
1:45–2:05 pm	Anti-biofilm Technologies	Dr. Dustin Williams, Chief Scientific Officer, Curza
2:05–2:25 pm	Antimicrobial –Resistance	Dr. John Chapman, Scientist, Ashland Chemical
2:25 – 2:45 pm	Standard Methods for Testing Anti-Biofilm Technology: Progress and Future Directions	Dr. Paul Sturman, Industrial Coordinator & Research Professor, CBE
2:45 – 2:55 pm	Wrap up of afternoon session	Dr. Michael Waters, Reviewer, CDRH/OIR
Afternoon presentations moderator		Dr. Thelma Valdes, Biomedical Engineer, CDRH/ODE
2:55 – 3:15 pm	BREAK	BREAK
3:15 – 4:45 pm	PANEL DISCUSSION – Anti-biofilm technology and medical devices	Panel discussion moderator: Dr. K. Scott Phillips (LCDR, USPHS); Dr. Dinesh Patwardhan: CDRH/OSEL

TECHNOLOGY TRANSFER: NEWS HIGHLIGHTS

CBE welcomes new members to its Industrial Associates Program:

ATS Labs began in 1989 as a part of a company called ViroMed, which was a regional reference laboratory performing infectious disease detection testing. The combination of ViroMed's virology and microbiology expertise and a strong commitment to quality made it one of the premier testing laboratories in the country. In 2002 ATS Labs was established and continued to build expertise in bacterial, fungal and viral testing by expanding testing facilities to better serve clients. They've developed an outstanding reputation with all the regulatory agencies. **Josh Luedtke** is the CBE's designated representative. Read more about the company at: <http://www.ats-labs.com>

Curza joined the program as a small business member. Curza has developed multiple classes of proprietary antimicrobial compounds that kill, disperse and inhibit the formation of bacterial biofilms. These novel compounds have a broad spectrum of applications in the fields of: oil, gas, water, paper & pulp, machining fluids, medical & healthcare, agriculture, paints & coatings, consumer goods and many others fields. Ryan Davies, Curza CEO, is the CBE's designated representative. Read more about [Curza](#)

Sterilex is a recognized leader in developing antimicrobial, anti-biofilm, and decontamination products for infection control, biofilm removal, biodecontamination, and chemical decontamination. Sterilex specialty biofilm-control biocides, disinfectants, and decontamination products are used in a variety of applications including human health, dental health, animal health, food processing, water care, industrial processing, and environmental remediation. Sterilex joined the CBE as a small business member. Mark Wozniak is the CBE's designated representative. Read more about [Sterilex](#)

Zimmer is a world leader in musculoskeletal health solutions. For nearly 100 years, Zimmer has been dedicated to restoring mobility, alleviating joint pain, and improving the quality of life for people through the development of effective, creative, joint replacement solutions for orthopaedic surgeons as they work to relieve the pain of arthritis and traumatic injuries. The company's headquarters is in Warsaw, Indiana, and their CBE designated representative is Craig Fryman. Read more about [Zimmer](#)

CBE partners with FDA for joint meeting on biofilms

The CBE co-sponsored a public workshop on biofilms with the federal Food and Drug Administration on Thursday, February 20, at the FDA campus in Silver Spring, Maryland.

The workshop was designed to share scientific information between the academic and healthcare communities, U.S. government scientists, and industry interested in developing products to address biofilm contamination. Major topics covered at the workshop included:

- Research on biofilms and their public health impact;
- Challenges faced by the scientific community, clinical community, government and industry on addressing biofilm contamination of medical devices;
- Critical areas of research that will address the scientific and clinical challenges faced by the stakeholders when developing technologies that are intended to prevent biofilm formation.

For the full MSU press release on the meeting, go to:

www.montana.edu/news/12435/msu-s-center-for-biofilm-engineering-co-sponsoring-conference-with-fda

To view the meeting webcast and access presentation slides, go to (scroll to the center of the page):

<http://www.fda.gov/MedicalDevices/NewsEvents/WorkshopsConferences/ucm381336.htm>

To read a report on the summary of presentations and attendance from the FDA/CBE Public Workshop Report, go to:

<http://www.biofilm.montana.edu/content/biofilm-fdacbe-public-workshop-report>

Biofilm meeting and workshop bring industry scientists to Bozeman

The CBE was recently featured by Montana State University for the industrial interaction at their semi-annual biofilm science and technology meetings. The story highlights the CBE's extensive corporate membership program as well as the educational interaction that takes place during the Center's industry meetings and hands-on workshops.

Read the full story at MSU News Service: ["MSU biofilm meeting, workshop bring industry scientists to Bozeman"](#)

New Knowledge Sharing Articles (KSAs)

KSA-SM-13: Using *R* to assess resemblance, repeatability, and reproducibility for quantitative and semi-quantitative disinfectant methods

The CBE Standard Biofilm Methods Lab presents their thirteenth article on standardized methods. Previous articles have discussed how to interpret results from a multi-laboratory collaborative study. This KSA provides computer code using the statistical software *R* to analyze either multi-lab study data, or multi-experiment data from a single lab. Application of the software is illustrated using data from a published collaborative study. A short tutorial explaining how to install and use *R* is also provided. Read the [full KSA-13](#) (pdf)

KSA-SM-14: Using *R* to calculate confidence intervals for the repeatability and reproducibility standard deviations and the intra-laboratory correlation coefficient of a disinfectant test method

The CBE Standard Biofilm Methods Lab presents their fourteenth knowledge sharing article on standardized methods. KSA-SM-14 pertains to the evaluation of the estimates of variability of a standardized disinfectant test method. The previous article (KSA-SM-13) provided *R* computer code for analyzing a multi-lab study of a test method by calculating estimates of the repeatability and reproducibility SDs, among other statistics. This new article shows how to use *R* to calculate the uncertainty of the estimates via confidence intervals (CI). It includes *R* computer code, numerical examples, and a brief review of CI concepts. Read the full [KSA-SM-14](#) (pdf)

View the [complete KSA series](#)

CBE faculty member elected to ASTM Committee

CBE faculty member Darla Goeres, assistant research professor in chemical and biological engineering, was recently elected to serve as First Vice-Chairman of ASTM Committee E35 on Pesticides, Antimicrobials, and Alternative Control Agents.

Formed in 1973, ASTM Committee E35 on Pesticides is responsible for developing standardized test methods and recommending practices relating to efficacy, safety, quality, and impact in appropriate environments of pesticides, antiseptic and antimicrobial agents, biological agents, devices, and equipment. The committee has a membership of about 230 people from industry, academia, and government. It currently has five technical subcommittees that have jurisdiction of over 80 standards.

ASTM International is one of the largest international standards development and delivery systems in the world. ASTM International meets the World Trade Organization (WTO) principles for the development of international standards: coherence, consensus, development dimension, effectiveness, impartiality, openness, relevance and transparency. ASTM standards are accepted and used in research and development, product testing, quality systems and commercial transactions.

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TECHNOLOGY TRANSFER: Industry and Agency Interactions

Jason Tanguay, DDS, from the Mint Dental Studio in Bozeman, Montana visited the CBE's Medical Biofilm Laboratory researchers to discuss potential collaborative projects.

Dennis Enning of ExxonMobil Upstream Research visited the Center to review the CBE's lab capabilities and discuss potential project work. He met with several CBE faculty PIs and staff researchers.

Bill Aljoe and **Mark Ackiewicz**, representatives from the US Department of Energy's (DOE) Office of Fossil Energy, recently met with CBE faculty member **Robin Gerlach** and CBE researchers **Ellen Lauchnor** and **Adie Phillips**. Aljoe, is the project manager of the DOE's Zero Emissions Research and Technology (ZERT) program and Ackiewicz is the director of the carbon capture and storage research and development office. The group met to discuss a collaborative project. MSU associate vice president for researcher, Lee Spangler, was also part of the meeting and Center tour.

Jim Kirksey with Schlumberger visited the CBE July 1–2, 2013. Kirksey met with CBE faculty members **Robin Gerlach** and **Al Cunningham** as well as CBE researchers **Ellen Lauchnor** and **Adie Phillips** to review results obtained from a well preparation test at their Alabama field site in May 2013. The well development is part of a US Department of Energy (DOE) funded project "Field test and evaluation of engineered biomineralization technology for sealing existing wells."

André Côté from The Sani-Marc Group in Quebec, Canada visited the CBE July 8–9, 2013 to learn standard methods for growing biofilm and efficacy testing at the CBE's Standardized Biofilm Methods Lab. Sani Marc joined the CBE industrial program in December 2012.

Steve Bolkan, director of R&D with Church & Dwight, visited the Center on July, 31 2013. He met with CBE team members **Phil Stewart**, **Paul Sturman** (industrial coordinator), and the algal biofuels group—**Brent**

Peyton, Rob Gardner (postdoctoral research associate), and **Egan Lohman** (PhD student). The group discussed the progress of a Church and Dwight sponsored algal biofuels project. Nick Zelter, associate director in the MSU Office of Technology Transfer was also part of the meeting.

Denise Akob and **Bill Orem** with United States Geological Survey (USGS) visited the Center on August 21, 2013. They met with CBE faculty members **Al Cunningham** (professor, civil engineering), **Robin Gerlach**, **Matthew Fields** (associate professor, microbiology), and CBE PhD student **Elliott Barnhart** (microbiology) to discuss coal-bed methane field work as well as laboratory experiments to better understand the impacts of microbial dynamics on coal-dependent methane generation.

CBE industrial coordinator **Paul Sturman** hosted John Gast, research fellow from Ashland Chemical on Monday, October 7, 2013. Gast spent the day touring the Center and meeting with CBE faculty and researchers to discuss Ashland's potential collaboration with the CBE. Ashland provides specialty chemicals and technologies for a wide variety of markets and applications including architectural coatings, automotive, construction, energy, personal care, pharmaceutical, tissue and towel, and water treatment.

Bart Lomans from Shell visited the CBE on November 4, 2013. Bart met with CBE faculty members Robin Gerlach, associate professor, chemical and biological engineering, and Al Cunningham, professor, to discuss progress on several ongoing CBE research projects including biomineralization of sandstone and shale, CO₂ injection at the Kevin Dome near Shelby, Montana, and coal-to-methane conversion by biogenesis. Bart is a collaborator on all of these projects.

Paul Sturman, CBE research engineer and industrial coordinator, presented "Industrial biofilms and testing," at Novozymes Biologicals, Roanoke, Virginia, November 6, 2013.

Phil Stewart, CBE director, was an invited seminar speaker at the following CBE member companies:
 Ecolab, February 5, 2014
 Dow Microbial Control, February 19, 2014
 The Clorox Company, April 16, 2014

Paul Sturman, CBE research engineer and industrial coordinator, met with CBE member company Masco Corporation on February 17, 2014. The purpose of his visit was to discuss current CBE-Masco projects.

OUTREACH: News highlights

The Center for Biofilm Engineering hosted a week-long workshop “Cyanos to Soils,” October 22–25, 2013. The workshop focused on the use of cyanobacteria as a potential replacement for chemical nitrogen fertilizer and was attended by Chinese scientists from academia and industry, including the Chinese National Academy of Sciences, Jientec, Elion, and Penn State University. CBE hosts included faculty members from chemical and biological engineering—**Rich Macur**, assistant research professor, and **Brent Peyton**, professor—along with research scientist **Rob Gardner**, and PhD graduate **Lisa Weeks**. Funding for the workshop was provided by the Accelry Corporation.

The use of nitrogen fixing cyanobacteria for biofertilizer represents a technology that has the potential to replace chemical nitrogen fertilizer. Nitrogen fixation by cyanobacteria is driven by solar energy and the benefits of using these organisms as a fertilizer replacement include a much lower carbon footprint, improved long term soil quality and decreased nitrogen pollution. CBE scientists are currently collaborating with Chinese and other scientists to move this technology forward.

On September 17, 2013, **Dr. Yuhan Sun** from the Chinese National Academy of Sciences, along with **Rocco Fiato** and **Mark Allen** of Accelry Corporation, visited the CBE to discuss collaborative research efforts on phototrophs for biofertilizers.

Dr. Sun is the Secretary of the Chinese Party Committee and recently founded the Shanghai Advanced Research Institute. His main research interests include chemistry of coal/natural gas-based syngases and chemicals, catalysis and engineering for CO₂ utilization, application of nano-materials in green chemistry, and optical films. He has published over 300 papers and has more than 40 authorized patents.

The group was hosted by members of MSU’s algal biofuels research team, including CBE faculty members **Rich Macur**, **Brent Peyton**, and **Robin Gerlach** of MSU’s Department of Chemical and Biological Engineering, CBE postdoctoral research associate **Robert Gardner**, and MSU research professor emeritus Keith Cooksey (microbiology).

Details and photos of the visit were featured on the Algae Biomass Organization website in the article “Montana’s Summer of Algae.” Read [full story](#)

CBE faculty and researchers participated in MSU’s 2014 NanoDays on April 2, 2013. **Connie Chang**, assistant research professor in chemical and biological engineering, presented “Tiny test tubes created using the magic of microfluidics,” to fifth graders from local elementary schools. Chang was assisted by **Natasha Mallette**, CBE postdoctoral researcher, and **Robert Schaefer**, CBE masters student in chemical and biological engineering.

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

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

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OUTREACH: Visiting Researchers

Visiting Student Researchers

In the summer of 2013 CBE hosted a high school student researcher as part of the American Indian Research Opportunities (AIRO) Montana Apprenticeship Program (MAP). **Samantha Werk**, a junior at Dodson High School (Dodson, Montana) studied constructed wetlands with CBE faculty member **Mark Burr**, research assistant professor, land resources and environmental sciences. After high school graduation, Werk plans on studying nursing at MSU.

Montana Apprenticeship Program is a structured, six-week, hands-on summer research experience for both students and teachers under the direction of active science research mentors at Montana State University. The goal of MAP is to increase the number of Native American high school students who want to pursue careers in science, technology, engineering, and math career fields. Funding for MAP is provided in part by the Howard Hughes Medical Institute.

Two MSU undergraduate students completed a 10-week apprenticeship at CBE as part of the Complex Biological Systems Summer Undergraduate Research Program (CBS-SURP). **Trace Hobbs**, an undergraduate in biochemistry from Kalispell, Montana, worked under CBE faculty member **Robin Gerlach** (associate professor, chemical and biological engineering) and his biomineralization research group. **Kate Lamm**, an undergraduate in chemical and biological engineering from Big Fork, Montana, worked under CBE faculty member **Ross Carlson** (associate professor in chemical and biological engineering).

The apprenticeship, open to MSU freshmen, sophomores, and juniors, is a structured summer research program that introduces undergraduates to the rigors and challenges of scientific research in a mentor-based environment. Students work fulltime on an independent research project, and participate in a weekly seminar, extracurricular activities, and a full-day trip to Yellowstone National Park. This interdisciplinary program supports students from all fields of scientific interest including cell biology, neuroscience, microbiology, chemistry, biochemistry, immunology, biofilm engineering, mathematics, and psychology. Funding is provided by the Howard Hughes Medical Institute.

Two students from Chief Dull Knife College in Lame Deer, Montana—**Jeffery Brown** and **Lloydine Runsabove**—participated in a summer research program with the CBE Algae Biomass Group. The primary focus of their research was to isolate nitrogen-fixing cyanobacteria from cryptobiotic soil crusts collected in south-central Montana and characterize their growth in aqueous media. They presented their research findings at the Leadership Alliance conference in Stamford, CT. The students were mentored by CBE research assistant professor **Rich Macur**, CBE masters student in chemical and biological engineering **Lisa Weeks**, and CBE faculty member **Brent Peyton**, professor, chemical and biological engineering. Funding, in part, was provided by the American Indian Research Opportunities (AIRO) program—Bridging Tribal Colleges to MSU, a program designed for building a seamless educational experience between reservation-based colleges and MSU.

Amanda Macaluso, masters student in bioengineering at Clemson University, SC, visited the CBE August 12–16, 2013. She spent the week working with CBE faculty member **Darla Goeres** on CDC/DF reactor protocols. Macaluso’s advisor, Melinda Harman, assistant professor in bioengineering, attended the July 2013 Montana Biofilm Meeting and visited with Goeres and CBE medical biofilms lab manager Garth James. Harman’s research interest is orthopedic implant performance and medical device reprocessing.

Visiting Research Faculty/Staff

Greg Characklis, professor in the Department of Environmental Sciences & Engineering at the School of Global Public Health at the University of North Carolina in Chapel Hill, North Carolina will be spending June and July at the CBE conducting research. As a regular collaborator with the CBE, Characklis will be working with the algal biofuels research team on shared projects.

Accompanying Characklis is his new graduate student, **Adam Hise**, a biological systems engineering graduate from Virginia Tech in Blacksburg, Virginia. Hise will be learning about the CBE’s algal biofuels research activities. His graduate research focuses on modeling the biofuel production process and the life-cycle/economic elements associated with the development of sustainable algal biorefineries.

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Medical doctor and research fellow **Jun Fei** from the Rothman Institute at Thomas Jefferson University Hospital in Philadelphia, Pennsylvania visited the CBE September 3–20, 2013. Dr. Fei learned about biofilms and worked with CBE faculty member Mike Franklin, professor of microbiology.

Federica Villa returns to the CBE from the University of Milan, Italy to work for the next two years as a postdoctoral researcher in the lab of CBE director **Phil Stewart**. She was previously a visiting graduate student at the CBE in 2009. Villa is the recipient of a competitive Marie Curie International Fellowship. While at the CBE, she will pursue her project related to understanding how cyanobacterial biofilms contribute to deterioration of outdoor stone materials.

In October, the CBE welcomed visiting PhD student **Maureen Kesaano**. She will be working at the CBE through March 2013 under the direction of CBE faculty member **Brent Peyton**, professor, chemical and biological engineering. Maureen's research project is the "Characterization, performance and optimization of algal biofilms for industrial applications." Her home university is Utah State University in Logan, Utah where she is a biological engineering PhD student.

Shinya Matsumoto joined **Phil Stewart** to work as a postdoctoral researcher with Stewart for two years on topics of dormancy and antimicrobial tolerance in biofilms. Matsumoto received his PhD in chemical engineering in 2009 from Waseda University in Tokyo. He has worked on aspects of biofilm-based wastewater treatment, individual-based biofilm modeling (with Cristian Picioreanu at Delft University of Technology), and persister cells. His current position is supported through a competitive fellowship from the Japanese Society for Promotion of Science.

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CBE Tours

Phil Stewart, CBE director, led a CBE tour for **Connie Chang**, postdoctoral researcher from Harvard University, and a faculty candidate in MSU's Department of Chemistry and Biochemistry.

CBE faculty member **Brent Peyton** and CBE researchers **Randy Heibert** and **Lisa Kirk** hosted representatives from **Montana Technological University**—Doug Cameron, Paul Conrad, Bill Gleason, and Jay McCloskey.

Phil Stewart hosted a tour for Sharon Peterson and Liz Ching of the **Montana Bioscience Alliance**. The alliance serves as a hub for Montana's biotechnology companies, entrepreneurs, laboratories, hospitals, clinics, and universities to commercialize, grow, and sustain globally competitive bioscience companies — ultimately to create high-quality jobs and economic opportunity in Montana.

September 30, 2014: CBE faculty member **Matthew Fields**, associate professor in microbiology, gave a brief CBE tour to the **president of Lanzhou University (LZU)** and five faculty members. The delegation was on campus to explore a partnership agreement with MSU. LZU is ranked in the top tier (top 39) of Chinese research universities and is located in northwest China. LZU's strengths are in the sciences (physics, chemistry, life sciences), math, agriculture and engineering.

October 14, 2013: **Ann Willis**, CBE technical operations manager, provided a Center tour for Jennifer Weidhaas, assistant professor at **West Virginia University's Department of Civil and Environmental Engineering**. Weidhaas received her undergraduate degree in civil engineering from MSU in 1999. Currently she works with biofilms at WVU and was interested in seeing the CBE labs. Her current research focus includes biological, chemical and physical environmental engineering approaches, including water/wastewater treatment, hazardous waste and emerging contaminants remediation, water quality modeling, and bacterial source tracking of contaminants.

October 15, 2013: John McCutcheon, assistant professor, and James Van Leuven, PhD student, from the **University of Montana**, visited the Center. They worked with CBE facilities manager and research scientist **Betsey Pitts** on the confocal microscope and discussed potential future collaborations with the CBE.

November 4–5, 2013: **Ann Willis**, CBE technical operations manager, led a Center tour for a group of high school students from **Glacier High School in Kalispell, Montana** on November 5, 2013. The forty students visited the MSU campus on November 4th and 5th as members of Montana Gear Up, a program that is dedicated to helping Montana students reach their goal of attending college. CBE undergraduate **Trace Hobbs**, chemistry and biochemistry, helped to organize the tour.

January 24 2014: **Garth James**, CBE medical projects manager, hosted a small group of **dentists and dental hygienists** from Billings, Montana and Cody, Wyoming.

January 24, 2014: **Phil Stewart**, CBE director, hosted three newly-appointed MSU deans—**Brett Gunnick**, Dean of the College of Engineering, **Karlene Hoo**, Dean of Graduate Studies, and **Nicol Rae**, Dean of the College of Letters and Science. The group learned about the Center's commitment to student education, interdisciplinary teamwork, and industrial interaction. They heard directly from students and staff, in their laboratories, about diverse projects related to algal biofuels, biofilm control strategies, and standardized biofilm methods. They also toured the CBE's state-of-the-art confocal microscope facility.

February 28, 2014: **Ann Willis**, CBE technical operations manager, led a tour of prospective graduate students for **MSU's Molecular Biosciences program**. The program was conducting a large recruiting event including campus tours, a poster session, and short lectures.

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OUTREACH:
 Web image library use 2013-14

Requests for CBE graphics were submitted from **32** of the U.S. states and Puerto Rico:

Arkansas	Georgia	Michigan	New York	Virginia
Arizona	Illinois	Minnesota	Ohio	Washington
California	Indiana	Mississippi	Oklahoma	Wisconsin
Colorado	Iowa	Missouri	Pennsylvania	and
Connecticut	Kentucky	Montana	South Carolina	Puerto Rico
Delaware	Maryland	New Jersey	Texas	
Florida	Massachusetts	North Carolina	Utah	

There were requests from an additional **33** countries:

Australia	Mexico
Belgium	Netherlands
Brazil	Nigeria
Canada	Norway
China	Philippines
Czech Republic	Poland
Denmark	Saudi Arabia
Finland	Singapore
France	Spain
Germany	Sweden
India	Switzerland
Indonesia	Thailand
Iran	Turkey
Ireland	United Arab Emirates
Israel	United Kingdom
Italy	
Japan	

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FACILITIES:

Center for Biofilm Engineering Facilities Overview

The CBE moved into the MSU's Engineering/Physical Sciences Building when it was built in 1997. The >20,000 ft² facility includes offices and conference rooms for faculty, staff, and students; two computer laboratories; and thirteen fully equipped research laboratories. The full-time CBE Technical Operations Manager oversees the research laboratories, provides one-on-one training for students, ensures safe laboratory practices, and maintains equipment. State-of-the-art instruments and equipment are available for use by all CBE faculty, staff, and students. General use areas include a microbiology lab, a media kitchen, an instrument lab, and an isolated radioactive isotope lab. Facilities of particular note are described below.

New equipment added to CBE instrument lab

CBE associated faculty **Brent Peyton**, professor, chemical and biological engineering, generously added the Synergy™ H1 Hybrid Multi-mode Plate Reader to the CBE instrument room. The reader, provided by BioTek® Instruments, Inc., is a flexible monochromator-based multi-mode instrument and will enhance the Center's analytical capabilities. The system supports top and bottom fluorescence intensity, UV-visible absorbance, and high performance luminescence detection. It is the ideal system for all the standard microplate applications found in life science research laboratories and will greatly benefit CBE researchers. The instrument features Gen5™ software. BioTek® is a family-run company based in Winooski, Vermont. The Synergy™ H1 is made in the USA.

CBE labs continue sustainable practices

Collaborative efforts have been successful in replacing the use of highly toxic ethidium bromide (EtBr) with GelRed™ Nucleic Acid Gel Stain. This dye was developed by scientists at Biotium, Inc. with a goal of low toxicity, high sensitivity, and exceptional stability. This change is part of the CBE's continued effort to improve lab safety and support sustainable practices.

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 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 has also been added. Mass spectrometers are very well suited for unknown compound identification and high sensitivity speciation measurements of organic and inorganic compounds; this equipment enhances the CBE's research capabilities significantly. The Environmental and Biofilm Mass Spectrometry Facility is operated as a user facility and allows access for academic and non-academic researchers.

Microsensor Laboratory

A specialized Microsensor Laboratory provides the capability of measuring microscale chemical and physical parameters within biofilms. The laboratory maintains a microsensor fabrication and testing area that includes electrode pullers, microscopes, and grinding machines. All of these electrodes are used in conjunction with computer-controlled micropositioners for depth profiling, and a computer-controlled x-y table for mapping parameters in a horizontal plane. The microsensor lab also has instrumentation for measuring corrosion and other electrochemical phenomena associated with biofilms. A recent addition to this lab's capabilities is time-dependent sampling which can be synchronized with changes in light intensity. This expansion provides tools for microscale spatial analysis of phototrophic biofilms and many other photochemistry effects.

Microscope Facilities

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

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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 cooled CCD cameras from Photometrics (we have a CoolSnapfx, and a CoolSnapEZ) 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. Other equipment in the Optical Microscopy Lab includes a Nikon SMZ-1500 barrel zoom stereomicroscope equipped with a color camera, a Leica CM1800 cryostat, a Zeiss Palm Laser Capture Dissection microscope and a dry ice maker.

The **Confocal Microscopy Lab** contains two brand-new (2011) Leica SP5 Confocal Scanning Laser Microscopes (CSLMs).

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

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

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

The **Microscope Resource Room / Digital Imaging Lab** is where CBE researchers examine and reconstruct the stacks of image data they have collected using our image analysis software. For quantitative analysis, such as intensity or particle-size measurements, we use Universal Imaging Corporation's MetaMorph software. We use Bitplane's *Imaris* software for 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, SCSI drives 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.

Flow Cytometry Facility

The flow cytometry facility is available for research staff to investigate physical and/or chemical properties of disaggregated biofilm cells in suspension. This facility is an excellent complement to the microscope facility in that biofilms may be examined in situ under the microscope and then later disaggregated for single-cell examination in the flow cytometer. This instrument has a wide variety of uses from examining heterogeneous populations, to counting cells, to sorting specific populations within a sample.

The facility is equipped with a Becton Dickinson FACSAria flow cytometer. Housed with three lasers, a 405 nm, 488 nm and a 633 nm, the FACSAria is able to detect up to seven different fluorochromes, plus forward and side scatter simultaneously.

High-speed sorting is also a feature of the FACSria. Two- and four-way sorting can be performed as well as sorting into 96-well plates.

Computer Facilities

CBE staff and students have access to workstations connected to the MSU College of Engineering computer network. A student computer laboratory offers ten state-of-the-art PCs along with scanning and printing services. In addition, the COE maintains computational PCs and a computational cluster for data manipulation, mathematical modeling, and graphic image analysis.

SPECIALIZED CBE LABORATORY GROUPS

Ecology/Physiology Laboratory

The Ecology/Physiology Laboratory headed by Dr. Matthew Fields has general microbiology equipment, anaerobic gassing stations, Shimadzu UV-VIS spectrophotometer, biofilm reactors, protein and DNA electrophoresis, Qbit fluorometer, 2 PCR machines (96-well), incubators, laminar/fume hoods, microcentrifuges, table-top centrifuges, and a microcapillary gas chromatograph with dual TCDs. The lab also has a light-cycle controlled photo-incubator as well as photo-bioreactors for the cultivation of algae and diatoms, and the lab maintains one -20°C freezer and a -70°C freezer for sample storage.

This laboratory also houses a 454 GS-Jr. pyrosequencer. The GS-Jr. uses 454 technology at an intermediate scale (100,000 reads with up to 40-50 Mb of sequence). The GS Jr. offered by Roche is a high-throughput, multi-parallel sequencing instrument that is capable of delivering the information of approximately 100,000 different DNA molecules of approximate 450 nucleotides long within 48 hours. We have been using the GS-Jr. for approximately 1 year, and have developed an in-house Python script that deals with filtering raw sequences based upon quality scores (Bowen DeLeon et al., in revision). We have also modified the protocols for the GS-Jr. in consultation with Roche to improve quality scores (Ramsay et al., manuscript in preparation).

Medical Biofilm Laboratory

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

Currently, fifteen companies, including CBE Industrial Associates, sponsor MBL projects. The MBL is also collaborating with small businesses on two Phase I Small Business Innovation Research (SBIR) grants. In addition, MBL principal investigator Kelly Kirker recently received an R03 research grant from the National Institutes of Health (NIH) to investigate staphylococcal biofilm induction of apoptosis in human epithelial cells. Other MBL projects include evaluating treatments for oral biofilms, testing needle-free connectors, catheters, and other medical devices, as well as evaluating novel treatments for medically-related biofilms. The MBL is a prime example of integration at the CBE, bringing together applied biomedical science, industrial interaction, and student educational opportunities.

Standardized Biofilm Methods Laboratory

The Standardized Biofilm Methods Laboratory (SBML) was designed to meet research and industry needs for standard analytical methods to evaluate innovative biofilm control technologies. SBML staff and students develop, refine, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBML members work with international standard setting organizations on the approval of biofilm methods by the standard setting community. Under a contract with the U.S. Environmental Protection Agency (EPA), the SBML conducts laboratory research to support the development and standardization of test methods for measuring the performance of antimicrobial products—including those for biofilm bacteria—and provide statistical services related to EPA's Office of Pesticide Programs Antimicrobial Testing Program. In addition, they conduct applied and fundamental research experiments and develop testing protocols. Methods include: design of reactor systems to simulate industrial/medical systems; growing biofilm and quantifying cell numbers and activity; testing the efficacy of chemical constituents against biofilms; and microscopy and image analysis of biofilms. SBML staff offer customized biofilm methods training workshops for CBE students, collaborators, and industry clients.

Microbial Ecology and Biogeochemistry Laboratory

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

OTHER Montana State University facilities available for collaborative research

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.

Current Instrumentation

- * 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/home/index.asp>