2009 APPENDIX

Center for Biofilm Engineering

Montana State University
Bozeman

TABLE OF CONTENTS

RESEARCH

EDUCATION

TECHNOLOGY TRANSFER

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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
Sample topics: antimicrobial efficacy | biocides | bioelectric effect | disinfectants | inhibitory coatings | nitrous oxide effects

Energy solutions
Sample topics: biofuels | microbial fuel cells

Environmental subsurface technologies
Sample topics: bioremediation | wetlands | CO_2 sequestration | biobarriers

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

Industrial systems & processes
Sample topics: biofouling | biocorrosion | product contamination | microbe-metal interactions | biomineralization

Standardized methods
Sample topics: product claims | regulatory issues | ASTM methods acceptance

Water systems
Sample topics: drinking water quality | premise plumbing | water treatment | distribution systems

FUNDAMENTAL TOPICS

Multicellular/extracellular
Sample topics: ecology | physiology | community analysis | population dynamics | material properties | structure-function | heterogeneities | matrix |flow and transport in biofilm systems

Cellular/intracellular
Sample topics: phenotype | genetics | metabolic pathways | proteomics

ANALYTICAL TOOLS & TECHNIQUES

Instrumentation
Sample topics: microscopy | nuclear magnetic resonance imaging | gas chromatography | ToF SIMS |molecular biology techniques

Methods development
Sample topics: experimental design | variability | ruggedness | repeatability statistical evaluation

Modeling
Sample topics: cellular automata modeling | mathematics | hydrodynamics

Techniques
Sample topics: basic microbiological techniques |molecular biology techniques

RESEARCH:
2008–2009 CBE RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Bioelectrochemistry	Microbial fuel cells to power submersed electronic devices	Lewandowski	ONR
Bioremediation	Subsurface biofilm barriers for enhanced geologic sequestration of supercritical CO_2	Cunningham Spangler	DOE/ZERT
Bioremediation	Mechanistically-based field scale models of uranium biogeochemistry from up scaling pore-scale experiments and models [*2]	Seymour Codd	DOE
Bioremediation	Mobility of source zone heavy metals and radionuclides: The mixed roles of fermentative activity on fate and transport of U and Cr	Gerlach Peyton	DOE
Bioremediation	Seasonal, operational, and plant effects on oxygen potential and microbial responses influencing constructed wetland performance	Stein	USDA
Bioremediation	Biocomplexity: Biogeochemical cycling of heavy metals in contaminates sediments at Lake Coeur d'Alene [*2]	Peyton	NSF
Bioremediation	Identification of molecular and cellular responses of *Desulfovibrio vulgaris* biofilms under culture conditions relevant to field conditions for bioreduction of heavy metals	Fields	DOE
Bioremediation	Genome sequencing of multiple *Anaeromyxobacter* species: Comparative genomics for insight into the ecophysiology, genetics and evolution of metal-reducing and halorespiring bacteria	Fields	DOE
Bioremediation	Rapid deduction of stress pathways in metal reducing bacteria	Fields	DOE via University of Oklahoma
Bioremediation	Effects of groundwater chemistry on the distribution of soil microorganisms in natural media	Fields	Oak Ridge National Lab
Bioremediation	Subsurface biotechnology	Fields	Inland Northwest Research Alliance
Bioremediation	Environmental responses to geologic CO_2 sequestrations	Cunningham	DOE
Bioremediation	Microbial activity and precipitation at solution-solution mixing zones in porous media	Gerlach	DOE
Education	Biofilms: The Hypertextbook	Cunningham Ross	NSF
Education	Partners in Science program	Pulcini	MJ Murdock Charitable Trust

Research Area	Title	Principal Investigator	Funding Agency
Energy	Extremophilic microalgae: Advanced lipid and biomass production for biofuels and bioproducts	Peyton Fields	DOE
Industrial and Environmental Water Treatment	Control of microbial processes for enhanced water treatment using floating island treatment systems	Cunningham Camper	MBRCT
Industrial and Environmental Water Treatment	Towards sustainable materials for drinking water infrastructure	Camper	NSF
Industrial and Environmental Water Treatment	Synthesis document on the state of science of molecular techniques for application to the drinking water industry	Camper Burr Nocker	AwwaRF
Industrial and Environmental Water Treatment	Biodegradation of HAAs in distribution systems	Camper	AwwaRF via University of Minnesota
Industrial and Environmental Water Treatment	Investigation of the mode of action of stannous chloride as an inhibitor of lead corrosion	Camper	AwwaRF via University of Minnesota
Industrial and Environmental Water Treatment	Effect of nitrification on corrosion in the distribution system	Camper	AwwaRF via Virginia Tech
Medical Biofilms	Determination of proteins and peptides unique to MRSA biofilms	James	Columbia Biosystems
Medical Biofilms	*Staphylococcus aureus* and production of toxic shock syndrome toxin	Lewandowski	Procter & Gamble
Medical Biofilms	Transcutaneous devices permitting skin cell attachment	Stewart James	NIH via University of Washington
Medical Biofilms	Mobilization of *Candida albicans* biofilms	Suci	NIH
Medical Biofilms	Healing chronic wounds by controlling microbial biofilm	Stewart James	NIH
Medical Biofilms	Non-invasive clinical device that is effective in clearing persistent infections in prosthetic knee implants	McLeod	MTBRC
Medical Biofilms	Novel chemical analysis of the biofilm-biomaterial interface	Carlson	NIH via University of Illinois
Medical Biofilms	Development of bismuth-thiol based therapeutic agents for treating chronic wounds	Stewart	MBRCT
Natural Organic Matter	Collaborative proposal: Biogeochemistry of dissolved organic matter in Pony Lake, Ross Island[3]	Foreman	NSF

Research Area	Title	Principal Investigator	Funding Agency
Natural Organic Matter	Collaborative research: The biogeochemical evolution of dissolved organic matter in a fluvial system on the Cotton Glacier, Antarctica	Foreman	NSF
Physiology & Ecology	A genome to geochemical analysis of geothermal features in Yellowstone National Park[4]	Gerlach, Peyton, Inskeep, McDermott, Fields	NASA
Physiology & Ecology	Role of non-coding RNAS in *P. aeruginosa* biofilm development[1]	Franklin	NIH
Physiology & Ecology	Localized gene expression in *P. aeruginosa* biofilms[1]	Franklin	NIH
Physiology & Ecology	Virtual institute for microbial stress & survival	Fields	Lawrence Berkley National Lab
Physiology & Ecology	Methanogenesis in subglacial environments --- biosignatures of extraterrestrial life	Mitchell	MSGC-NASA
Physiology & Ecology	Metabolic engineering of *Alicyclobacillus acidocaldarius* for lactic acid production from biomass derived monosaccharides	Carlson	Idaho National Lab
Standardized Biofilm Methods	Antimicrobial test methodology	Goeres	EPA
Standardized Biofilm Methods	Research support for standardizing a comprehensive biofilm efficacy test system	Goeres Cunningham	MBRCT
Structure-Function	Cohesive strength & detachment of bacterial biofilms	Stewart	NSF via University of Minnesota

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

[1]MSU Department of Microbiology
[2]MSU Department of Chemical and Biological Engineering
[3]MSU Department of Land Resources & Environmental Sciences
[4]MSU Thermal Biology Institute

List of Acronyms

AwwaRF American Water Works Association Research Foundation
DOE U.S. Department of Energy
EPA U.S. Environmental Protection Agency
MSGC Montana Space Grant Consortium
MBRCT Montana Board of Research and Commercialization Technology
NASA National Aeronautics and Space Administration
NIH National Institutes of Health
NSF National Science Foundation
ONR Office of Naval Research
USDA U.S. Department of Agriculture
ZERT Zero Emissions Research and Technology

RESEARCH:
FY 2009 New CBE Research Grants

SPONSOR	TITLE	PI	PERIOD	AMOUNT
Montana Board of Research and Commercialization Technology	Development of Bismuth-thiol Based Therapeutic Agents for Treating Chronic Wounds	Stewart	1 yr	100,470
Montana Board of Research and Commercialization Technology	Control of Microbial Processes for Enhanced Water Treatment Using Floating Island Treatment Systems	Cunningham/ Camper	2 yr	250,316
Montana Board of Research and Commercialization Technology	Research Support for Standardizing a Comprehensive Biofilm Efficacy Test System	Goeres/ Cunningham	2 yr	133,970
EPA	Crystal Richards EPA Fellowship	Camper	3 yr	8,134
Columbia Biosystems	Determination of Proteins and Peptides Unique to MRSA Biofilms	James	1 yr	142,023
DOE EPSCoR	Environmental Responses to Geologic CO_2 Sequestrations	Cunningham	3 yr	1,440,000
DOE-ZERT	Basic Science of Retention Issues, Risk Assessment & Measurement, Monitoring & Verification for Geologic CO_2 Sequestrations	Cunningham	1 yr	187,669
DOE	Extremophilic Microalgae: Advanced Lipid and Biomass Production for Biofuels and Bioproducts	Peyton/ Fields	3 yr	900,583
NSF	Collaborative Research: The Biogeochemical Evolution of Dissolved Organic Matter in a Fluvial System on the Cotton Glacier, Antarctica	Foreman	3 yr	314,503
DOE-ERSP	Microbial Activity and Precipitation at Solution-Solution Mixing Zones in Porous Media	Gerlach	3 yr	331,138
	Total grant awards to CBE for FY 2009			$3,808,806

RESEARCH:
CBE Associated Faculty and Their Specialties, 2008–2009

NAME	DEPARTMENT	SPECIALTY
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
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	Land Resources & Environ Sciences	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
Thom Hughes	Cell Biology & Neuroscience	Fluorescent proteins, genetically encoded biosensors
Garth James	Chemical & Biological Engineering	Medical biofilms
Warren Jones	Civil Engineering	Water distribution systems
Isaac Klapper	Mathematical Science	Mathematical modeling
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure
Tom Livinghouse	Chemistry & Biochemistry	Organic synthesis, signaling analogues
Bruce McLeod	Electrical & Computer Engineering	Bioelectric effect
David Miller	Mechanical & Industrial Engineering	Experimental mechanics
Andy Mitchell	Civil Engineering	Geomicrobiology
Al Parker	Statistics	Statistical models in biofilm systems
Brent Peyton	Chemical & Biological Engineering	Environmental biotechnology and bioremediation
Barry Pyle	Microbiology	Environmental, water, and food microbiology
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
Peter Suci	Microbiology	Fungal biofilms
Tianyu Zhang	Mathematics	Mathematical modeling

RESEARCH:
PUBLICATIONS
June 2008–May 2009

2008 Publications

Borch T, Camper AK, Biederman JA, Butterfield PW, Gerlach R, Amonette JE, "Evaluation of characterization techniques for iron pipe corrosion products and iron oxide thin films," *J Environ Eng* 2008; 134(10):835–844. Abstract 08-033

Carlson RP, Taffs R, Davison W, Stewart P, "Anti-biofilm properties of chitosan-coated surfaces," *J Biomater Sci Polymer Edn* 2008; 19(8):1035–1046. Abstract 08-018

Christner BC, Cai R, Morris CE, McCarter KS, Foreman CM, Skidmore ML, Montross SN, Sands DC, "Geographic, seasonal, and precipitation chemistry influence on the abundance and activity of biological ice nucleators in rain and snow," *PNAS* 2008; 105(48):18854–18859. Abstract 08-027

Christner BC, Skidmore ML, Priscu JC, Tranter M, Foreman C, "Bacteria in subglacial environments," In: *Psychrophiles: From Biodiversity to Biotechnology*, eds: Margesin R, Schinner F, Marx J-C, and Gerday C, Springer-Verlag, 2008; pp. 51–71. Abstract 08-030

Cunningham AB, Gerlach R, Spangler L, Schultz L, Mitchell AC, "Microbially enhanced geologic containment of sequestered supercritical CO_2," In: *Proceedings of the 9th International Conference on Greenhouse Gas Technologies*, 16–20 November, 2008; Omni Shorehouse Hotel, Washington D.C.

Dewan A, Beyenal H, Lewandowski Z, "Scaling up microbial fuel cells," *Environ Sci Technol,* 2008; 42: 7643–7648. Abstract 08-025

Hornemann JA, Lysova AA, Codd SL, Seymour JD, Busse SC, Stewart PS, Brown JR, "Biopolymer and water dynamics in microbial biofilm extracellular polymeric substance," *Biomacromolecules,* 2008; 9(9):2322–2328. Abstract 08-022

James G, Swogger E, deLancey-Pulcini E, "Microbial ecology of human skin and wounds," In: *The Role of Biofilms in Device-Related Infections*, eds: Shirtliff M and Leid JG, Springer, 2008; pp1–14. Abstract 08-028

Klayman BJ, Klapper I, Stewart PS, Camper AK, "Measurements of accumulation and displacement at the single cell cluster level in *Pseudomonas aeruginosa* biofilms," *Environ Microbiol*, 2008; 10(9):2344–2354. Abstract 08-020

Mitchell AC, Phillips AJ, Hamilton MA, Gerlach R, Hollis WK, Kaszuba JP, Cunningham AB, "Resilience of planktonic and biofilm cultures to supercritical CO_2," *J Supercritical Fluids,* 2008; 47:318–325. Abstract 08-029

Mitchell A, Phillips A, Kaszuba J, Hollis W, Cunningham A, Gerlach R, "Microbially enhanced carbonate mineralization and the geologic containment of CO_2," *Geochimica et Cosmochimica Acta*, 2008; 72 (12):A636. Abstract 08-023

Mulholland T, Cunningham AB, Kania BG, Osterlund MT, Stewart FM, "Floating islands as an alternative to constructed wetlands," *Land Contamination and Reclamation*, 2008; 16(1):25–33. Abstract 08-035

Naumenko EA, Naumova AV, Suvorova ES, Gerlach R, Ziganshin AM, Lozhkin AP, Silkin NI, Naumova RP, "Participation of oxygen in the bacterial transformation of 2,4,6-trinitrotoluene," *Biochemistry* (Moscow), 2008; 73(4):463–469. Abstract 08-026

Perez-Osorio AC, and Franklin MJ, (2008) "Isolation of RNA and DNA from biofilm samples obtained by laser capture micro-dissection microscopy," *Cold Spring Harbor Protocols,* 2008; doi:10.1101/pdb.prot5065. Abstract 08-036

Perez-Osorio AC and M.J. Franklin MJ, "qRT-PCR of microbial biofilms," *Cold Spring Harbor Protocols,* 2008; doi:10.1101/pdb.prot5066. Abstract 08-037

Pitts B and Stewart P, "Confocal laser microscopy on biofilms: Successes and limitations," *Microscopy Today,* 2008; July:18–22. Abstract 08-019

Priscu JC, Tulaczyk S, Studinger M, Kennicutt II MC, Christner BC, Foreman C, "Antarctic subglacial water: Origin, evolution and ecology," In: *Polar Lakes and Rivers*, eds: Vincent W and Laybourn-Parry J, Oxford Press, 2008; pp 119–136. Abstract 08-003

Tomasino SF, Pines RM, Cottrill MP, Hamilton MA, "Determining the efficacy of liquid sporicides against spores of *Bacillus subtilis* on a hard nonporous surface using the quantitative Three Step Method: Collaborative study," *J AOAC International*, 2008; 91(4): 833–852. Abstract 08-024

Veluchamy R, Beyenal H, Lewandowski Z, "Characterizing temporal development of biofilm porosity using artificial neural networks," *Wat Sci Technol,* 2008; 57(12):1867–1872. Abstract 08-021

Viamajala S, Gerlach R, Sivaswamy V, Peyton BM, Apel WA, Cunningham AB, Petersen JN, "Permeable reactive biobarriers for in-situ Cr(VI) reduction: Bench scale tests using *Cellulomonas sp*. strain ES6," *Biotechnol Bioeng*, 2008; 101(6):1150–1162. Abstract 08-032

2009 Publications

Altman SJ, McGrath LK, Souza SA, Murton JK, Camper AK, "Integration and decontamination of *Bacillus cereus* in *Pseudomonas fluorescens* biofilms," *J Appl Microbiol*, 2009; 107:287–299. Abstract 09-016

Ammons MC, Ward LS, Fisher ST, Wolcott RD, James GA, "In vitro susceptibility of established biofilms composed of a clinical wound isolate of *Pseudomonas aeruginosa* treated with lactoferrin and xylitol," *Int J Antimicrob Agents*, 2009; 33:230–236. Abstract 09-012

Arce FT, Carlson R, Monds J, Veeh R, Hu FZ, Stewart PS, Lal R, Ehrlich GD, Avci R, "Nanoscale structural and mechanical properties of nontypeable *Haemophilus influenzae* biofilms," *J Bacteriol*, 2009; 191: 2512–2520. Abstract 09-010

Bauman WJ, Nocker A, Jones WL, Camper AK, "Retention of a model pathogen in a porous media biofilm," *BiofoulinG,* 2009; 25(3):229–240. Abstract 09-004

Carlson RP, "Decomposition of complex microbial behaviors into resource-based stress responses," *Bioinformatics,* 2009; 25(1):90–97. Abstract 09-020

Goeres DM, Hamilton MA, Beck NA, Buckingham-Meyer K, Hilyard JD, Loetterle LR, Lorenz LA, Walker DK, Stewart PS, "A method for growing a biofilm under low shear at the air-liquid interface using the drip flow biofilm reactor," *Nature Protocols*, 2009; 4(5):783–788. Abstract 09-018

Hornemann JA, Codd SL, Fell RJ, Stewart PS, Seymour JD, "Secondary flow mixing due to biofilm growth in capillaries of varying dimensions," *Biotechnol Bioeng*, 2009; 103(2):353–360. Abstract 09-011

Hornemann JA, Codd SL, Romanenko KV, Seymour JD, "T2-T2 exchange in biofouled porous media," *Diffusion Fundamentals*, 2009; 10:1.1–1.3. Abstract 09-017

Hwang C, Wu W, Gentry T, Carley J, Corbin G, Carroll S, Watson D, Jardine P, Zhou J, Criddle C, Fields M, "Bacterial community succession during in situ uranium bioremediation: Spatial similarities along controlled flow paths," *ISME J*, 2009; 3:47–64. Abstract 09-006

Kim J, Hahn JS, Franklin MJ, Stewart PS, Yoon J, "Tolerance of dormant and active cells in *Pseudomonas aeruginosa* PAO1 biofilm to antimicrobial agents," *J Antimicrob Chemother,* 2009; 63:129–135. Abstract 09-001

Leach LH, Zhang P, LaPara TM, Hozalski RM, Camper AK, "Detection and enumeration of haloacetic acid-degrading bacteria in drinking water distribution systems using dehalogenase genes,"*J Appl Microbiol*, 2009; 107(3):978–988. Abstract 09-015

Lewandowski Z and Beyenal H, "Mechanisms of microbially influenced corrosion," In: *Marine and Industrial Biofouling*, eds: Flemming H-C, Murthy PS, Venkatesan R and Cooksey KE, Springer, 2009; pp. 35–65. Abstract 09-003

Mitchell AC, Phillips A, Hiebert R, Gerlach R, Cunningham AB, "Biofilm enhanced subsurface sequestration of supercritical CO_2," *Int J Greenhouse Gas Control*, 2009; 3(1): 90–99. Abstract 09-014

Nocker A, Camper AK, "Novel approaches toward preferential detection of viable cells using nucleic acid amplification techniques," *FEMS Microbiol Lett* 2009; 291(2):137–142. Abstract 09-002

Nocker A, Mazza A, Masson L, Camper AK, Brousseau R, "Selective detection of live bacteria combining propidium monoazide sample treatment with microarray technology," *J Microbiol Meth,* 2009; 76(3):253–261. Abstract 09-007

Polerecky L, Bissett A, Al-Najjar M, Faerber P, Osmers H, Suci PA, Stoodley P, de Beer D, "Modular spectral imaging system for discrimination of pigments in cells and microbial communities," *Appl Environ Microbiol,* 2009; 75(3) 758–771. Abstract 09-019

Priscu JC, Foreman CM, (2009) "Lakes of Antarctica," In: *Encyclopedia of Inland Waters*, ed: Likens GE, Oxford: Elsevier, 2009; Vol2: 555–566 Abstract 09-021

Sellam A, Al-Niemi T, McInnerney K, Brumfield S, Nantel A, Suci PA, "A *Candida albicans* early stage biofilm detachment event in rich medium," *BMC Microbiol*, 2009; 9(1):25. Abstract 09-009

Takenaka S, Pitts B, Trivedi HM, Stewart PS, "Diffusion of macromolecules in model oral biofilms," *Appl Environ Microbiol*, 2009; 75(6):1750–1753. Abstract 09-008

Zhang Y, Griffin A, Rahman M, Camper A, Baribeau H, Edwards M, "Lead contamination of potable water due to nitrification," *Environ Sci Technol,* 2009; 43(6):1890–1895. Abstract 09-005

RESEARCH:
MSU shares in $1.4 million grant for carbon sequestration research

MSU News Services, January 22, 2009
by Michael Becker

Researchers at Montana State University, Montana Tech and the University of Montana have been awarded a $1.4 million grant from the Department of Energy to study the effects carbon sequestration sites may have on the surrounding environment.

The project will study the environmental effects of geologic carbon sequestration, which involves injecting large volumes of liquefied carbon dioxide deep underground. Storing CO2 underground keeps it out of the atmosphere and keeps it from contributing to global climate change.

"I see this as bringing other contributors from outside of MSU into a research program that is very important to the entire state," said Al Cunningham, the grant's principal investigator and a professor at MSU's Center for Biofilm Engineering.

Cunningham noted the importance of carbon capture and sequestration to the development of "clean coal" technologies in Montana. Developing ways to keep CO2 out of the atmosphere will allow the state to use its large coal reserves without contributing to net global CO2 emissions, he said.

Using advanced magnetic resonance imaging technology, researchers will study the effects of injecting large volumes of CO2 into porous underground rocks. These injections could affect the rock's pore structures, their material properties or the microbial activity in the rocks, which could affect how well CO2 is sequestered in those rocks.

The project's second goal is to understand how increased levels of carbon dioxide may affect microbes and plants near sequestration sites. Excess CO2 can cause stress on plants and microbes. Observing this stress can give scientists an indicator of whether a sequestration site is leaking CO2. That study will be done through a series of field experiments at a test site just west of MSU.

Researchers from the University of Montana and Montana Tech will be involved in both objectives, Cunningham said.

Collaborations between different campuses, even within the same state, are valuable, Cunningham said.

"I think, personally, that direct research collaboration between the three campuses is something to be encouraged," he said. "This project will bring in talents and capabilities we don't have at MSU and focus them on carbon sequestration."

The grant, awarded in September, will last three years with the possibility of a three-year renewal. The money will be split between the campuses, Cunningham said.

The grant comes from the Department of Energy's Experimental Program to Stimulate Competitive Research, referred to as EPSCoR. Five DOE national laboratories will also be involved in the funded research.

Cunningham's grant and project are not connected with the work being done by the MSU-based Big Sky Carbon Sequestration Partnership, he said, though the project's focus is related to that group's sequestration work.

Contact: Al Cunningham at 406-994-6109 or at al_c@biofilm.montana.edu

Wound Biofilm Retreat
February 4, 2009
Hilton Garden Inn, Bozeman

Montana State University
Center for Biofilm Engineering

1:00–1:20
Lactoferrin, xylitol and the inhibition of *Pseudomonas aeruginosa* biofilms
Mary Cloud Ammons, Research Scientist, CBE

1:20–1:40
Oxygen concentration gradients in biofilms formed by wound isolates
Haluk Beyenal, Assistant Professor, Chemical and Bioengineering, Washington State University, Pullman, WA

1:40–2:00
Scratch model of biofilm infection
Kelly Kirker, Research Scientist, CBE

2:00–2:20
Host/pathogen interactions in an in vitro chronic wound model
Pat Secor, PhD Candidate, Cell Biology, CBE

2:20–2:30
CBE strategy for moving forward
Phil Stewart, CBE Director

3:00–4:00
New technologies: Posters from member companies

4:00–5:00
Roundtable discussion: Critical questions/steps

RESEARCH: PRESENTATIONS June 2008–May 2009

108th General Meeting of the American Society for Microbiology, June 2008

Anne Camper presented "Disinfection of biofilms," at the ASM General Meeting, Boston, MA, May 31–June 5, 2008.

Melinda Clark, PhD candidate, presented the poster "Transcriptomic and proteomic analysis of *Desulfovibrio vulgaris* ATCC 29579 biofilms under conditions conducive to metal reduction," at the ASM General Meeting, Boston, MA, May 31–June 5, 2008.

Matthew Fields presented "Biodiversity and spatial concordance of an engineered subsurface environment," at the ASM Conference, Boston, MA, May 31–June 5, 2008.

Chiachi Hwang, PhD candidate, presented a poster "Genomic and physiological characterization of *Anaeromyxobacter* fw109-5, a metal- and nitrate-reducing bacterium isolated from uranium-contaminated sediment," at the ASM General Meeting, Boston, MA, May 31–June 5, 2008.

Garth James presented the following posters at the ASM General Meeting, Boston, MA, May 31–June 5, 2008:

> "Penetration and efficacy of daptomycin in staphylococcal biofilms," co-authors: Steenbergen J, Davison W, Boegli L, Stewart P.
>
> "In vitro urinary catheter biofilm models: A comparison of Foley catheter and drip flow reactor models," Co-authors: Abdul Rani S, Belisle B, Khosrovi D, Celeri C, Bassiri M, Bickle L, de Lancey-Pulcini E.
>
> "Production of cell-cell signaling molecules by bacteria isolated from human chronic wound biofilms," co-authors: Colacino KR, Zander C, Pulcini ED, Rhoads D, Wolcott R, James G, Rickard AH.

Laura K. Jennings, PhD candidate, presented the poster "Proteomic and transcriptomic analyses reveal genes upregulated by cis-dichloroethene in *Polaromonas sp*. JS666," (co-authors: Nishino SF, Payne RB, Spain JC, and Gossett JM) at the 108th ASM General Meeting, Boston, MA, June 1–5, 2008.

Anitha Sundararajan, PhD candidate, presented a poster "Transcriptomic characterization of a sensory-box mutant during transitions between aerobic and anoxic growth conditions," at the ASM General Meeting, Boston, MA, May 31–June 5, 2008.

Laura Jennings, visiting PhD student from Cornell University, presented the poster "Proteomic and transcriptomic analyses reveal genes upregulated by cis-dichloroethene in Polaromonas sp. JS666" (co-authors: Nishino SF, Payne RB, Spain JC, and Gossett JM) at the 108th General Meeting of the American Society for Microbiology, Boston, MA, June 1–5, 2008.

Ross Carlson presented the poster "Laser desorption 7.87 eV Postionization mass spectrometry of antibiotics in *S. epidermidis* bacterial biofilms," at the ASMS 56th Conference, Denver, CO, June 1–5, 2008. Co-authors also included: Gasper GL, Akhmetov A, Moore JF, and Hanley L.

Phil Stewart presented "Research and industrial interaction at the Center for Biofilm Engineering," at the 2008 New Frontiers Conference: Propelling Montana Research in Bozeman, MT, June 2, 2008.

Phil Stewart gave a keynote lecture, "Antimicrobial tolerance in staphylococcal biofilms," to the Japanese Society for Chemotherapy, Okayama, Japan, June 7, 2008.

Anne Camper presented "Pathogens and biofilms," at the AWWA Annual Meeting, Atlanta, GA, June 8–10, 2008.

Christine Foreman served on the panel for the NASA ASTEP (Astrobiology Science and Technology for Exploring Planets) in Pasadena, CA, June 9–13, 2008. The ASTEP program combines the science and technology communities in order to validate and improve existing technology enabling future space missions to test for life in our solar system and beyond.

Bruce McLeod presented "The use of electromagnetic fields to augment the efficacy of antibiotics used to control bacterial biofilms found in prosthetic knee implants," at the Bioelectromagnetics Society (BEMS) meeting in San Diego, CA, June 9, 2008. Bruce and Robin Patel, MD, (Mayo Clinic College of Medicine, Rochester, MN) opened the first session: "Bench to Bedside 1: Biofilms neuroprotection."

Sarah Codd gave an invited seminar "Magnetic resonance microscopy studies of fluid dynamics in complex systems," at the Sir Peter Mansfield Magnetic Resonance Centre at the University of Nottingham, Nottingham, UK, June 2008.

Ross Carlson presented the poster "Laser desorption 7.87 eV Postionization mass spectrometry of antibiotics in *S. epidermidis* bacterial biofilms," (co-authors: Gasper GL, Akhmetov A, Moore JF, and Hanley L.) 30th Annual Symposium on Applied Surface Analysis, Pennsylvania State University, University Park, PA, June 11–13, 2008.

Sarah Codd presented "Magnetic resonance studies of biofilm systems," Magnetic Resonance Research Center, Cambridge University, Cambridge UK, June 26, 2008.

Joe Seymour presented "Magnetic resonance microscopy of transport dynamics: What can it tell us about structure function relationships of materials?" Department of Chemical Engineering and Magnetic Resonance Research Center, Cambridge University, Cambridge UK, June 26, 2008.

Rocky Ross presented "Hypertextbooks and a hypertextbook authoring environment," a presentation that showcased *Biofilms: The Hypertextbook* at the Innovation and Technology in Computer Science Education (ITiCSE), Madrid, Spain, June 28–July 2, 2008. He was also a member of a 4-day working group that produced the report "Design patterns for online learning environments." Subsequently he attended the Program Visualization Workshop, which also convened in Madrid on July 3 and 4, as a program committee member and session chair.

Andrew Mitchell presented "Microbially enhanced carbonate mineralization and containment of CO_2," at the Goldschmidt Conference, Vancouver, Canada, July 11–19, 2008. The abstract has been published in a supplemental issue of *Geochimica et Cosmochimica Acta*. 72 (12), A636.

Jennifer Hornemann presented the following research poster at the 9th International Bologna Conference of Magnetic Resonance in Porous Media (MRPM9) and won best poster out of 114 posters. Hornemann JA, Codd SL, Seymour JD, Romanenko K, "Magnetic resonance microscopy application to biofouling in porous media," P-096 9th International Bologna Conference of Magnetic Resonance in Porous Media (MRPM9), Cambridge, MA, USA, July 13–17, 2008.

Joe Seymour as an invited speaker presented "Magnetic resonance measurement of the interplay of structure and transport in porous media," at the 9th Biannual Magnetic Resonance in Porous Media (MRPM) Conference, Cambridge, MA, July 13–17, 2008.

Taimur Khan presented the research poster "Control of biofilm accumulation on chitosan-coated antimicrobial surfaces" at the IWA Young Water Professional Conference, University of California, Berkeley, CA, July 16–18, 2008. Co-authors on the poster were: Stewart PS, Nelson S, and Camper AK. He also participated in a discussion panel on hybrid processes for surface/seawater treatment.

Betsey Pitts presented "Using fluorescence microscopy to assess microbial activity and antimicrobial performance in biofilms," Microscopy & Microanalysis 2008 Meeting, Albuquerque, NM, August 3–7, 2008.

Anne Camper presented "The current state of biofilm and nitrification research" at the 5th Annual EPA Drinking Water Workshop: Treatment and distribution system compliance challenges, Cincinnati, OH, August 4–7, 2008.

Mari Eggers and Crescentia Cummins presented the poster "Community based risk assessment on the Crow Reservation" at the National Institute for Health's IDeA Conference, Washington, DC, August 6–8, 2008. Co-authors were: Plaggemeyer S, Richards CL, (Crow Environmental Health Steering Committee), Goes Ahead J, Lopez A, Plenty Hoops A, White Clay M, Hugs J, Broadaway SC, Hamner S, Camper AK, and Ford TE.

Ross Carlson presented the poster "Decomposition of complex microbial behaviors into ecologically relevant stresses," at the International Society of Microbial Ecology 2008 Meeting, Cairns, Australia, August 17–22, 2008.

Ross Carlson presented the poster "In silico analysis of material and energy flux in a microbial mat community" (co-authors: Aston J, Brileya K, Fields M, Gerlach R, Inskeep W, Jay Z, Klatt C, Mallette N, McGlynn S, Montross S, Skidmore M, Taffs R, and Ward D) at the International Society of Microbial Ecology 2008 Meeting, Cairns, Australia, August 17–22, 2008.

Zbigniew Lewandowski was an invited lecturer at the National University of Ireland, Galway, Ireland, August 25–September 2, 2008. He delivered several lectures including "Quantifying biofilm structure and activity," "The concept of stratified biofilms," "Mechanisms of microbially influenced corrosion,"and "From microbial corrosion to microbial fuel cells."

Rocky Ross as an invited speaker presented *Biofilms: The Hypertextbook* at a plenary session and in a poster session at the Society of General Microbiology (SGM) Conference, Trinity College, Dublin, Ireland, September 8, 2008.

Zbigniew Lewandowski participated in several significant activities at the IWA Water Congress, Vienna, Austria, September 8−12, 2008. He chaired the session "Biofilm Processes," and presented a paper "Characterizing temporal development of biofilm porosity using artificial

neural networks." This paper has been published as "Characterizing temporal development of biofilm porosity using artificial neural networks," Angathevar Veluchamy RR, Beyenal H, Lewandowski Z, *Water Science and Technology* 57:1867–1872, 2008. He chaired the meeting of the IWA Biofilm Specialist Group. Working with the chairs of two other specialist groups—Water Reuse and Membrane Technology—Dr. Lewandowski helped organized a workshop, "Biofouling of membranes for water and wastewater." He presented "Mechanisms of biofilm processes," for the workshop. He also participated in the meeting of the organizing committee of the Biofilm Reactors Conference. It will be organized jointly by the Water Environment Federation (WEF) and the International Water Association (IWA). The conference is scheduled for 2010.

Phil Stewart presented "Physics and physiology of staphylococcal biofilms," Syracuse University, NY, September 12, 2008.

Christine Foreman lectured at the Museum of Natural History in Cleveland, OH, September 12 –13, 2008. She presented "Polar Palooza: Stories from a changing planet" and a hands-on-children's activity "A celebration of polar research," as part of the Explorer's Lecture Series.

Matthew Fields presented "Biodiversity and spatial dynamics of an engineered subsurface environment" at the MicroEnGen-IV: 4th SCOPE Workshop on Microbial Environmental Genomics, Central South University, Changsha, China, September 17–24, 2008.

Mari Eggers et al. participated on the panel: "Community based risk assessment on the Crow reservation," Montana INBRE Faculty Networking Forum, Pablo, MT, September 18–19, 2008. Other panel members included: Cummins C, Plaggemeyer S, Richards CL, (Crow Environmental Health Steering Committee), Goes Ahead J, Lopez A , Plenty Hoops A, White Clay M, Hugs J, Broadaway SC , Hamner S, Camper AK , and Ford TE.

Phil Stewart presented "Alternative strategies for biofilm control" at a workshop focusing on biofilms and biocorrosion sponsored by the Army Research Office, on September 22, 2008, Dallas, TX.

Christine Foreman presented the poster "DOC, microbial abundance and activity in the Upper WAIS Divide Core" at the annual science meeting for the West Antarctic Ice Sheet Divide Project, Denver, CO, September 30–October 2, 2008. Poster co-authors: McConnell J and Priscu JC.

Sabrina Behnke presented the poster "Chlorine susceptibility of *Salmonella typhimurium* and biofilm detachment characteristics" at the Montana American Water Resources Association (AWRA) conference, October 2–3, 2008 in Big Sky, MT.

Lisa Kirk won second place for a student presentation "In-situ subsurface microbial transformation of selenium as source control in backfilled phosphate overburden, SE Idaho," at the Montana American Water Resources Association (AWRA) conference, October 2–3, 2008 in Big Sky, MT.

Phil Stewart presented "Visualization of antimicrobial action in *Staphylococcus epidermidis* biofilms" at the International Biofilms III Conference in Munich, Germany, October 4–9, 2008.

Mervin Failing, a Bridging Tribal College Student to MSU (summer program) received the Best Poster award for "Response of bacteria to freezing," at the Society for Advancement of Chicanos and Native Americans in Science, Salt Lake City, UT, October 9–12, 2008. Mervin is a student at Ft. Peck Community College, MT, majoring in education. For his efforts, Mervin received a certificate and $500. Poster co-authors: Dieser M, Pitts B, and Foreman CM.

Christine Foreman presented two talks—"Impact of climate change on polar organisms" and "Stories from a changing planet"—as well as teacher workshops at the Society for Advancement of Chicanos and Native Americans in Science, Salt Lake City, UT October 9 –12, 2008.

Elinor Pulcini presented "Biofilms, antimicrobial device testing protocols, and FDA requirements," Anti-microbial Focus Group Meeting, Medtronic Spinal Division, Toronto, Canada, October 16, 2008.

Ross Carlson presented the poster "A laser desorption vacuum ultraviolet post-ionization imaging mass spectrometer for biological sample analysis," (co-authors: Moore JF, Akhmetov A, Gasper GL, Blaze M, and Hanley L), AVS 55th International Symposium, Boston, MA, October 19–24, 2008.

Al Cunningham and Lee Spangler presented "An overview of geologic storage projects in a US-DOE regional carbon sequestration partnership and research activities in the zero emission research and technology collaborative (ZERT)," at the Geological Storage of CO_2 International Seminar, University of Stuttgart, Germany, October 20–22, 2008.

Phil Stewart as an invited speaker presented "Antimicrobial tolerance in staphylococcal biofilms," at the 48th Annual ICAAC/IDSA 46th Annual Meeting, Washington, DC, October 25–28, 2008.

Garth James presented "Prevention of *S. aureus* biofilm in vitro using 5-FU-coated central venous catheters" at the 48th Annual ICAAC/IDSA 48th Annual Meeting, Washington, DC, October 25−28, 2008. Co-authors: S Fisher S, Rosebrough SF, and Perry JE.

Christine Foreman presented a webinar to teachers on "Life in icy environments" through the Arctic Research Consortium of the US (ARCUS), October 29, 2008. The podcast is archived at: http://67.202.210.57/launcher.cgi?room=ARCUS_Live_2008_1029_1839_24 Room ID: ARCUS_Live

Phil Stewart presented a seminar "Diverse phenotypes in biofilms: Implications for antimicrobial control," Department of Microbiology, University of Washington, Seattle, WA, November 4, 2008.

Otto Stein traveled to Indore, India, where he attended the 11th International Conference on Wetland Systems for Water Pollution Control. It is sponsored by the International Water Association (IWA) specialty group on constructed wetlands (analogous to the Biofilm group). He presented the following papers. Three CBE graduate students appear as authors on the papers: **Jennifer Faulwetter**, **Rickey Schultz**, and **Carrie Taylor**.

Faulwetter JL, Burr MD, Stein OR, Camper AK. 2008. "Characterization of sulfate reducing bacteria in constructed wetlands." *Proc. 11th International Conference on Wetland Systems for Water Pollution Contro*l, November 1–7, 2008. Indore, India. Accepted.

Schultz RL, Stein OR, Hook PB. 2008. "Temperature, plant species and residence time interactions in treatment wetlands," *Proc. 11th International Conference on Wetland Systems for Water Pollution Control*, November 1–7, 2008. Indore, India. Accepted.

Taylor CL, Stein OR, Hook PB, Zabinski CA. 2008. "Comparing 19 plant species' seasonal effects on COD removal in model constructed wetlands," *Proc.11th International Conference on Wetland Systems for Water Pollution Control*, November 1–7, 2008. Indore, India. Accepted.

Rousseau DPL, Shi W, Stein OR, Hook PB. 2008. "Simulation of carbon, nitrogen and sulphur cycles in lab scale constructed wetlands," *Proc. 11th International Conference on Wetland Systems for Water Pollution Control*, November 1–7, 2008. Indore, India. Accepted. (The Rousseau paper was prepared with collaborators at UNESCO (United Nations in The Netherlands), based on data collected by **Joel Biederman** and **Winthrop Allen** (two CBE students from 9–10 years ago).

Pat Secor, PhD candidate, presented "Host pathogen interactions in an in vitro biofilm model" at Molecular Probes in Eugene, OR, November 13, 2008.

Phil Stewart visited Ciba Specialty Chemicals, Tarrytown, NY, and presented "Biofilm basics, methods, and control," November 14, 2008.

Anne Camper gave the following presentations at the Water Quality Technology Conference, Cincinnati, OH, November 15-19, 2008.
Workshop presentation: "Nitrifying biofilms and 'new' organisms: Household plumbing simulations."
Conference presentation: "Nitrification in a simulated domestic plumbing system," (co-author Rahman MS).
Poster presentation: "Isolation and characterization of a heterotrophic nitrifying bacterium from a reactor that simulates premise plumbing,"(co-authors Encarnacion GD, Leach LH, Rahman MS, Hisey BS).

Phil Stewart was invited to present "Physics and physiology of staphylococcal biofilms" at the Division of Biological Sciences, University of Montana, Missoula, MT, November 24, 2008.

Ross Carlson presented "Modeling community function from interactions among individuals," at Pacific Northwest National Laboratory, Pascoe, WA, December 2, 2008.

Phil Stewart was invited to present "Four big hits at the Center for Biofilm Engineering" at the NSF Engineering Research Centers Annual Meeting, Bethesda, MD, December 5, 2008. The CBE was featured at the ERC meeting as one of four successful "graduated" centers from the program. The CBE graduated in 2001.

Joseph Seymour as an invited speaker presented "Magnetic resonance measurement of scale dependent dynamics in porous media: Interplay of structure and transport," (co-author **SL Codd**), Invited Talk H23H-01, American Geophysical Union Fall Meeting, San Francisco, CA, December 15–19, 2008.

Mari Eggers and Crescentia Cummins, Crow Environmental Health Steering Committee, presented the poster "Community based risk assessment on the Crow Reservation," at the NIH Summit: The Science of Eliminating Health Disparities, National Harbor, MD, December 16–18, 2008. Poster co-authors include: Plaggemeyer S, Richards CL, Goes Ahead J, Lopez A, Plenty Hoops A, White Clay M, Hugs J, Broadaway SC, Hamner S, Camper AK and Ford TE.

Christine Foreman made a presentation to eighth grade students, taught a workshop, and was Distinguished Lecturer at the Houston Museum of Natural Sciences "Polar Palooza: Stories from a changing planet," January 13, 2009. Christine also presented "Life in ice" at the Earth Sciences Colloquium at Rice University, Houston, TX, January 12, 2009.

Elinor Pulcini and **Paul Anderson**, visiting researcher and Bozeman science teacher, attended the Partners in Science Conference in San Diego, CA, January 15–21, 2009. Paul presented a poster, "Effects of antibiotic resistance on biofilm formation capabilities in clinical isolates." Partners in Science is a program funded by the MJ Murdock Charitable Trust of Vancouver, WA, to encourage partnerships between universities and high school teachers.

Anne Camper presented "Your drinking water: Capturing bacterial pathogens using microbial slimes," at the *Bringing the U to You* evening lectures, Heritage Hall, MSU–Great Falls, MT, January 29, 2009.

Crescentia Cummins and **Mari Eggers** presented the poster "Mercury levels detected in fish from rivers of the Crow Reservation, Montana" at the 2009 SCREES National Water Conference, St. Louis, MO, February 8–11, 2009. Poster co-authors are: Hamner S, Camper AK and Ford TE.

Matthew Fields presented "Temporal and spatial organization within a syntrophic bacterial-archael biofilm" and "Characterization of metal-reducing communities and isolates from uranium-contaminated groundwater and sediments," at the DOE-GTL PI Awardee Workshop, Bethesda, MD, February 8–12, 2009.

Al Cunningham and Frank Stewart presented "Control of microbial processes for enhanced water treatment using floating island treatment systems," for the Montana Board of Research and Commercialization Technology in Helena, MT, February 10, 2008.

Darla Goeres and **Matthew Radons**, an undergraduate in Chemical and Biological Engineering, presented two posters "Bringing research tools to a commercial market," and "Research support for designing a comprehensive biofilm efficacy test system," at the Montana Board of Research and Commercialization Technology poster session, Helena, MT, February 10, 2009.

Phil Stewart presented "Evaluation of bismuth thiols: Antiseptics against bacteria isolated from chronic wounds," for the Montana Board of Research and Commercialization Technology in Helena, MT, February 10, 2009.

Ross Carlson presented the poster "Laser desorption vacuum ultraviolet post-ionization mass spectrometry of small molecule analytes within intact bacterial biofilms," (co-authors: Gasper GL, Akhmetov A, Moore JF, and Hanley L), 2009 Gaseous Ions Gordon Research Conference, Galveston, TX, March 1–6, 2009.

Matthew Fields presented "Ecological and cellular responses of Desulfovibrio to physiological constraints," at Southern Illinois University, Carbondale, IL, March 6, 2009.

Ross Carlson presented "The effect of quorum-sensing on *Escherichia coli* biofilm formation and antibiotic tolerance" at the Pacific Northwest American Institute of Chemical Engineers Regional Meeting, Vancouver, BC, Canada, March 6–7, 2009. Co-authors: Zuroff TR, Lloyd-Randolfi J, Bernstein H.

Ross Carlson presented the poster "Laser desorption 7.87 eV post-ionization mass spectrometry of antibiotics in *S. epidermidis* bacterial biofilms," (co-authors: Gasper GL, Akhmetov A, Hanley L, and Moore JF, Pittcon 2009, Chicago, IL, March 9–13, 2009.

Matthew Fields presented "Lipid-derived biofuels: Determination of factors that control triglyceride accumulation in microalgae," at the Institute for Biological Engineering Conference, Santa Clara, CA, March 20, 2009.

Robin Gerlach presented "Metal and carbon dioxide sequestration through biologically induced mineral precipitation: Influence of hydrodynamics," Platform Presentation. 237th ACS National Meeting. Division of Geochemistry," in Session: Coprecipitation of Metals During Chemically and Biologically Induced Mineral Precipitation, Salt Lake City, UT, March 21-26, 2009.

Phil Stewart and Garth James presented, "Update on the Center for Wound Biofilm," at the NIH Meeting, Bethesda, MD, March 25-27, 2009.

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MSU Campus Research Celebration, April 2009

Elliott Barnhart, Undergraduate Microbiology; Poster title: "Community analysis of methanogenic archaea within underground coal beds"

Erik Beil, Undergraduate Microbiology; Poster title: "Elucidation of function for a conserved sensory box protein in *Desulfovibrio vulgaris*"

Kristen Brileya, PhD Microbiology; Poster title: "Temporal and spatial organization within a syntrophic bacterial-archaeal biofilm"

Margaret Eggers, PhD Microbiology; Poster title: "Community based risk assessment on the crow reservation"

Robert Fortenberry, Undergraduate Chemical & Biological Eng; Poster title: "Biofilm growth impact on homogeneous radial flow"

Philip Gardner, Undergraduate Biology; Poster title: "Characterization of microbial communities from thermoalkaline springs in Yellowstone National Park"

Rachel Holmen, Undergraduate Microbiology; Poster title: "The efficacy of daptomycin on biofilms:

Luis O. Serrano Figueroa, MS Microbiology; Poster title: "Bacterial siderophores: Purification by HPLC;" mentor: Abigail Richards, CBE and Dept. of Chemical & Biological Engineering.

Trevor Zuroff, Undergraduate Chemical & Biological Eng; Poster title: "Influence of environmentally sensitive AI-2 mediated quorum-sensing behaviors on microbe response to antibiotic challenges"

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Kelly Kirker presented the poster "Testing wound dressings using a new in vitro wound model," at the Symposium for Advanced Wound Care and Wound Healing Society Meeting, Dallas, TX, April 26–29, 2009. Poster co-authors are: Lipp CJ, Kirker KR, Agostinho A, James GA, and Stewart PS.

Mary Cloud Ammons presented "Lactoferrin, xylitol, and the inhibition of *Pseudomonas aeruginosa* biofilms" at the Symposium for Advanced Wound Care and Wound Healing Society Meeting, Dallas, TX, April 29, 2009.

Phil Stewart presented "Targeting microbial biofilms to heal chronic wounds" Symposium for Advanced Wound Care and Wound Healing Society Meeting, Dallas, TX, April 29, 2009.

Al Cunningham presented, "Microbially enhanced carbonate mineralization and geologic containment of sequestered supercritical CO2," at the 8th Annual Conference on Carbon Capture & Sequestration, Pittsburgh, PA, May 4-7, 2009. Co-authors: Logan Schultz, Robin Gerlach, John P Kaszuba, Stacy Parks, Lee Spangler, Andrew C Mitchell.

Mary Cloud Ammons presented "Lactoferrin, xylitol, and the inhibition of *Pseudomonas aeruginosa* biofilms" at the XCLEAR Xylitol Conference in Rome, Italy, May 4–8, 2009.

Garth James and **Paul Sturman** presented "Urinary catheter biofilms and solutions," Foley Tubing Demonstration, Providence Health & Services, Renton, WA, May 20, 2009.

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109th General Meeting of the American Society for Microbiology, May 2009

Phil Stewart as invited speaker presented "Biofilms as agents of infection," American Society for Microbiology General Meeting, Philadelphia, PA, May 21, 2009.

Posters:
Laura Jennings, PhD candidate, presented the poster: "Expression of a novel ncRNA in *Pseudomonas aeruginosa* during stationary-phase growth and iron starvation" (co-authors: Law A, Jennings LK, Oh YN, Dlakic M, and Franklin MJ) at the 109th General Meeting of the American Society for Microbiology, Philadelphia, PA, May 17–21, 2009.

Bradley Ramsay, "Isolation of a sulfate-reducing bacterium from groundwater stimulated for uranium(VI) bioreduction," in Session: Microbes from Diverse Environments, May 20, 2009. Co-authors: Carroll S, (Oak Ridge Natl. Lab., Oak Ridge, TN) Hwang C, Fields, M.

Anitha Sundararajan, "Growth effects of oxygen exposure on *Desulfovibrio vulgaris* planktonic and biofilm cells" at the 109th General Meeting of the American Society for Microbiology, Philadelphia, PA, May 17–21, 2009.

Kristen Brileya, "Temporal and spatial organization within a syntrophic bacterial-archaeal biofilm" at the 109th General Meeting of the American Society for Microbiology, Philadelphia, PA, May 17–21, 2009.

Kelly O'Shea, "Microbial conversion of biodiesel by-products to biofuel" at the 109th General Meeting of the American Society for Microbiology, Philadelphia, PA, May 17–21, 2009.

Kara Bowen, "Bacterial community structure from alkaline springs along a thermal gradient in Yellowstone National Park" (Co-authors: Dowd SE, Wolcott RD, Ramsay BD, Gardner P, Peyton B, Hwang C, Fields MW) at the 109th General Meeting of the American Society for Microbiology, Philadelphia, PA, May 17–21, 2009.

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EDUCATION:

Graduate Students: Summer 2008, Fall 2008, Spring 2009

Masters Candidates

1.	Akabari, Ratilal (Z. Lewandowski)	M	Microbiology	India
2.	Bernstein, Hans (R. Carlson)	M	Chem & Bio Eng	Kalispell, MT
3.	Brindle, Eric (P. Stewart)	M	Mech & Ind Eng	Bozeman, MT
4.	Girardot, Crystal (B. Peyton)	F	Chem & Bio Eng	Billings, MT
5.	Meehan, Andrew (Z. Lewandowski)	M	Elec & Comp Eng	Helena, MT
6.	Mousseau, Kenneth (A. Richards)	M	Chem & Bio Eng	Ontario Canada
7.	Pannier, Andy (R. Gerlach)	M	Geology	Bozeman, MT
8.	Parks, Stacy (A. Cunningham)	F	Chem & Bio Eng	Livingston, MT
9.	Schultz, Logan (A. Cunningham)	M	Chem & Bio Eng	Chelan, WA
10.	Serrano Figueroa, Luis (A. Richards)	M	Microbiology	Puerto Rico
11.	Wheeler, Laura (A. Cunningham)	F	Chem & Bio Eng	Helena, MT

PhD Candidates

1.	Aston, John (B. Peyton)	M	Chem & Bio Eng	Bozeman, MT
2.	Behnke, Sabrina (A. Camper)	F	Microbiology	Voerde, Germany
3.	Brileya, Kristen (M. Fields)	F	Microbiology	Bozeman, MT
4.	Clark, Melinda (M. Fields)	F	Microbiology	Beloit, OH
5.	Clark, Stewart (A. Camper)	M	Microbiology	South Africa
6.	De Leon, Kara (M. Fields)	F	Microbiology	Bozeman, MT
7.	Dieser, Markus (C. Foreman)	M	Land Res & Env Sci	Walchsee, Austria
8.	Eggers, Margaret (A. Camper)	F	Microbiology	California
9.	Encarnacion, Gem (A. Camper)	F	Microbiology	The Philippines
10.	Faulwetter, Jennifer (A. Camper)	F	Microbiology	Morgan Hill, CA
11.	Field, Erin (R. Gerlach)	F	Microbiology	Deep River, CT
12.	Gardner, Robert (B. Peyton)	M	Chem & Bio Eng	Afton, WY
13.	Hornemann, Jennifer (S. Codd)	F	Chem & Bio Eng	Bozeman, MT
14.	Hwang, Chiachi (M. Fields)	F	Microbiology	Taiwan
15.	Jennings, Laura (A. Cunningham)	F	Civil Engineering	Helena, MT
16.	Kirk, Lisa (B. Peyton)	F	Chem & Bio Eng	Bozeman, MT
17.	Mallette, Natasha (P. Stewart)	F	Chem & Bio Eng	Fayetteville, AR
18.	Moberly, James (Peyton)	M	Chem & Bio Eng	Moscow, ID
19.	O'Shea, Kelly (M. Fields)	F	Microbiology	Colorado Springs, CO
20.	Perez-Osorio, Ailyn (Franklin)	F	Microbiology	Valencia, Venezuela
21.	Plaggemeyer, Sara (A. Camper)	F	Microbiology	Big Timber, MT
22.	Rahman, M. Shahedur (Camper)	M	Civil Engineering	Rangpur, Bangladesh
23.	Richards, Crystal (A. Camper)	F	Micriobiology	Bozeman, MT
24.	Sandvik, Elizabeth (B. McLeod)	F	Chem & Bio Eng	Rapid City, SD
25.	Secor, Pat (E. Pulcini)	M	Cell Bio & Neurosci	Bozeman, MT
26.	Shirley, Storm (B. Peyton)	M	Microbiology	Belgrade, MT
27.	Sundararajan, Anitha (M. Fields)	F	Microbiology	India
28.	Taffs, Reed (R. Carlson)	M	Civil Engineering	Helena, MT
29.	Valenzuela, Jacob (M. Fields)	M	Microbiology	San Luis Obispo, CA
30.	Van Engelen, Catherine (B. Peyton)	F	Chem & Bio Eng	Lake City, PA
31.	Van Engelen, Michael (B. Peyton)	M	Chem & Bio Eng	Spokane, WA
32.	Vogt, Sarah (J. Seymour)	F	Chem & Bio Eng	Rolla, MO

EDUCATION:

Graduate Students: Summer 2008, Fall 2008, Spring 2009

Rotations and Traineeships

2: Molecular Bioscience
PhD: 2F De Leon, Kara (PhD, M. Fields)
O'Shea, Kelly (PhD, M. Fields)

2: IGERT (Integrative Graduate Education & Research Traineeship)
PhD: 2 M Valenzuela, Jacob (PhD, M. Fields)
F Zarndt, Rachel (PhD, C. Foreman)

Graduating with advanced degrees, 2008–2009

Melinda Clark, PhD, Microbiology, Miami University of OH, August 2008: "Physiological Analysis of *Desulfovibrio vulgaris* Hildenborough under conditions relevant to the subsurface environment: Carbon and energy limitation and biofilm formation."

Stewart Clark, PhD, Microbiology, Montana State University, August 2008: "Keys to Unlocking the Biofilm Phenotype of a virulent Environmental Isolate of Salmonella."

Chiachi Hwang, PhD, Microbiology, Miami (OH) University, April 2009: "Assessment of bacterial communities and an iron-reducing bacterium in relation to an engineered bioremediation system designed for the treatment of uranium-nitric acid contaminated groundwater."

Laura Jennings, PhD, Civil Engineering, Cornell University, August 2008: "Proteomic and transcriptomic analyses reveal genes unregulated by CIS-dichloroethene in Polaromonas JS666."

Ailyn Cecilia Perez-Osorio, PhD, Microbiology, Montana State University, January 2009: "Quantitative assessment of localized growth rates and gene expression patterns in *Pseudomonas aeruginosa* biofilms."

Andy Pannier, MS, Microbiology, April 2009: "Reductive transformation of 2,4,6-Trinitrotoluene by *Yarrowia lipolytica* AN-L15 under conditions of different initial pH of the culture medium or in the presence of ferrihydrite."

Stacy Biebel Parks, MS, Chemical & Biological Engineering, May 2009: "Kinetics of calcite precipitation by ureolytic bacteria under aerobic and anaerobic conditions."

Mohammad Shahedur Rahman, PhD, Environmental Engineering, Montana State University, August 2008: "Nitrification in premise plumbing systems."

Laura Wheeler, MS, Chemical & Biological Engineering, Montana State University, August 2008: "Establishment of ureolytic biofilms and their influence on the permeability of pulse-flow porous media column systems."

Student awards

Ferguson Fellowship Award
Jennifer Faulwetter, PhD candidate in microbiology, received the Ferguson Graduate Student Fellowship Award of $5,000 for her outstanding contributions both in research and in teaching. A generous contribution from an alumna of the Department of Microbiology generated this award. The recipient is chosen by the Graduate Curriculum Committee, and is based on the student's contributions toward teaching and research.

Fellowship Award
Crystal Richards, PhD candidate in Microbiology, and faculty sponsor Anne Camper received a 3-year EPA STAR (Science to Achieve Results) Graduate Fellowship, beginning August 5, 2008.

Montana INBRE Program
Kara Bowen and Kelly O'Shea, as part of the Montana INBRE Program (IDeA Network of Biomedical Research Excellence), attended the Pathways into Health Conference in Girdwood, Alaska, September 8–10, 2008. The conference covered education of Native Americans in health professions. INBRE invited Kara and Kelly to attend as representatives since they do heavy-metal contamination work and could contribute to discussions.

EDUCATION:
MSU Student Research Celebration
CBE Participants

More than 200 Montana State University students who conducted research this school year presented their findings April 14, 2009, at the Student Research Celebration at Montana State University, Bozeman, MT. This year's event consisted of 42 graduate presentations and 168 undergraduate presentations. Most of the students presented their work with posters and informal conversations. Event sponsors are the American Indian Research Opportunities Program, Hughes Undergraduate Biology Program, Center for Biofilm Engineering, Montana EPSCoR Program, Montana INBRE Program, Montana Space Grant Consortium and Big Sky Institute. The Undergraduate Scholars Program, Office of the Provost and Office of Graduate Education organized this year's celebration.

Poster presentations by students mentored by CBE researchers are listed below.

Poster Title: Elucidation of function for a conserved sensory box protein in *Desulfovibrio vulgaris*
Student Presenter: Erik Beil: Microbiology;
Mentor: Matthew Fields, Microbiology

Poster Title: Characterization of microbial communities from thermoalkaline springs in Yellowstone National Park
Student Presenter: Philip Gardner: Cell Biology and Neuroscience - Biomedical
Mentor: Matthew Fields, Microbiology

Poster Title: Temporal and spatial organization within a syntrophic bacterial-archaeal biofilm
Student Presenter: Kristen Brileya: Microbiology
Mentor: Matthew Fields, Microbiology

Poster Title: Community analysis of methanogenic archaea within underground coal beds
Student Presenter: Elliott Barnhart: Microbiology
Mentors: Matthew Fields and Alfred Cunningham, Microbiology & Civil Engineering

Poster Title: Community based risk assessment on the crow reservation
Student Presenter: Margaret Eggers: Microbiology
Mentors: Anne Camper and Timothy Ford, Microbiology

Poster Title: Biofilm growth impact on homogeneous radial flow
Student Presenter: Robert Fortenberry: Chemical Engineering
Mentor: Robin Gerlach, Center for Biofilm Engineering

Poster Title: Influence of environmentally sensitive AI-2 mediated quorum-sensing behaviors on microbe response to antibiotic challenges
Student Presenter: Trevor Zuroff: Chemical Engineering
Mentor: Ross Carlson, Chemical and Biological Engineering

EDUCATION:

Undergraduate Students: Summer 2008, Fall 2008, Spring 2009

Undergrads: Summer 2008, Fall 2008, Spring 2009

1.	Barnhart, Elliot (Fields)	M	Microbiology	Broadus, MT
2.	Beil, Erik (Fields)	M	Microbiology	Dillon, MT
3.	Bozeman, Jared (Peyton)	M	Cell Biology & Neuroscience	Bozeman, MT
4.	Butz, Thomas (Pulcini)	M	Chemical & Biological Engineering	Bozeman, MT
5.	Driscoll, Elizabeth (Codd)	F	Mech & Indust. Engineering	Bozeman, MT
6.	Egger, Christina (Stein)	F	Civil Engineering	Bozeman, MT
7.	Fabich, Hilary (Codd)	F	Chemical & Biological Engineering	Livingston, MT
8.	Failing, Mervin (Foreman)	M	AIRO	Poplar, MT
9.	Floener, Jenifer (Stein)	F	Civil Engineering	Bozeman, MT
10.	Fortenberry, Robert (Gerlach)	M	Chemical & Biological Engineering	Kalispell, MT
11.	Gardner, Phillip (Fields)	M	Cell Biology & Neuroscience	Bozeman, MT
12.	Geer, Lindsey (Walker)	F	Chemical & Biological Engineering	Browning, MT
13.	Gengler, Jon (Stewart)	M	Ag Biotechnology	Helena, MT
14.	Graham, Andrew (Stein)	M	Civil Engineering	Ronan, MT
15.	Guggiana, Drago (Camper)	M	Chemical & Biological Engineering	Chile
16.	Harrer, Travis (Richards)	M	Chemical & Biological Engineering	Great Falls, MT
17.	Hisey, Bennett (Camper)	M	Civil Engineering	Bozeman, MT
18.	Holmen, Rachel (Pulcini)	F	Microbiology	Billings, MT
19.	Hoops, Jeanette (Pulcini)	F	Nursing (Bridges)	Bozeman, MT
20.	Ivie, Zach (Willis)	M	Business	Bozeman, MT
21.	Jara, Mateo (Ross)	M	Computer Science	Black Eagle, MT
22.	Justin, Grant (Fields)	M	Microbiology	Bozeman, MT
23.	Kirschbaum, Abby (Neuman)	F	Psychology	Kalispell, MT
24.	Lange, Rachel (Skidmore)	F	Environmental Science (LRES)	Racine, WI
25.	Lloyd-Randolfi, Jenn (Carlson)	F	Chemical & Biological Engineering	Baltimore, MD
26.	Nelson, Sara (Lewandowski)	F	Cell Biology & Neuroscience	Kalispell, MT
27.	Oksness, Garret (Pulcini)	M	Microbiology	Bozeman, MT
28.	Perkins, Myles (Goeres)	M	Chemical & Biological Engineering	Albuquerque, NM
29.	Pieper-Jordan, Seanna (Burr)	F	AIRO (Bridges)	Mililani, HI
30.	Radons, Matthew (Goeres)	M	Chemical & Biological Engineering	Snohomish, WA
31.	Ready, Tiffany (Goeres)	F	Microbiology	Bozeman, MT
32.	Samuelson, Derrick (Pulcini)	M	Chemical & Biological Engineering	Bozeman, MT
33.	Spear, Cinnamon	F	AIRO	Lame Deer, MT
34.	Stavin, Ari (Peyton)	F	Chemical & Biological Engineering	Georgetown, TX
35.	Woods, Jeremy (Pulcini)	M	Cell Biology & Neuroscience	Bozeman, MT
36.	Zuroff, Trevor (Carlson)	M	Chemical & Biological Engineering	Bozeman, MT

Undergraduates Summary: 2008-2009

Discipline / Program	Male	Female	Total
Ag Biotech	1		1
AIRO	1	2	3
Business	1		1
Cell Biology & Neurosci	3	1	4
Chem & Bio Eng	8	4	12
Civil Engineering	2	2	4
Computer Science	1		1
Environmental Sci (LRES)		1	1
Mech & Indust. Eng		1	1
Microbiology	4	2	6
Nursing (Bridges)		1	1
Psychology		1	1
Totals	**21**	**15**	**36**

Undergraduate Scholars Program (USP)

Participants 2008-09

R. Fortenberry	NSF-EPSCoR and College of Engineering
R. Holmen	MT Space Grant Consortium
R. Lange	NSF-EPSCoR and College of Agriculture
J. Woods	College of Letters & Sciences
T. Zuroff	INBRE Program

EDUCATION:
Graduate Student Highlight

Doctoral student hopes corrosion research will make the world a bit 'greener'

April 20, 2009 -- by Michael Becker, MSU News Service

BOZEMAN -- Montana State University doctoral student Jennifer Hornemann didn't start her college career with any intention of studying biofilms. Instead, she started out studying physics because, she said, it sounded hard.

"It was the hardest thing I could think of at the time, and I knew it would be a challenge for me," Hornemann said. "Most people who know me at all would not be surprised by that."

Recently, Hornemann accepted a new challenge. After she finishes her doctorate at MSU, the 32-year-old chemical engineer will take what she's learned at MSU's Center for Biofilm Engineering and Magnetic Resonance Transport Phenomena Lab to Houston. There, she hopes to help Exxon Mobil expand its research into the corrosive havoc that microbes can cause to pipelines and other equipment.

"I want to build a bridge between the Center for Biofilm Engineering here at MSU and Exxon Mobil's research division," she said. "That would be a great win-win scenario for Exxon Mobil and MSU."

Microbes, living together in colonies called biofilms, can corrode pipes and other hardware vital to getting oil from one place to another, Hornemann said. That damage can affect the oil supply, which in turn affects the price of gas and diesel fuel.

At MSU, Hornemann uses nuclear magnetic resonance microscopy to study the ways that biofilms absorb and use nutrients and other substances. Understanding how substances move through and around biofilms could lead to better techniques for removing, preventing or killing harmful biofilms.

Better, more efficient techniques would need fewer chemicals to get rid of biofilms, and that would decrease the environmental impact of dealing with biofilms, an outcome that pleases the environmentally conscious Hornemann.

Hornemann, who will defend her dissertation in June, began her college career at Stephen F. Austin University in her hometown of Nacogdoches, Texas. After earning her physics degree, she went on to receive a master's degree in chemical engineering from the University of Arkansas.

After earning her master's, Hornemann took a break from school to spend several years working as a mechanical engineer for General Electric's gas and wind turbine division; but the temptation to go back for her doctorate was too hard to resist, despite her engineer's salary, she said.

"I went from earning $80,000 a year to $20,000 a year by choice," she said. "When I think about those figures, I have to remember that I came here for a reason."

Part of that reason is to make the world as clean a place as possible for future generations, including her 3-year-old son. In fact, Hornemann turned down the prestigious Presidential Postdoctorate Fellowship at the University of California to work with Exxon Mobil because she believes the work she'll do in Texas will have a more immediate and farther-reaching impact on the world.

Another part of that reason is that Hornemann wanted to help more women succeed in engineering, a field that isn't exactly rich with women, she said.

Many of the women she met in science and engineering fields throughout college eventually switched to other majors because they didn't have the support, guidance and positive role models they needed to be successful, Hornemann said. "I've never had any doubt that I could do it, but I've had all the support in the world along the way," she said. Some women aren't as fortunate, which is why mentoring and advising young women is important to Hornemann. "I think that any challenges people face can be overcome, if they're driven and have a support network."

Hornemann said that returning to the deadline-oriented corporate world will be a homecoming of sorts because she had such a hard time adjusting to the academic mindset when she arrived at MSU.

Her adviser, mechanical and industrial engineering assistant professor Sarah Codd, had to remind her that research doesn't usually follow detailed corporate schedules, plans and timelines.

"I think Jennifer has embraced the idea that the research environment is more exploratory than deadline-oriented," Codd said. "And that's earned her a job that will require even more of that exploratory problem-solving ability that she's honed here at MSU."

"I used to be very black and white," Hornemann said. "Now I realize that there are so many variables in everything we do. I have a newfound respect for science, and that was unexpected."

In all, Hornemann is proud of the research, teaching and mentoring she's done at MSU, especially considering that she's an older, non-traditional student and a mother. And while she's heading back to the corporate world for now, she said that after her time at MSU, she now wants to return to teaching someday to share her experience.

"I thought I would just do some research, publish some papers and leave here the same old Jennifer, but MSU has really changed me for the better, I think," she said.

EDUCATION:
Undergraduate Student Highlight

Engineering student works to inspire a new generation to save the world

MSU News Services, February 25, 2009
by Michael Becker

Chemical engineering student Trevor Zuroff has always had a desire to help other people, but that desire became a passion when he came to Montana State University.

"It really exploded when I came to college and found all these opportunities to get involved," said the 20-year-old MSU junior. "I really want to help people, and now I feel that it's my duty to help people."

In addition to his regular classes, preparing for graduation and the business of applying for graduate school, the Glendive native volunteers for so many activities around MSU and Bozeman that he needs a list to remember them all.

Zuroff involves himself with Big Brothers Big Sisters and the Wellness Community, a cancer support group. On campus, he's the president of the MSU chapter of the American Institute of Chemical Engineers and a member of the Engineering Ambassadors.

He's also a tutor for the Montana Apprenticeship Program and for the Learning Engineering by Application Program. Those summer programs invite Montana middle and high school students to MSU for hands-on research experiences with science and engineering.

That's just to name a few, and bear in mind that Zuroff has been piling on the volunteerism since he was a sophomore.

"I have a tendency to take on too much responsibility," Zuroff admitted.

He traces some of that tendency to a childhood with cancer. In 2002 when he was in eighth grade, Zuroff was diagnosed with AML, a form of leukemia. He spent months in hospital beds enduring harsh chemotherapy.

"I matured exponentially during that time," he said, showing off a tattoo he -- and the rest of his family -- got to commemorate the end of his cancer treatments. The tattoo shows an orange cancer ribbon and the date he entered remission: Dec. 3, 2007. "I feel the need to appreciate life more, and I've found in the last few years that I can really help other people and make their lives better too."

Alongside his studies and volunteering, Zuroff works in two laboratories, one in the Department of Chemical and Biological Engineering and another at the Center for Biofilm Engineering.

The lab was a change from the years Zuroff spent working in auto body shops before coming to MSU. He loved working on the cars, but Zuroff said that at the end of his freshman year, he wanted to get some experience that would help him toward his goal of becoming an engineering professor. Shop work was out; lab work was in.

Now Zuroff studies quorum sensing, the tendency of bacteria living together in colonies -- called biofilms -- to communicate with each other and act as a unit.

Ross Carlson, assistant professor of chemical and biological engineering, said Zuroff has been one of the most dedicated workers in both labs over the past two years.

"His productivity is as good as a master's graduate student, and he's more organized than just about any professor I know," Carlson said.

Zuroff is interested in how biofilm bacteria can be used to create things like biofuel and bio-plastics. Using bacteria to create these products can be more efficient than the traditional methods, which use fossil fuels. But to use bacteria effectively, engineers need to understand how biofilms communicate and work together.

Zuroff knows that the alternative energy and manufacturing processes he's studying will be important to the future of the U.S. and the world, which is all the more reason to pass those lessons on to younger students today, he said.

"Everybody talks about global warming and climate change, and to solve these problems we're going to need engineers, scientists and mathematicians," he said. "We need to instill the desire to solve these problems into the younger generation."

Finding every opportunity he can to reach out to younger students makes him feel like he's making a difference and taking a step toward solving those problems, Zuroff said.

"You feel like you make an impact in maybe two out of 10 kids," he said. "Maybe they won't grow up to be engineers, but when the time comes to apply for college, they might remember that they learned about engineering once and that it was kind of cool."

EDUCATION:
Undergraduate Student Highlight

Native American student brings home conference award

MSU News Service, 12/10/2008, by Melynda Harrison

Mervin Failing spent 14 years educating children. As a teacher's aide at Poplar Elementary School in Poplar, Mont., Failing watched children learn, graduate and go on to college. He also watched some of them return as teachers, which made him think about his own career.

"I figured if the kids I taught were becoming teachers, I should too," recalled Failing.

Inspired by his students' success, the 54-year-old Sioux-Assiniboine Indian from Fort Peck, Montana, decided to pursue his own career in education by applying to Montana State University's BRIDGES (Bridging Tribal Colleges to MSU) program.

The BRIDGES program aims to increase the number of Native American students successfully transferring from two-year tribal colleges to MSU for studies in biomedicine and other health related sciences. Native Americans have historically been underrepresented in those fields.

BRIDGES students take one 3-credit class (along with tutoring for the class) with tuition and books provided by the program. They work in a research laboratory under the mentorship of a faculty mentor. BRIDGES students also attend study skills seminars that reinforce training offered at the tribal college and introduce students to university resources such as the library.

While BRIDGES students aren't guaranteed entrance to MSU, the program gives them coursework and research experience to improve their chances of acceptance and ease their transition into a four-year university.

By the end of the summer, Failing was not only ready to attend MSU full-time, he had presented his research at two conferences, won an award for his work and changed his focus to teaching science.

Through BRIDGES, Failing worked with Christine Foreman, assistant research professor at MSU's Center for Biofilm Engineering, and her graduate student, Markus Dieser. Foreman looked at Failing's interests and strengths, and crafted a program for him. She incorporated lab techniques and skills that Failing can use in the classroom as a teacher.

Since Failing was also interested in film, she provided him with a camera attached to a microscope that allowed him to take images of bacteria as they froze. Failing learned that when subjected to harsh conditions, such as freeze/thaw cycles, bacteria produce a biofilm--an arrangement of cells that increases their chance of survival.

"Working with them (Foreman and Dieser) really changed my focus," said Failing. "I learned so much about science and polar research."

Failing incorporated the images of freezing bacteria into a PowerPoint presentation that he gave at the National Leadership Alliance conference in Connecticut in July.

After his success in Connecticut, he created a poster based on the PowerPoint presentation. He entered the poster at the Society for the Advancement of Chicanos and Native Americans in Science (SACNAS) where he won the outstanding poster award.

Nearly 600 students entered the competition at the SACNAS meeting held in Salt Lake City Oct. 9-12. The winners were from a mix of Ivy League schools, large universities and smaller schools like MSU-Bozeman, said Marjorie Old Horn, American Indian Research Opportunities (AIRO) program director.

"Through Dr. Foreman, Mervin was able to perform cutting-edge research on how bacteria survive in the Antarctic," Old Horn said. "It's unique research and an outstanding opportunity for Mervin."

According to Old Horn, Failing is a model of what the BRIDGES program is meant to do. He was selected from a remote reservation and exposed to a variety of science techniques and methodologies that he otherwise may not have had the opportunity to experience. He started the program without an undergraduate degree and is now considering graduate school to continue his science studies.

"The premise of BRIDGES is to help and engage tribal students and to motivate them to go to graduate school and continue in research fields," Old Horn said.

Failing will receive his teaching credential at Fort Peck Community College this spring and hopes to enroll at MSU next fall to become a science teacher. Math and science weren't part of Failing's original plan, but after a summer in the BRIDGES program, he shifted directions.

"Participating in BRIDGES and winning at SACNAS was the experience of a lifetime," Failing said. "I'll never forget it. It changed my life and steered me toward science."

CBE Seminar Series – Fall 2008

Date	Speaker	Title
04 September	First week of classes	
11 September	No seminar	
18 September	Dr. David Cummings Associate Professor of Biology, Point Loma Nazarene University, San Diego, CA	The spread of antibiotic resistance genes in California's coastal environment
25 September	Dr. David Jenkins Professor Emeritus, Department of Civil and Environmental Engineering, UC Berkeley	From TSS to FISH – the evolution of activated sludge population dynamics
02 October	Dr. Seth D'Imperio CBE Post Doctoral Researcher	Hydrogen and sulfide as energy sources for primary production in a geothermal spring
09 October	Dr. Darla Goeres CBE Assistant Research Professor, Chemical and Biological Engineering	Methods development update
16 October	Dr. Gary Strobel MSU Professor, Department of Plant Sciences	The discovery of volatile antibiotic producing fungi
23 October	Dr. Sarah Bellum Visiting researcher, Amygdala College	Assimilation at the CBE: The Borg or something else?
30 October	Chiachi Hwang PhD Candidate, Microbiology, Miami University, Ohio	Changes in microbial community structure during biostimulation for uranium reduction
06 November	Dr. Alice Dohnalkova Senior Research Scientist, Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory	EM imaging techniques for environmental microbiology / biogeochemistry
13 November	Jennifer Hornemann PhD Candidate, Chemical & Biological Engineering	Magnetic resonance microscopy (MRM) application to biofouling in porous media
20 November	Dr. Alessandra Agostinho CBE Research Associate	The drip flow/colony biofilm model: a new method to grow biofilms
27 November	Thanksgiving break	No seminar
04 December	Dr. Brett Baker President and CEO, Microbion, Bozeman	Preclinical development of a broad spectrum antibiotic with antibiofilm properties SEMINAR CANCELED
11 December	Last week of classes	No seminar

CBE Seminar Series – Spring 2009

Date	Speaker	Affiliation	Topic
15-Jan	First Week of Class		No seminar
22-Jan	Dr. Paul Majors	Pacific Northwest National Laboratories, Richland, WA	MRI of biofilm metabolism
29-Jan	Dr. Phil Stewart	CBE Director	Four big hits at the Center for Biofilm Engineering
5-Feb	TAC		No seminar
12-Feb	Dr. Dean Drenk	Retired, College of Business, MSU	Nine Villages from Sidy's grandfather to Kesu Yiriwere: Partnering in sustainable village development
26-Feb	Dr. Beth Marlowe	Kaiser Permanente Regional Reference Laboratory, North Hollywood, CA	A nature lover's guide to molecular testing
5-Mar	Dr. Shawn Lewenza	University of Calgary, Alberta, Canada	Extracellular DNA is a multifaceted component of *Pseudomonas aeruginosa* biofilms
12-Mar	Laura Bickle	CBE Research Assistant	Meyer's-Briggs Personality Indicator (MBTI)
19-Mar	Spring Break		No seminar
26-Mar	Dr. Lisa Fauci	Center for Computational Science at Tulane and Xavier University	Interaction of elastic biological structures with complex fluids
2-Apr	Dr. Matthew Fields	Department of Microbiology, MSU	Microbial ecology and physiology lab update
9-Apr	University Day 4/10		No seminar
16-Apr	Mike Van Engelen	Department of Chemical and Biological Engineering, MSU	A mechanism of uranium toxicity in prokaryotic cells
23-Apr	Dr. Brett Baker	Microbion Biosciences Corp., Bozeman, MT	Preclinical development of a broad spectrum antibiotic with antibiofilm properties
30-Apr	Last week of class		No seminar

TECHNOLOGY TRANSFER:
Industrial Associates, 2008–09

3M
Alcon Research
Bausch & Lomb
Baxter Healthcare
Bayer MaterialScience
BD Medical
Bridge Preclinical Testing Services
CareFusion *(formerly Cardinal Health)*
Church & Dwight Company
Ciba Specialty Chemicals *(now part of BASF)*
Colgate-Palmolive
Covidien
Embro Corporation
Ethox International
Glanbia Nutritionals
GlaxoSmithKline
ICU Medical
Kane Biotech
Kimberly-Clark
Masco Corporation
Molnlycke Health Care
NASA
Novozymes A/S
Procter & Gamble
Quiescence Technologies *(formerly QuoNova)*
Rohm and Haas *(now a subsidiary of The Dow Chemical Company)*
Sandia National Laboratories
Sherwin-Williams
Unilever
W.L. Gore & Associates
Whirlpool

TECHNOLOGY TRANSFER:
Technical Advisory Conference
July 15–17, 2008

Monday July 14

6:00–8:30 p.m.
Pre-registration and welcome reception
Hilton Garden Inn, Bozeman

Tuesday July 15

7:30–8:30 a.m.
Registration and continental breakfast
Hilton Garden Inn reception area

8:30–8:45
Introductory remarks
Larkspur Ballroom
Paul Sturman, CBE Industry Coordinator
Ruth Cutright, W.L. Gore, TAC Chair
Phil Stewart, CBE Director

SESSION 1:
Coatings for Biofilm Inhibition

8:45–8:50
Session Introduction
Phil Stewart

8:50–9:35
Combating bacterial adhesion, biofilms, and implant-associated infection via nitric oxide release
Mark Schoenfisch, Associate Professor, Department of Chemistry, University of North Carolina at Chapel Hill, NC

9:35–10:00
Methods of assessing biofilm inhibition on surfaces
Diane Walker, CBE Research Engineer

10:25–11:00
Biopassive and bioactive (biocidal) surfaces
Andreas Mühlebach, Ciba Specialty Chemicals, Inc. Basel, Switzerland

SESSION 2:
Environmental Biofilms

11:00–11:05
Session Introduction
Al Cunningham, Professor, Civil Engineering, CBE

11:05–11:30
Biologically induced mineralization: Fundamentals and possible applications
Robin Gerlach, Associate Professor, Chemical & Biological Eng., CBE

11:30–12:00
Biological ice nucleators in snow and rain
Christine Foreman, Assistant Research Professor, CBE

Special Presentation

1:00–1:30
State of the CBE
Phil Stewart

SESSION 3:
Water / Industrial Biofilms

1:30–1:55
Session Introduction
Water quality changes in premise plumbing
Anne Camper, Professor, Civil Engineering, CBE

1:55–2:30
Legionella—(re-)awakening to the amoeba-based pathogens of distribution system biofilms
Nick Ashbolt, Senior Research Microbiologist, US EPA, Cincinnati, OH

2:30–3:00 Break

3:00–3:30
Effect of chlorite on microbial nitrification in a simulated premise plumbing system
Shahed Rahman, PhD candidate, Civil Engineering and Lynne Leach, Postdoctoral Research Associate, CBE

3:30–4:05
Water treatment biocide applications and automated controls of industrial cooling water systems
Mike Dorsey, Senior Materials Corrosion Technologist, DuPont Engineering Technology and Doug McIlwaine, Senior Scientist, ChemTreat, Inc.

4:05–4:30
From microbially influenced corrosion to microbial fuel cells
Zbigniew Lewandowski, Professor, Civil Engineering, CBE

4:30–5:00
Consumer product biofilm related problems
Alex Blanchard, Senior Scientist in R&D Microbiology, Procter & Gamble Technical Centres, Egham, Surrey, UK

Wednesday
July 16

7:30–8:30 a.m.
Registration and continental breakfast
Hilton Garden Inn reception area

SESSION 4:
Biofilm Methods and Microscopy

8:30–8:55
Session Introduction
Standardizing a method for rapid biofilm analysis
Darla Goeres, Assistant Research Professor, CBE

8:55–9:25
Laser microscopy in biofilm research—current options and future potential
Thomas Neu, Senior Scientist, Department of River Ecology, Helmholtz-Zentrum für Umweltforschung, Magdeburg, Germany

9:25–9:45
***Salmonella typhimurium* biofilms at the gene level**
Stewart Clark, PhD candidate, Microbiology, MSU

10:15–10:35
Protein expression in biofilm models
Elinor deLancey Pulcini, Research Scientist, CBE

10:35–10:55
Biofilm impact on keratinocyte morphology
Pat Secor, PhD candidate,
Cell Biology & Neuroscience, CBE

10:55–11:15
Proteomic analysis for the determination of biodegradation pathways in *Polaromonas* sp. JS666
Laura Jennings, visiting PhD candidate,
Environmental Engineering, Cornell University

11:15–11:45
Helpful Insights: How can the FDA Antimicrobial Guidance apply to biofilm claims in medical devices
Chiu Lin, Director, Division of Anesthesiology, General Hospital, Infection Control, and Dental Devices, FDA

11:45–12:00
Update on *Biofilms: The Hypertextbook*
Al Cunningham, Professor, Civil Engineering and Rocky Ross, Professor, Computer Science

Poster Session & Laboratory Open House
2:30–5:00
CBE Laboratories, 3rd Floor EPS Building, MSU

Thursday
July 17

7:30–8:30 a.m.
Registration and continental breakfast
Hilton Garden Inn reception area

7:30–8:30 a.m.
TAC Business Meeting (Industrial Associate Representatives) with breakfast, Larkspur Ballroom

SESSION 5:
Nitrogen Compounds and Their Biofilm Impact
8:30–8:40
Session introduction
Garth James, Medical Projects Manager, CBE

8:40–9:20
Gaseous nitric oxide (gNO): A novel antimicrobial agent
Bevin McMullin, University of British Columbia, Vancouver, Canada

9:20–10:00
Genetic & metabolic clues for the treatment of anaerobic *Pseudomonas aeruginosa* biofilm infections
Dan Hassett, Professor, Molecular Genetics, Biochemistry & Microbiology, University of Cincinnati College of Medicine, OH

10:00–10:20
Consequences of nitrate and nitrite stress in *Desulfovibrio vulgaris*
Matthew Fields, Assistant Professor, Microbiology, CBE

SESSION 6:
Physics of Biofilm Control

10:50–11:00
Session introduction
Phil Stewart, Professor, Chemical & Biological Engineering, CBE

11:00–11:20
Biofilm viscoelastic properties— measurements & modifications
Warren Jones, Associate Professor, Civil Engineering, CBE

11:20–11:40
Penetration and efficacy of daptomycin against staphyococcal biofilms
Phil Stewart

11:40–12:00
Modeling material aspects of biofilms
Isaac Klapper, Professor, Mathematics, CBE

12:00–12:10 Meeting wrap up

TECHNOLOGY TRANSFER:
Advanced Biofilm Methods Workshop
July 14, 2008
8:30 a.m.–5:00 p.m.

Description

The July 2008 TAC Workshop was focused entirely on microscopy of biofilms.

The workshop began with presentations by guest instructor Diane Gray from Molecular Probes/Invitrogen, and from special guest instructor Dr Thomas Neu, of the Helmholtz Centre for Environmental Research-UFZ, Department of River Ecology in Magdeburg, Germany. Dr Neu is widely recognized as an expert in confocal imaging of biofilms, particularly using fluorescent lectin probes. The morning session concluded with a group discussion led by our guest instructors during which participants chose a bacterial biofilm and appropriate fluorescent stain to work with, then prepared samples in the laboratory with assistance from Center research staff.

The afternoon session consisted of hands-on imaging by participants of their stained biofilm samples, and other, previously prepared samples such as wound tissue. Workshop instructors assisted participants in imaging using the following techniques: cryoembedding and cryosectioning, epifluorescence microscopy, stereomicroscopy, and confocal laser scanning microscopy (CSLM). Dr Neu worked with pairs of participants on the confocal microscope, Diane Gray was available to discuss staining of biofilms for microscopy and flow cytometry, and the CBE's staff expert demonstrated scanning electron microscopy (SEM) of fully hydrated biofilms. Additional, optional sessions were available during the afternoon, and included basic biofilm methods, qualitative and quantitative image analysis, and flow cytometry.

This workshop was available to member companies at no charge. There was an additional fee of $400 for non-member companies. Attendance at the workshop was limited to 16 persons.

CBE Workshop Contact:
Paul Sturman, Ph.D., P.E.
Industrial Coordinator
Center for Biofilm Engineering
(406) 994-2102 or paul_s@biofilm.montana.edu

TECHNOLOGY TRANSFER:
Technical Advisory Conference
February 3–4, 2009

Monday
February 2

6:00–8:30 p.m.
Pre-registration and welcome reception
Hilton Garden Inn, Bozeman

Tuesday
February 3

7:30–8:15 a.m.
Registration and continental breakfast
Hilton Garden Inn reception area

8:15–8:30
Introductory remarks
Larkspur Ballroom
Paul Sturman, CBE Industrial Coordinator
Bill Schwingel, Masco, TAC Chair
Phil Stewart, CBE Director

SESSION 1:
Quorum Sensing

8:30–9:10
Session introduction and quorum sensing review
Phil Stewart

9:10–9:50
Small organic antagonists of bacterial quorum sensing that disrupt the formation of mature biofilms
Hiroaki Suga, Professor, Research Center for Advanced Science and Technology, University of Tokyo, Japan

9:50–10:20 Break

10:20–10:50
Quorum sensing control of dispersion in *Staphylococcus aureus* biofilms
Alex Horswill, Assistant Professor, Microbiology, Carver College of Medicine, University of Iowa

10:50–11:20
Laser desorption post-ionization mass spectrometry of quorum sensing peptides and antibiotics within intact bacterial biofilms
Luke Hanley, Professor, Chemistry, University of Illinois, Chicago

11:20–11:50
Counterintuitive effects of quorum sensing on biofilm antibiotic tolerance
Ross Carlson, Assistant Professor, Chemical and Biological Engineering, MSU-CBE

SESSION 2:
Industrial & Environmental Biofilms

1:00–1:20
Toxicity of copper and zinc to aerobic and anaerobic microorganisms
James Moberly, PhD Candidate, Chemical and Biological Engineering, MSU-CBE

1:20–1:40
Biofilm mediated calcite precipitation: Controlling hydraulic conductivity, carbon sequestration, and the transport of radionuclides
Robin Gerlach, Associate Professor, Chemical and Biological Engineering, MSU-CBE

1:40–2:00
Microbial conversions for the production of bio-fuels and chemical feedstocks
Matthew Fields, Assistant Professor, Microbiology, MSU-CBE

2:00–2:20
Opportunistic pathogens in water systems
Anne Camper, Professor, Civil Engineering, MSU-CBE

2:20–3:15
Biofilm Methods Advisory Committee

Poster Session & Laboratory Open House
3:30–5:30
CBE Laboratories, 3rd Floor EPS Building, MSU

Dinner on your own for networking opportunities

Wednesday
February 4

7:30–8:00 a.m.
Registration and
continental breakfast
Hilton Garden Inn reception area

SESSION 3:
Wound Biofilms

8:00–8:15
History of the biofilm hypothesis in chronic wound healing
Phil Stewart

8:15–8:40
Ecology of biofilms in chronic wounds
Thomas Bjarnsholt, Associate Professor, International Health, Immunology and Microbiology, Univ. of Copenhagen, Denmark

8:40–9:05
Wound microbiology and models
Stephen Davis, Research Associate Professor, Dermatology and Cutaneous Surgery, Miller School of Medicine, University of Miami, FL

9:05–9:40
Role of bacteria in the healing of chronic wounds
Gerald Lazarus, MD, Director, Johns Hopkins Wound Center, Bayview Medical Center, Baltimore, MD; and Jonathan Zenilman, MD, Chief, Infectious Diseases, Bayview Medical Center

9:40–10:05
Rabbit and mouse models of biofilm wound infections
Thomas Mustoe, MD, Chief of Plastic Surgery, Northwestern Memorial Hospital, Chicago, IL

10:30–10:55
MicroRNA in wound healing
Chandan K. Sen, Director, Ohio State University Comprehensive Wound Center, Columbus, OH

10:55–11:20
Development of an *in vitro* pig skin wound model of mature biofilms and microbicidal effects of wound dressings
Gregory Schultz, Professor, Institute for Wound Research, College of Medicine, University of Florida, Gainesville, FL

11:20–11:45
Mouse model of biofilm wound infection
Ge Alice Zhao, Postdoctoral Researcher, University of Washington School of Medicine, Seattle, WA

TECHNOLOGY TRANSFER:
Basic Biofilm Methods Workshop
February 2, 2009

8:30 – 8:45 EPS 323
Welcome
Phil Stewart, CBE Director
Group introductions

8:45 – 9:15 EPS 323
An Introduction to Biofilms
Paul Sturman

9:15 – 9:45 EPS 323
A Systematic Approach to Standardizing Research Methods
Darla Goeres

9:45 – 10:15 EPS 323
Experimental Design & Data Analysis in the Biofilm Laboratory
Marty Hamilton

10:15 – 10:30 Morning Refreshments

10:30 - 12:00 EPS 301
Biofilm Reactor Protocol: Hands-on Sampling and Analysis
Diane Walker, Kelli Buckingham-Meyer, Lindsey Lorenz

12:00 – 1:00
LUNCH – Habit Restaurant, MSU Campus

1:00 – 1:30 EPS 323
Staining Biofilms
Diane Gray, Guest instructor from Molecular Probes/Invitrogen

Group A:
1:30 – 2:15 EPS 326/327
Microscopy of Biofilms
Betsey Pitts, Diane Gray, Alessandra Agostinho, Kelly Kirker, Chelsea Lipp, Natasha Mallette, Pat Secor

2:15 – 3:00 ICAL EPS 339
Scanning Electron Microscopy
Steve Fisher

Group B:
1:30 – 2:15 ICAL EPS 339
Scanning Electron Microscopy
Steve Fisher

2:15 – 3:00 EPS 326/327
Microscopy of Biofilms
Betsey Pitts, Diane Gray, Alessandra Agostinho, Kelly Kirker, Chelsea Lipp, Natasha Mallette, Pat Secor

3:00 – 3:15 Afternoon Refreshments

3:15 – 4:15 COBL 324
Biofilms and MRI
Sarah Codd & Jennifer Hornemann

4:15 – 5:00 EPS 323
Applications of 16S Phylochip to Assess Biofilm Microbial Diversity
Brent Peyton & Seth D'Imperio

Wrap-Up/Discussion EPS 323

OUTREACH:
Visitors

Greg Characklis, Associate Professor in the Department of Environmental Sciences and Engineering at the University of North Carolina at Chapel Hill visited for several weeks in the summer of 2008.

Alim Dewan, a PhD Candidate from Washington State University, Pullman WA, assisted Zbigniew Lewandowski with the Biofilms Workshop in July 2008.

Claudia Doberenz visited the CBE for nine months on a Fulbright fellowship from Germany, where she earned a MS degree in microbiology from Martin Luther University in Halle-Wittenberg. She was at the CBE as a non-degree graduate student, working in the Industrial & Environmental Water Systems lab as part of her Fulbright fellowship experience, and studied interspecies competition in a biofilm. Claudia will return to Germany to complete her PhD.

Mariana Fittipaldi, a PhD student from the Laboratorio de Microbiologia Sanitaria y Medioambiental, Universitat Politécnica de Catalunya, Barcelona Spain, worked in the Industrial & Environmental Water Systems laboratory. One of her co-workers, Jordi Morato, came to the CBE as a visitor in 1999.

Jordan Gruber, a student intern with Procter & Gamble and a senior in microbiology at Clemson University, worked in the Standard Biofilm Methods lab for two months in the summer of 2008.

Anna Heinkel, from the University of Duisburg-Essen in Germany, worked on research contributing to her Bachelor's thesis in the Industrial & Environmental Water Systems laboratory.

Patrizia Peters, also a visiting undergrad from the University of Duisberg-Essen in Germany worked on her Bachelor's thesis with Keith Cooksey, MSU.

Jennifer Lloyd-Randolfi, an undergraduate in Chemical and Biological Engineering at Johns Hopkins University in Baltimore, MD, spent the summer 2008 working in Dr. Ross Carlson's laboratory.

Yvonne Reinhardt, an environmental engineering student at the University of Stuttgart, Stuttgart, Germany with Dr. Rainer Helmig, worked at the CBE for four months. Yvonne worked on adapting a multiphase fluid simulation model to data from the MSU ZERT carbon sequestration experimental site with Al Cunningham and Lee Spangler.

Federica Villa is a visiting graduate student from the University of Milan, where she is pursuing a doctorate in the Department of Food Science, Technology, and Microbiology. She studied the anti-fouling properties of a chemical isolated from a marine plant against bacterial and fungal biofilms. She worked in the control lab through August 2009.

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 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 note are described below.

Mass spectrometry facility

In 2005 an equipment grant was awarded for an Environmental and Biofilm Mass Spectrometry Facility through the Department of Defense University Research Instrumentation Program (DURIP). The grant funded the acquisition of an Agilent 1100 series high performance liquid chromatography system with autosampler and fraction collector, an Agilent SL ion trap mass spectrometer, and an Agilent 6890 gas chromatograph 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.

Microscope Facilities

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

> The Optical Microscopy Lab houses two Nikon Eclipse E-800 microscopes, which are used for transmitted light and epi-fluorescent imaging of biofilms. Both microscopes are equipped with cooled CCD fluorescent cameras, a video camera, and a color camera; they use Universal Imaging Corporation's MetaVue software for digital image acquisition. One of the microscopes uses manually-switched filter blocks for epi-fluorescence and the other uses an electronically controlled filter wheel and shutter. Images collected on the Nikons range from pictures of in situ biofilms as they accumulate over time on glass tubing to FISH (Fluorescence In Situ Hybridization)-probed, cryosectioned colony biofilms.
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> The Optical Microscopy Lab also includes a Nikon SMZ-1500 Stereo Zoom Microscope, with a magnification range from roughly 7.5 to 110X. The stereo scope gives researchers stunning, 3-dimensional views of biofilms on a more macroscopic scale than can be achieved with other microscopes. Finally, the lab includes a Leica CM 1850 cryostat which is used to cut very thin sections (usually 5 micrometers) of frozen biofilm.
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> The Confocal Microscopy Lab contains two Leica upright Confocal Scanning Laser Microscopes (CSLM). The Leica configuration is ideal for continuous monitoring of biofilm formation and detachment phenomena because it causes only minimal specimen damage due to heating and

allows for high-resolution time-lapse monitoring of the biofilm. 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 each 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 three-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.

Our TCS-NT confocal has three laser lines available for fluorescence excitation: 488, 568 and 633 nm. The second, new, confocal system is a Leica TCS-SP2 AOBS with an add-on: a Spectra Physics MaiTai 2-photon infra-red laser and detector. With this new system we can image a biofilm, then switch between AOBS confocal mode and 2-photon mode—we only need to switch detectors and lasers. The AOBS system uses no excitation or emission filters, so it offers extreme flexibility in wavelength selection; it includes seven available laser lines for excitation (458, 476, 488, 496, 514, 543 and 633nm). The MaiTai gives us still another unique imaging capability. It has been established that in tissue-like materials 2-photon imaging provides much greater resolution, especially in the z-direction. We have seen that the MaiTai can image biofilms three to four times deeper than the AOBS or any other 1-photon confocal. So, for imaging thick or dense biofilms, the MaiTai is the perfect tool.

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 FACSAria. 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 personal computers connected to the MSU College of Engineering computer network. A student computer laboratory offers twelve state-of-the-art PCs along with scanning and printing services. In addition, the CBE maintains computational PCs, and a computational server for data manipulation, mathematical modeling, and graphic image analysis.

SPECIALIZED CBE LABORATORIES

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 currently includes five full- time research scientists, three technicians, one graduate student, and four undergraduate research assistants.

Activity in the MBL has expanded substantially during recent years. Seventeen companies, including CBE Industrial Associates, currently sponsor MBL projects. The MBL is also performing research in support of two NIH-funded grants. Projects include examining the role of biofilms in chronic wound infections, evaluating biofilm formation on biomaterials, and testing medical devices. 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 (SBM) was designed to meet research and industry needs for standard analytical methods to evaluate innovative biofilm control technologies. SBM staff and students develop, refine, and publish quantitative methods for growing, treating, sampling, and analyzing biofilm bacteria. The SBM 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 SBM will conduct 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. SBM staff offer customized biofilm methods training workshops for CBE students, collaborators, and industry clients.

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 MSU was established in order to promote interdisciplinary collaboration in research, education, and industry, and to strengthen existing cooperation between the physical, biological, and engineering sciences by providing critically needed analytical facilities. These facilities are open to academic researchers.

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

The ICAL currently contains seven complementary microanalytical systems:
Atomic Force Microscope (AFM)

Auger Scanning Electron Microprobe (Auger)

Field Emission Scanning Electron Microscope (FESEM)

Scanning Electron Microscope (SEM)

Time of Flight Secondary Ion Mass Spectrometer (SIMS)

Small-Spot X-ray Photoelectron Spectrometer (XPS)

X-Ray Powder Diffraction Spectrometer (XRD)

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