2012 APPENDIX

Center for Biofilm Engineering

Montana State University
Bozeman

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RESEARCH

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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, industrial memberships, and sponsored projects; and
- produces both fundamental and applied results.

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

APPLIED RESEARCH AREAS & PROJECTS

Biofilm control strategies antimicrobial efficacy | biocides | bioelectric effect | disinfectants | inhibitory coatings | nitrous oxide

Energy solutions biofuels | microbial fuel cells

Environmental subsurface technologies bioremediation | wetlands | CO_2 sequestration | biobarriers

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

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

Standardized methods product claims | regulatory issues | ASTM methods acceptance

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

FUNDAMENTAL TOPICS

Biofilms in nature microbes in cold environments | role of biofilms in natural processes | thermophiles

Cellular/intracellular phenotype | genetics | metabolic pathways | proteomics

Ecology/physiology population characterization | spatial and temporal population dynamics

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

ANALYTICAL TOOLS & TECHNIQUES

Instrumentation microscopy | nuclear magnetic resonance imaging | gas chromatography | ToF-SIMS | laser microdissection

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

Modeling cellular automata modeling | mathematics | hydrodynamics

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

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

RESEARCH:

2011–2012 CBE RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Biofilms in Nature	NASA fellowship: Heidi Smith	Foreman	NASA
Biofilms in Nature	Collaborative research: The biogeochemical evolution of dissolved organic matter in a fluvial system on the Cotton Glacier, Antarctica	Foreman	NSF
Biofilms in Nature	Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS divide replicate core	Foreman	NSF
Biofilms in Nature	Collaborative research: Integrated high resolution chemical and biological measurements on the deep WAIS divide core. *[1]	Foreman	NSF
Education	Improving Montana community health through graduate education	Camper	NIH
Energy Solutions	Montana biodiesel initiative	Peyton	DOE
Energy Solutions	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface	Codd	DOE
Energy Solutions	CBE collaboration with Little Bighorn College: Cultivation and characterization of oil producing algae	Peyton	Little Big Horn College
Energy Solutions	Environmental responses to geologic CO_2 sequestrations	Cunningham	DOE EPSCoR
Energy Solutions	Basic science of retention issues, risk assessment and measurement, monitoring, and verification for geologic CO_2 sequestrations	Cunningham	DOE
Energy Solutions	Extremophilic microalgae: Advanced lipid and biomass production for biofuels and bioproducts	Peyton, Fields	DOE
Energy Solutions	Cultivation and characterization of phototrophs for renewable organic fertilizer	Peyton, Macur	DOE - AISES
Energy Solutions	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	Church & Dwight Co Inc.
Energy Solutions	EFRI-HyBi: Fungal processes for bioconversion	Peyton	NSF-ARRA
Environmental Technologies	Subsurface biofilm barriers for enhanced geologic sequestration of supercritical CO_2	Cunningham, Spangler	DOE-ZERT
Environmental Technologies	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
Environmental Technologies	ZERT II—Cunningham task II	Cunningham	DOE-ZERT
Environmental Technologies	Plant, season, and microbial controls on complete denitrification in treatment wetlands	Stein	NSF
Environmental Technologies	Microbial activity and precipitation at solution-solution mixing zones in porous media	Gerlach	DOE-ERSP
Infrastructure	MRI: Acquisition of a state of the art confocal microscope at the CBE	Stewart	NSF
Infrastructure	State of the art biological imaging facility	Stewart	MJ Murdock Charitable Trust
Medical Biofilms	Development of novel anti-biofilm compounds for treating chronic wounds	James	NIH
Medical Biofilms	Novel chemical analysis of the biofilm-biomaterial interface	Carlson	NIH via University of Illinois
Methods Development	Antimicrobial test methodology	Goeres	EPA
Modeling	CMG Research	Klapper	NSF

Research Area	Title	Principal Investigator	Funding Agency
Multicellular/ Extracellular	Cohesive strength & detachment of bacterial biofilms	Stewart	NSF via University of Minnesota
Physiology & Ecology	Virtual institute for microbial stress & survival	Fields	Lawrence Berkley National Lab
Physiology & Ecology	Role of IbpA in maintaining viability of *P. aeruginosa* biofilm persister cells[*2]	Franklin	NIH
Physiology & Ecology	Metabolic engineering of *Alicyclobacillus acidocaldarius* for lactic acid production from biomass derived monosaccharides	Carlson	Idaho National Lab

*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 Land Resources and Environmental Sciences*
[2]*MSU Department of Microbiology*

List of Acronyms

AISES	American Indian Science & Engineering Society
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
MBRCT	Montana Board of Research and Commercialization Technology
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NSF	National Science Foundation
USDA	U.S. Department of Agriculture
ZERT	Zero Emissions Research and Technology

FY12 New CBE Research Grants **(July 1, 2011 to June 30, 2012)**

Sponsor	Title	PI	Period	Amount
NIH	Improving Montana community health through graduate education	Camper	3 yrs	$379,203
Little Big Horn College	CBE collaboration with Little Bighorn College: Cultivation and characterization of oil producing algae	Peyton	1 yr	$25,485
USDOE w/Vista Clara Inc. (SBIR/STTR)	Low cost in situ NMR technologies for monitoring biological and geochemical processes in the subsurface	Codd	1 yr	$25,000
NIH w/Agile Sciences STTR)	Development of novel anti-biofilm compounds for treating chronic wounds	James	1 yr	$95,003
Church & Dwight Co. Inc.	Lipid derived biofuels: Bicarbonate induced triacylglycerol accumulation in microalgae	Peyton	1 yr	$121,680
NSF	Molecular level characterization of dissolved organic carbon and microbial diversity in the WAIS divide replicate core	Foreman	2 yrs	$162,266
USDOE w/American Indian Science & Engineering Society (AISES)	Cultivation and characterization of phototrophs for renewable organic fertilizer	Peyton Macur	1 yr	$35,000
	Total grant awards to CBE for FY 2012			**$843,637**

RESEARCH:
NEWS

CBE makes the cover of *Microscopy Today*

The CBE garnered the cover image and feature article in the September 2011 issue of *Microscopy Today*. The cover image, obtained with a confocal scanning laser microscope (CSLM) by Logan Schultz and Betsey Pitts of the CBE, shows four reconstructed digital image slices through clusters of *Sporosarcina pasteurii* bacteria growing around calcium carbonate precipitates inside a glass capillary.

The image illustrates the featured article "Imaging biologically induced mineralization in fully hydrated flow systems," authored by **Logan Schultz**, CBE MS 2010 graduate; **Betsey Pitts**, CBE research scientist and microscope facilities manager; and CBE associated faculty—**Andrew Mitchell** (at Aberystwyth University, UK); **Al Cunningham**, civil engineering; and **Robin Gerlach**, chemical and biological engineering.

The idea of promoting and/or controlling biologically induced calcium carbonate precipitation is of interest in several possible subsurface applications: enhancing soil stability, immobilizing groundwater contaminants, enhancement of oil recovery, and geologic carbon sequestration via controlled permeability reduction.

The biggest challenge to developing these technologies is to identify and control a carbonate precipitation route that is industrially, environmentally, and economically viable. This study highlights the usefulness of microscopy at two different scales to better understand the process of biomineralization quantitatively and qualitatively.

Stereomicroscopy was used to analyze the large-scale features: size and distribution of calcite precipitates, the overall immobilization of dissolved calcium, and the potential solubility of precipitates as a function of position. Confocal laser microscopy allowed for the study of the microbe-mineral interactions that ultimately dictate the large-scale processes.

Being able to understand and control the spatial distribution of calcium carbonate precipitates in porous media can lead to the development of strategies to manipulate porous media permeability and reactive transport on large scales.

Microscopy Today, Sep 2011; (19)5: 12-15.

CBE makes cover of *Biotechnology and Bioengineering*

The CBE garnered the cover image and an article in the December 2011 issue of *Biotechnology and Bioengineering*. The cover image of *Staphylococcus epidermidis* biofilm imaged by confocal microscopy, shows microcolonies (yellow clusters) and extracellular matrix material (red). Each microcolony contains thousands of bacteria. The image was obtained with a confocal scanning laser microscope (CSLM) by **Betsey Pitts**, CBE microscope facilities manager; **Willy Davison**, CBE PhD 2008 graduate, **Paul Perry**, former CBE undergraduate, and **Phil Stewart**, CBE director and professor, chemical and biological engineering.

In addition to a cover image, the December issue featured the CBE in the article, “Hydrodynamic deformation and removal of *Staphylococcus epidermidis* biofilms treated with urea, chlorhexidine, iron chloride, or dispersinB," authored by **Eric Brindle**, CBE PhD 2009 graduate, **David Miller**, CBE faculty member, mechanical engineering, and CBE director **Phil Stewart**, chemical and biological engineering. Statistical analysis was provided by **Al Parker**, CBE research engineer and biostatistician.

Biotechnology and Bioengineering, December 2011; (108)12:2968–2977.

CBE's new microscopes advance understanding of microbes

Web Feature, *MSU News*, January 13, 2012:

One of the nation's most advanced confocal scanning laser microscope arrays has finished its first semester of work at Montana State University's **Center for Biofilm Engineering** and exceeded researchers' expectations in advancing our understanding of the role of bacteria in everything from infection to industrial corrosion to basic science.

The $900,000 grant-funded microscope array is housed and operated by MSU's Center for Biofilm Engineering. Founded in 1990, the center is a world leader in the study of bacterial biofilms. Built by Leica, the microscope array is used primarily by the CBE to study the sticky bacterial colonies known as biofilms that attach to human tissue in wounds, the insides of pipelines and can gum up machinery, causing billions of dollars in damages and lost production.

There are only five other similarly equipped confocal microscope arrays in the U.S., and the CBE has the only one in the Northwest. The microscope array allows researchers to video live microbes in their natural conditions -- something that has been previously impossible.

Many other microscope systems require samples to be treated and dried before imaging, which kills cells and destroys the structure of biofilms. *Click here to see images from the microscope.*

"If you can imagine comparing microbial cells to the study of fish, it's like we have been putting fish in a tub of water kept at the wrong temperature, shining bursts of skin-burning light on them, and taking one picture every five minutes," said Betsey Pitts, research scientist and microscope facilities manager for the CBE. "Now, our 'fish' are at the water temperature they like, the detectors are so sensitive and the picture-taking so fast that they may not even notice, and we can make a real-time video of them interacting."

The $900,000 to fund the array is the largest equipment grant in the 21-year history of the CBE, but the benefits have already been shared with six academic departments in two colleges across MSU. Designated a "core facility" of the university's research enterprise, the array is available for use by students and faculty from across the university as well as by private industry.

"The CBE integrates activities in three areas that are often difficult for universities to bring together successfully: research, education and industry partnership," said Phil Stewart, CBE's director. "This microscope array provides benefits to each of those three areas."

In the past year, 88 graduate and undergraduate students were involved in projects at the CBE, many of them using the new microscope system for interdisciplinary research on chronic wounds, remediating contaminated soils, corrosion of industrial pipelines, and the use of wetlands for water treatment.

"We are giving students hands-on experience operating and doing research with this million-dollar piece of technology. Such student access is almost unheard of in higher education. It's definitely a very special thing and something that would be hard to find at many larger universities," Stewart said.

Chemical and biological engineering graduate student James Connolly used the new microscopes to look at biofilms found in soils and aquifers.

"The new confocal scopes allow me to view larger samples at a higher resolution and get a better idea of their geometry," Connolly said. "This is big for a lot of people who now have that much more flexibility in what can be imaged."

Elsewhere on campus, Bill Inskeep, professor in the Department of Land Resources and Environmental Sciences, has used the new microscopes to investigate microbial mats pulled from Yellowstone's hot springs.

"We have a lot of the genomic and molecular data on these unusual microbes," Inskeep said. "What we are lacking is the three-dimensional sense of the mats and proof of where the microbes are in the mat."

With the confocal microscopes, Inskeep can see what is happening at each level of the microbial mat. Knowing which microbes are where in context with the chemical layers in the mat is important for understanding the micro-ecosystem. For example, if a certain species of microbes congregates at the top where there is more oxygen, it tells researchers something about that species.

"We can get a contextual and undisturbed sense of how organisms are configured in space," Inskeep said. "The images will give us both qualitative and quantitative data that translates to how a community works."

The new microscope array is also being utilized for industry-sponsored research. From its beginning 21 years ago, the CBE has fostered working relations with industry and currently has more than 30 companies inside and out of Montana sponsoring research at the center, including Colgate-Palmolive, which is interested in the cavity-causing biofilms commonly found on peoples' teeth.

"With the movie capacity on the new scopes, you don't have to be a scientist to see that there is gunk on your teeth and that a mouthwash washes it away," said Harsh Trivedi, senior technology associate at Colgate-Palmolive. "Now there is an unlimited capacity to see and show what is happening in a sample."

"These new microscopes will attract new projects and the results of those projects will attract new industrial members," Trivedi said.

The CBE purchased the microscopes with a $498,433 grant from the National Science Foundation and a complementary cost-sharing grant of $406,500 from the M.J. Murdock Charitable Trust. The total of the two awards were applied to the purchase of the two Leica SP5 Spectral Confocal Systems.

Summary of all current projects using the CBE confocals

(includes both CBE and other campus users)

Research projects based on use of the new microscopes in the last year are:

- use of confocal microscopy to visualize penetration and action of cationic antimicrobial peptides on different pseudomonas biofilms;
- time lapse imaging of action of commercially available mouth rinses on oral biofilms;
- development of a new flow cell to enable top-down, time lapse, three dimensional imaging of biofilm dispersion and response to osmotic changes;
- determining physiologically relevant cellular deformations and uncovering subcellular mechanisms of cellular mechanotransduction using gfp-labeled human cartilage cells;
- visualizing microbes from cold temperature environments to determine spatial arrangement on sediment particles and intrinsic fluorescent properties;
- testing of liquid treatments using the Treatment Flow Cell to supplement viable plate count data for development of standard methods such as ASTM E2871, Standard Test Method for Evaluating Disinfectant Efficacy against *Pseudomonas aeruginosa* Biofilm Grown in the CDC Biofilm Rector using the Single Tube Method;
- visualization of mechanosensory neural circuits in fruit fly larvae;
- analysis of targeting efficacy of oral biofilm drugs; investigation of interactions between microbial biofilms and reactive carbonate minerals in three dimensions over time;
- detecting cellular colocalization of STEAP3 with transferrin receptor-1 in mammalian cells through immunofluorescence;
- the study of structure-function in a dual-species anaerobic biofilm by measuring biovolume and spatial arrangement of each species via fluorescence in situ hybridization (FISH);
- measuring swimming speed and distance of a methanogenic archaeon toward hydrogen in a glass capillary;
- identification of polysaccharides produced by three different pseudomonas strains via targeted fluorescent staining;
- using fluorescent reporter genes to monitor bacterial attachment and biofilm development on wetland plant roots;
- identification and distribution of novel archaea from acidic ferric iron mats in Yellowstone National Park.

Additionally, the Standardized Biofilm Methods Lab and the Medical Biofilms Lab use the new confocals extensively in testing projects sponsored by industry and regulatory agencies, and smaller projects with CBE Industrial Associates.

Peyton lab adds new, hybrid multi-mode plate reader to CBE instrument room

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

RESEARCH:
CBE Associated Faculty and Their Specialties, 2011–2012

NAME	DEPARTMENT	SPECIALTY
Jennifer Brown	Chemical & Biological Engineering	Rheology and biofilm mechanics
Mark Burr	Land Resources & Environ Sciences	Microbial community analysis
Anne Camper	Civil Engineering	Biofilms in environmental systems
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic networks
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
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
Richard Macur	Chemical & Biological Engineering	Biofuels, geochemistry, geomicrobiology
Aurélien Mazurie	Microbiology	Bioinformatics
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
Elinor Pulcini	Chemical & Biological Engineering	Medical Biofilms
Abbie Richards	Chemical & Biological Engineering	Environmental biotechnology
Rocky Ross	Computer Science	Web-based, active learning education
Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Otto Stein	Civil Engineering	Engineered waste remediation
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Sturman	Civil Engineering	Biofilms in waste remediation and industrial systems
Peter Suci	Microbiology	Fungal biofilms
Tianyu Zhang	Mathematics	Mathematical modeling

CBE Associated Faculty Awards & News

2012 MSU Faculty Awards and Recognition

Two CBE associated faculty members—**Isaac Klapper** and **Sarah Codd**—were among the recipients of Montana State University's 2012 faculty awards. The annual awards honor achievement in faculty research, teaching, outreach, and creative projects. This year's awards were presented at the second annual MSU Spring Convocation on January 10. In keeping with the CBE's goal to provide high quality interdisciplinary research and education, it is of particular value to the CBE that the two associated faculty member awardees represent different disciplines.

Wiley Award for Meritorious Research and Creativity

Isaac Klapper, professor in the Department of Mathematics, was selected as one of three 2012 recipients of the Charles and Nora L. Wiley Faculty Awards for Meritorious Research and Creativity. The award is given in honor of the Wileys, who were pioneer ranchers in eastern Montana. Each recipient received $2,000 honorarium.

Isaac is recognized as a world-renowned leader and pioneer in the mathematical modeling and simulation of biofilms. A Harvard graduate and former Fulbright scholar and NSF postdoctoral fellow, Isaac has helped make MSU's Center for Biofilm Engineering a world leader in biofilm research. Besides being named the center's faculty member of the year, he is the principal investigator on four recent NSF grants that total more than $1 million. He has published more than 40 peer-reviewed articles and made more than 50 invited presentations at local, national and international levels since coming to MSU in 1996.

Sarah Codd, professor, mechanical and industrial engineering, received two awards for her contributions to research and outreach at Montana State University.

Provost's Award for Undergraduate Research/Creativity Mentoring

Sarah received this year's undergraduate research/creativity mentoring award. She will receive a $2,000 honorarium. Sarah is a top researcher in the field of magnetic resonance microscopy. Sarah's work gives undergraduates the ability to investigate everything from fuel cells to medical catheters to the cleanup of contaminated soil and water. Her lab is known as a place where undergraduates have a real opportunity to engage in cutting-edge research. To give them an added head start, Sarah hosts informational sessions for undergraduates to help steer them into activities and classes that will prepare them for graduate programs and grant-funded research.

Women's Faculty Caucus Distinguished Mentor Award

Sarah also received the 2012 Women's Faculty Caucus Distinguished Mentor Award. It carries a $1,000 honorarium. The award recognizes an MSU faculty member for mentoring junior women faculty members by helping them negotiate the promotion and tenure process, encouraging their research and teaching activities, and providing “whole woman” role models. Sarah is called a tireless academic committed to advancing the careers of female faculty and students in the College of Engineering. She has formed an informal forum for female faculty in the college, is the faculty adviser for the MSU chapter of the Society of Women Engineers and brings an infectious passion for science and engineering to all she does.

MSU College of Engineering 2012 Faculty Awards

Two CBE faculty were honored at the College of Engineering Luncheon on May 2nd. **Abbie Richards**, assistant professor, chemical and biological engineering, received the COE Faculty Award for Excellence in Teaching. **Joseph Seymour**, professor, chemical and biological engineering, received the inaugural COE Faculty Mentorship Award.

CBE 2012 Outstanding Faculty Award

The CBE presented its 2012 Outstanding Faculty Award to **Ross Carlson**, assistant professor, chemical and biological engineering. It was awarded in recognition of Ross' innovative research in metabolic modeling, collaborative style, and active engagement of his lab group with CBE activities. Ross was also recognized for his contributions to interdisciplinary education through MSU's Integrative Graduate Education and Research program (IGERT) and participation in industrially sponsored projects.

CBE 2011 Outstanding Researcher Award

Alessandra Agostinho, CBE research scientist, received the 2011 CBE Outstanding Researcher Award in July. Alessandra received this award in recognition of her excellent research in the areas of medical and dental biofilms, exceptional service to industrial project sponsors, contributions to CBE workshops, microscopy and imaging, and thoughtful mentoring of students. Alessandra, who is a doctor of dentistry, was a visiting scientist from the University of Sao Paulo, Brazil, in 2005, prior to joining the CBE research staff in 2006.

CBE faculty member and PhD student use grant to create educational opportunities for underrepresented minorities

Anne Camper, CBE faculty and associate dean for research and graduate studies in MSU's College of Engineering, and **Mari Eggers**, PhD student, microbiology, were awarded an R25 grant from the NIH's National Institute on Minority Health and Health Disparities (NIMHD) entitled "Improving Montana community health through graduate education." With the grant, they created the Graduate Education in Health for Minority Scholars (GEhMS) program at MSU. The program is designed to increase community capacity to reduce health disparities in our state by supporting underrepresented minority (URM) graduate students in biomedical and behavioral sciences who have strong ties to underserved Montana communities. Housed at the CBE, the program supports new and continuing URM graduate students in MSU health programs by facilitating opportunities to conduct community-based participatory research on health issues in their home communities, as well as by providing academic, financial, and social support.

Scholarships were recently awarded to former CBE research intern Dayle "Candy" Felicia, MS student, family and community health, and Yanet Eudave, an MSU McNair Scholar who will begin her graduate studies in family and community health in summer 2012.

CBE faculty receive DOE funding to develop carbon capture and sequestration technologies for biofuel advancement

CBE faculty **Rich Macur**, research assistant professor, chemical and biological engineering, and **Brent Peyton**, department head, chemical and biological engineering, along with Little Big Horn College's Jonah Morsette, science instructor, will receive $210,000 over three years to develop fast growing strains of nitrogen-fixing cyanobacteria to help advance carbon capture and sequestration (CCS) technologies. The program is sponsored by the US Department of Energy and the American Indian Research and Education Initiative and is designed to support the Crow Nation reservation as it evaluates opportunities for coal-to-liquid fuel and CCS projects. Located in southeast Montana, the Crow reservation contains 3% of the US coal reserves. Advances in CCS technology can lead to alternative fuel options for the US and job creation on the Crow reservation.

CBE Staff News

New Staff

The CBE welcomed **Olusegun (Olu) Oshota** as a new postdoctoral researcher in March. Olu recently received his PhD in systems biology from the University of Manchester, England, while working for Dr. P. Mendes. At the CBE, he works with **Brent Peyton, Ross Carlson**, and **Abbie Richards** on in silico and practical analysis of bacterial metabolic networks with the goal of controlling unwanted biofilm growth. The project is funded by a CBE industrial associate.

Dana Skorupa, has joined the CBE as a postdoctoral research associate. Dana works on a collaborative project between **Brent Peyton's** lab, Montana's Crow Indian Reservation, and Accelergy Corporation. The project's goal to use cyanobacteria

to help mitigate power-plant flue gas emissions by photosynthetic carbon conversion. Dana received her PhD in microbiology from Montana State University.

The CBE welcomed **Chiachi Hwang** as an industrial research scientist in April. Chiachi received her PhD in microbiology from Miami University in Ohio. Her PhD research focused on the microbial community dynamics at a uranium/nitric-acid waste contaminated site (Oak Ridge, Tennessee) treated for bioremediation. Her training has been in molecular tools (16S rRNA gene analysis via clone libraries, T-RFLP, and pyrosequencing) for characterization of microbial communities. Chiachi was a visiting graduate student at the CBE from 2007–2009 when she was finishing her PhD research. Returning to the CBE, Chiachi will be working on several industrial associate projects under the direction of CBE associated faculty **Matthew Fields**, microbiology.

Retired

At the end of December 2011, the CBE bid farewell to longtime staff member **Margie Hansen**, accounting analyst. Margie began working at the Center as an accounting technician in February 2000. Her attention to detail and loyalty to the CBE made her a valuable asset to the organization. Margie is retiring alongside her husband Lloyd, also a longtime MSU staff member. Their retirement allows Margie the opportunity to spend more time with her family, friends, and much loved horses.

RESEARCH:
PUBLICATIONS
June 2011–May 2012

2011 Publications

NOTE:
2011-001 through 2011-022 are listed in 2011 Appendix

Secor PR, James GA, Fleckman P, Olerud JE, McInnerney K, **Stewart PS**, "*Staphylococcus aureus* biofilm and planktonic cultures differentially impact gene expression, mapk phosphorylation, and cytokine production in human keratinocytes," *BMC Microbiol* 2011;11(143):1-13. *2011-023*

Rahman MS, Encarnacion G, Camper AK, **"**Nitrification and potential control mechanisms in simulated premises plumbing," *Water Research* 2011;45(17):5347-5806. *2011-024*

Villa F, **Pitts B, Stewart PS**, Giussani B, Roncoroni S, Albanese D, Giordano C, Tunesi M, Cappitelli F, "Efficacy of zosteric acid sodium salt on the yeast biofilm model *Candida albicans*," *Microb Ecol* 2011;62(3):584–598. *2011-025*

Folsom JP, Baker B, **Stewart PS,** "In vitro efficacy of bismuth thiols against biofilms formed by bacteria isolated from human chronic wounds," *J Appl Microbiol* 2011;111(4):989–996. *2011-026*

Han A, Zenilman JM, Melendez JH, Shirtliff ME, **Agostinho A**, **James G, Stewart PS**, Mongodin EF, Rao D, Rickard AH, Lazarus GS, "The importance of a multifaceted approach to characterizing the microbial flora of chronic wounds," *Wound Rep Reg* 2011; 19(5):532–541. *2011-027*

Brindle ER, **Miller DA, Stewart PS**, "Hydrodynamic deformation and removal of *Staphylococcus epidermidis* biofilms treated with urea, chlorhexidine, iron chloride, or dispersinB," *Biotechnol Bioeng* 2011; 108(12):2968-2977. *2011-028*

Corbin A, **Pitts B, Parker A, Stewart PS**, "Antimicrobial penetration and efficacy in an in vitro oral biofilm model," *Antimicrob Agents, Chemother* 2011; 55(7):3338–3344. *2011-029*

Behnke S, **Parker AE**, Woodall D, **Camper AK**, "Comparing the chlorine disinfection of detached biofilm clusters with those of sessile biofilms and planktonic cells in single- and dual-species cultures," *Appl Environ Microbiol* 2011;77(20):7176-7184. *2011-030*

Agostinho AM, Hartman A, **Lipp C**, **Parker AE**, **Stewart PS**, **James GA**, "An in vitro model for the growth and analysis of chronic wound MRSA biofilms," *J Appl Microbiol* 2011;111(5): 1275–1282. *2011-031*

Warren AE, Boulianne-Larsen CM, Chandler CB, Chiotti K, Kroll E, Miller SR, Taddei F, Sermet-Gaudelus I, Ferroni A, McInnerney K, **Franklin MJ**, Rosenzweig F, "Genotypic and phenotypic variation in *Pseudomonas aeruginosa* reveals signatures of secondary infection and mutator activity in certain Cystic Fibrosis patients with chronic lung infections," *Infect Immun* 2011;79(12):4802-18. 2011-032

Franklin MJ, Nivens DE, Weadge JT, Howell PL, "Biosynthesis of the *Pseudomonas aeruginosa* extracellular polysaccharides, alginate, Pel, and Psl," *Front Microbiol* 2011;2(167):1-10. *2011-033*

Suci P, Young M, "Selective killing of *Aggregatibacter actinomycetemcomitans* by ciprofloxacin during development of a dual species biofilm with *Streptococcus sanguinis*," *Archives of Oral Biology* 2011;56(10);1055-1063. *2011-034*

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2012 Publications

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RESEARCH: PRESENTATIONS June 2011–May 2012

Zbigniew Lewandowski, professor, civil engineering, taught several lectures on biofilm processes, microbially influenced corrosion, and fundamentals of biofilm research, Silesian University of Technology, Gliwice, Poland, May 7–June 2, 2011.

Rob Gardner, PhD candidate, and **Karen Moll**, MS student, chemical and biological engineering, presented the poster "A chemical trigger for inducing triacylglycerol accumulation in algae," American Society for Microbiology Meeting, New Orleans, LA, May 22–25, 2011.

Kara DeLeón, PhD candidate, and **Matthew Fields**, associate professor, microbiology, presented "SSU rDNA gene sequence region and quality-checking are essential for species richness and diversity estimates via pyrosequencing," American Society for Microbiology Meeting, New Orleans, LA, May 22–25, 2011.

Mari Eggers, PhD candidate, microbiology, presented "Community based risk assessment on the Crow Reservation—water quality issues," Harvard University Eco-Stewards Program, Paradise Valley, MT, June 2–9, 2011. Co-authors: Crow Environmental Health Steering Committee, Tamra Old Coyote (Little Big Horn College), and **Anne Camper** (CBE associated faculty).

Matthew Fields, associate professor, microbiology, presented "Lipid-derived biofuels: Determination of factors that control triglyceride accumulation in microalgae," Department of Defense PI Workshop (AFOSR), Arlington, VA, June 6–9, 2011.

Paul Sturman, research engineer and industrial coordinator, CBE, as an invited speaker presented "Biofilm growth in piping and fixtures," at a special meeting of the American Society of Plumbing Engineers, Chicago, IL, June 7, 2011.

Elliott Barnhart, PhD student, microbiology, and **Matthew Fields**, associate professor, microbiology, presented "Characterization of methane-producing communities in deep coal seams," International Symposium on Applied Microbiology and Molecular Biology in Oil Systems, Calgary, Alberta, Canada, June 12–15, 2011. **Barnhart**, also presented the poster "Analysis of methane producing communities within underground coal beds," International Symposium on Applied Microbiology and Molecular Biology in Oil Systems, Calgary, Alberta, Canada, June 13–15, 2011.

Anne Camper, professor, civil engineering, presented "Live versus dead determinations for microbial communities," How dead is dead II?—The ins and outs of bacterial dormancy conference (HDIDII), Eberhard Karls Universität, Tubingen, Germany, June 16–17, 2011.

Phil Stewart, CBE director, professor, chemical and biological engineering, as an invited speaker presented, "Biofilm concept and antimicrobial tolerance," European Cooperation in Science and Technology, Berlin, Germany, June 20–24, 2011.

Mari Eggers, PhD candidate, microbiology, was selected to attend a two-week course "Translational health disparities research" at the National Institute on Minority Health and Health Disparities (NIMHD), NIH campus, Bethesda, MD, June 20–July 1, 2011.

Zbignew Lewandowski, professor, civil engineering, invited speaker at the workshop "Biofouling of filtration membranes," as part of the Singapore International Water Week, Singapore, June 27–July 13, 2011.

Phil Stewart, CBE director, professor, chemical and biological engineering, as an invited speaker presented "The *Staphylococcal* biofilm defense," Eurobiofilms 2011 Conference, Copenhagen, Denmark, July 4–9, 2011.

Garth James, CBE medical projects manager, associate research professor, chemical & biological engineering, as an invited speaker presented "Oxygen, wound healing & biofilms," Eurobiofilms 2011 Conference, Copenhagen, Denmark, July 4–9, 2011.

Al Parker, bio-statistician and research engineer, CBE, was a presenter at the SIAM 7th International Congress on Industrial and Applied Mathematics, Vancouver, British Columbia, Canada, July 19, 2011. He presented "Polynomial accelerated iterative sampling of normal distributions," at the symposium on Statistics, Computations, and Inverse Problems.

Phil Stewart, CBE director, professor, chemical and biological engineering, presented "Chronic wounds: The biofilm hypothesis," American College of Wound Healing, Chicago, IL, August 3-5, 2011.

Robin Gerlach, associate professor, chemical and biological engineering, presented "Investigating and modeling the influence of biofilm formation and biofilm-mediated mineral formation on reactive transport in porous media," Pore Scale Modeling workshop, Environmental Molecular Sciences Laboratory, Pacific

Northwest National Laboratory, Richland, WA, August 8–11, 2011.

Hans Bernstein, PhD candidate, chemical and biological engineering, presented the poster "Diffusion and microbial consumption of oxygen in acidic geothermal iron-oxide mats," 2011 Goldschmidt conference, Prague, Czech Republic, August 14, 2011.

Hans Bernstein, PhD candidate, and **Ross Carlson**, assistant professor, chemical and biological engineering, presented the poster "Distribution and activity of iron-oxidizing microorganisms in acidic geothermal environments," 2011 Goldschmidt conference, Prague, Czech Republic, August 14–19, 2011. Co-authors: Beam JP, Kozubal MA, Inskeep WP

Ross Carlson, assistant professor, chemical and biological engineering, presented "In silico, physiological, proteomic, and cost-benefit analysis of resource-limited growth," 2011 Goldschmidt conference, Prague, Czech Republic, August 14–19, 2011. Co-authors: **Taffs RL**, **Folsom J**

Joe Seymour, professor, chemical and biological engineering, as an invited speaker presented "MR measurement of non-equilibrium thermodynamics: Microfluidic colloid suspension and critical phase transition flows," 11th International Conference on Magnetic Resonance Microscopy, Beijing, China, August 14–18, 2011. Co-authors: **Codd SL**, Fridjonsson EO, Rassi EM

Sarah J. Vogt, PhD student, chemical and biological engineering, presented the following two posters at the 11th International Conference on Magnetic Resonance Microscopy, Beijing, China, August 14–18, 2011:

> "Colloid transport and biofouling in model porous media," co-authors: **Fabich HT**, **Sanderlin AB**, **Codd SL**, **Seymour JD**
>
> "2D Relaxation and diffusion correlations in biopolymers," co-authors: **Fabich HT**, **Brown JR**, **Sherick ML**, **Seymour JD**, **Codd SL**

Darla Goeres, assistant research professor, chemical and biological engineering, as an invited speaker presented "Evaluation and remediation of bulk soap dispensers for biofilm," Bacterial Contamination of Bulk-Refillable Hand Soap in Public Restrooms workshop, GOJO Industries, Akron, OH, August 17, 2011.

Brandy Stewart, CBE postdoctoral researcher, presented the following research at the 242nd American Chemical Society National Meeting, Denver, CO, August 28–September 1, 2011:

> "Influence of chelating agents on biogenic uraninite reoxidation by Fe(III) (hydr)oxides," co-authors: **Girardot C**, **Peyton BM**
>
> "Stability of uranium incorporated into Fe(hydr)oxide structure under fluctuating redox conditions," co-authors: Nico PS, Fendorf S

Robin Gerlach, associate professor, chemical and biological engineering, presented the following research at the 242nd American Chemical Society National Meeting, Denver, CO, August 28–September 1, 2011:

> "Bacterially induced calcite precipitation and strontium co-precipitation under flow conditions in a porous media system," co-authors: **Schultz LN**, **Mitchell AC**, **Cunningham AB**
>
> "Microbially enhanced carbon capture and storage—pore and core scale experiments and modeling," co-authors: **Mitchell AC**, **Cunningham AC**, Spangler L, **Zhang T**, **Klapper I**, **Ebigbo A**, Helmig R

Kara DeLeón, PhD candidate, and **Matthew Fields**, associate professor, microbiology, presented the following two posters at the Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA) meeting, Lawrence Berkeley National Laboratory, Berkeley, CA, September 7–10, 2011:

> "Quality-score refinement of SSU rRNA gene pyrosequencing differs across gene region for in situ samples," co-author: **Ramsay BD**
>
> "Microbial community dynamics from groundwater and surrogate sediments during HRC® biostimulation of Cr(VI)-reduction," co-authors: **Ramsay BD**, Newcomer DR, Faybishenko B, Hazen TC, Zhou J

Matthew Fields, associate professor, microbiology, presented the poster "Structure impacts function for a syntrophic biofilm of *Methanococcus maripaludis* and *Desulfovibrio vulgaris*," Ecosystems and Networks Integrated with Genes and Molecular Assemblies (ENIGMA) meeting, Lawrence Berkeley National Laboratory, Berkeley, CA, September 7–10, 2011. Co-authors: **Brileya KA**, **Sabalowsky A**, **Ramsay B**, Zane G, Wall JD

Kara De León, PhD candidate, microbiology, presented "Microbial community analysis of alkaline springs along a thermal gradient in Yellowstone National Park," Thermophiles conference, Big Sky, MT, September 11–15, 2011.

Kara De León, PhD candidate, microbiology, was a translation ambassador, providing English as a Second Language (ESL) assistance, during meeting registration and session breaks at the 19th International Biohydrometallurgy Symposium, Changsha, China, September 18–22, 2011.

Robin Gerlach, associate professor, chemical & biological engineering, presented "Utility of biofilms and biologically induced mineralization in biotechnology and geologic carbon sequestration," 8th European Congress of Chemical Engineering/1st European Congress of Applied Biotechnology, Berlin, Germany, September 25–29, 2011.

Juliana D'Andrilli, postdoctoral research associate, presented the poster "Dissolved organic matter (DOM) in the West Antarctic Ice Sheet (WAIS) Divide ice core," 2011 WAIS Divide Meeting, Scripps Institute of Oceanography, La Jolla, California, September 27–29, 2011. Co-authors: **Foreman CM**, Priscu J, McConnell J

The following CBE faculty and PhD students presented research at the Algae Biomass Summit, Minneapolis, MN, October 23–27, 2011:

Ross Carlson, assistant professor, chemical & biological engineering, presented "A synthetic microbial community design based on syntrophic metabolite exchange."

Reed Taffs, PhD student, chemical & biological engineering, presented "Proteomic, physiological, and in silico testing of economic tradeoffs in metabolic networks."

Rob Gardner, PhD student, chemical & biological engineering, presented the poster "A chemical trigger for inducing triacylglycerol accumulation in algae."

Kris Hunt, PhD student, chemical & biological engineering, presented the poster "Fungal processes for direct bioconversion of cellulose to hydrocarbons."

The following CBE faculty presented research at the 2011 International Water Association (IWA) Biofilm conference in Shanghai, China, October 27–30, 2011:

Isaac Klapper, professor, mathematical sciences, presented "Discrete speciation of microbial species in continuously varying environments."

Tianyu Zhang, assistant professor, mathematical sciences, presented "Modeling of biocide action against biofilms."

Isaac Klapper, professor, mathematical sciences, presented "Modeling of microbial biofilms and mats," Department of Mathematics, Fudan University, Shanghai, China, October 27–30, 2011.

Juliana D'Andrilli, CBE postdoctoral research associate, assisted with experimentation and data processing on the Cotton Glacier project, National High Magnetic Field Laboratory, Tallahassee, FL, October 29–November 6, 2011.

Darla Goeres, assistant research professor, chemical & biological engineering, facilitated a discussion on the current biofilm method going through the review and approval process with the American Society of Testing and Materials (ASTM): "Standard test method for testing disinfectant efficacy against *Pseudomonas aeruginosa* biofilm grown in the CDC biofilm reactor using the single tube method." ASTM E35.15 Subcommittee meeting, Tampa, FL, November 1–4, 2011.

Garth James, CBE medical projects manager, associate research professor, chemical & biological engineering, presented "Biofilms in chronic wounds," at KCI Inc., Branchburg, New Jersey, November 8, 2011.

Anne Camper, professor, civil engineering, as an invited speaker presented the following research at the AWWA Water Quality Technology Conference, Phoenix, AZ, November 12–17, 2011:

"Ramping up for CCL3 pathogens—Data resources and data gaps," at the Quantitative Microbial Risk Assessment: New Applications, New Techniques, and Taking Stock of Challenges workshop.

"Biofilm control: Nutrients, disinfection, and pipe materials," at the special session on Microbial Water Quality at the Tap: An Emerging Issue.

Al Cunningham, professor, civil engineering, presented a seminar on biofilm modeling, Department of Mathematics, University of Texas-Arlington, Dallas, TX, November 17–19, 2011.

Garth James, CBE medical projects manager, associate research professor, chemical & biological engineering, presented "Biofilms, oxygen and wound healing," at the Wound Healing Science and Industry Conference, Rio Grande, Puerto Rico, December 9–11, 2011.

Natasha Mallette, PhD student, chemical & biological engineering, and **Elle Pankratz**, undergraduate student, chemical & biological engineering, presented the poster "Fungal bioconversion of cellulose to hydrocarbons," NSF Division of Emerging Frontiers in Research and Innovation (EFRI) Grantees Conference, Arlington, VA, March 8, 2012.

Karen Moll, MS student, microbiology, presented the poster "Diatom biofuels: Optimal nutrient requirements for lipid production," Functional Genomics Conference, Santa Fe, NM. March 22–23, 2012. Co-authors: **Gardner RD**, **Peyton BM**

Tianyu Zhang, assistant professor, mathematical sciences, presented "Biocide action against biofilms," Society for Industrial and Applied Mathematics (SIAM) Southeastern Atlantic Section (SEAS) Conference, University of Alabama, Huntsville, AL, March 23–25, 2012.

Mari Eggers, PhD student, microbiology, invited platform presentation "Health risks of lead exposure from elk and deer meat consumption," Native American Fish & Wildlife Society Conference, Bozeman, MT, March 29, 2012. Co-author: Emerson Bull Chief

Christine Foreman, associate research professor, land resources & environmental sciences, along with support from NSF and MSU education coordinator Susan Kelly, led a half-day teacher's symposium titled "Clues to the cryosphere," at the National Science Teachers Association National Conference, Indianapolis, IN, March 29–April 1, 2012. Additionally, Christine coordinated an exhibit booth and six follow-up talks by scientists.

Paul Sturman, CBE senior research engineer and industrial coordinator, presented "Biofilms and *Legionella* in water systems," Plumbing Manufacturers International spring conference, Sonoma, CA, April 2, 2012.

Al Parker, CBE bio-statistician and research engineer, as an invited speaker presented "Statistical assessment and standardization of the MBEC™ Assay for testing disinfectant efficacy against *Pseudomonas aeruginosa* biofilm," to attendees from the US Food and Drug Administration (FDA), National Institute of Standards and Technology (NIST), and industry at the Evaluation of Adhesion and Biofilm Formation on Medical Devices workshop hosted by Innovotech, Inc. in Silver Spring, MD, April 12, 2012.

Darla Goeres, assistant research professor, chemical & biological engineering, attended the ASTM E35.15 committee meeting in Phoenix, AZ on April 16–18, 2012. Darla lead discussions on two biofilm methods that were recently reapproved for growing biofilm in the RDR reactor and CDC reactor (Methods E2196-12 and E2562-12, respectively), the recently approved precision and bias statement for Method E2799-12, and the latest biofilm efficacy test Method E2871-12.

Al Cunningham, professor, civil engineering, co-instructed the short course "Multiphase flow, transport, and bioprocesses in porous media," at the Institute for Modeling Hydraulic and Environmental Systems, University of Stuttgart, Stuttgart, Germany, April 19–28, 2012. Co-instructor: Rainer Helmig, department head, hydromechanics and hydraulic modeling systems.

Phil Stewart, CBE director, professor, chemical and biological engineering, presented the opening lecture "Science and technology of biofilm control with antimicrobial agents," Quebec Center for Biotechnology Development (CQVB) meeting, St. Hyacinthe, Quebec, Canada, April 24, 2012.

Phil Stewart, CBE director, professor, chemical and biological engineering, presented "Biofilm control with antimicrobials and quorum sensing inhibitors," at NCH Corporation, Dallas, TX, April 25, 2012.

Phil Stewart, CBE director, professor, chemical and biological engineering, presented two seminars "Genetic basis of antibiotic tolerance of *Pseudomonas aeruginosa* in biofilms," and "The math of biofilm tolerance to antimicrobial agents," University of Texas, Arlington, TX, April 26 & 27, 2012.

Zbigniew Lewandowski, presented material at a workshop on the fundamentals of biofilm research, Tongji University, Shanghai, China, May 8–June 18, 2012.

Robin Gerlach, associate professor, chemical and biological engineering, presented "Improving control of microbial activity and microbially induced mineral precipitation in flow systems—Experiments and modelling," at the 4th International Conference on Porous Media and annual meeting of the International Society for Porous Media, Purdue University, West Lafayette, IN, May 14-16, 2012.

Tianyu Zhang, assistant professor, mathematical sciences, presented "Mathematical model of biofilm induced calcite precipitation at pore-scale," at the 4th International Conference on Porous Media and annual meeting of the International Society for Porous Media, Purdue University, West Lafayette, IN, May 14-16, 2012.

Isaac Klapper, professor, mathematical sciences, presented "Microbial-induced mineralization in biofilms," 2nd International Conference on Scientific Computing, Nanjing, China, May 22-25, 2012.

EDUCATION:

Undergraduate Students: Summer 2011, Fall 2011, Spring 2012

*****Graduating ‡ Native American

1.	Avera, Erika (Cunningham)	F	Cell Bio & Neurosci	Grass Valley, CA
2.	Bader, Erica (Richards)	F	Chem & Bio Eng	Boulder, CO
3.	Barnick, John (Gerlach)	M	Chem & Bio Eng	Glendive, MT
4.	Bergin, Bridget (Seymour)	F	Mech & Indust Eng (USP)	Sidney, MT
5.	Bleem, Alissa (Carlson)	F	Chem & Bio Eng (USP)	Fort Collins, CO
6.	Bogen, Thomas (Macur)	M	Land Res & Environ Sci (USP)	Bozeman, MT
7.	Davis, Steven (Carlson)	M	Chem & Bio Eng (McNair Scholar)	Billings, MT
8.	*DeGroat, Alec (Fields)	M	Microbiology	Billings, MT
9.	Dietrich, Eric (Camper)	M	Civil Engineering (INBRI)	Portland, OR
10.	Doane, Danielle (Pulcini)	F	Nursing	Townsend, MT
11.	Durch, Amanda (James)	F	Chem & Bio Eng (USP)	Newell, SD
12.	*Fabich, Hilary (Codd/Seymour)	F	Chem & Bio Eng (INBRE)	Livingston, MT
13.	‡ Felicia, Dayle (Camper)	F	Health & Human Dev (CNHP intern)	Wyola, MT
14.	Forrest, Devon (Cunningham)	M	Civil Engineering	Bozeman, MT
15.	Fritz, Blaine (Walker)	M	Ecology (USP)	Billings, MT
16.	Gulick, Stesha (Peyton)	F	Chem & Bio Eng	Helena, MT
17.	Hafla, Erin (Stein)	F	Civil Engineering	Idaho Falls, ID
18.	Halverson, Luke (Gerlach)	M	Chem & Bio Eng	Lansing, IA
19.	Hoag, Katie (Fields)	F	Cell Bio & Neurosci	Kalispell, MT
20.	Johnson, Sarah (Stein)	F	Civil Eng (BREN)	Maple Grove, MN
21.	Justin, Grant (Fields)	M	Microbiology	Cambridge, MA
22.	Morris, Dayla (Walker/Gerlach)	F	Chem & Bio Eng (USP)	Stockett, MT
23.	Moss, Jefferson (Stein)	M	Civil Engineering (USP)	Colorado Springs, CO
24.	Nagy, Justin (Fields)	M	Microbiology	Sunburst, MT
25.	Newhouse, Hannah (Peyton)	F	Chem & Bio Eng (USP)	Pocatello, ID
26.	Olson, Andrew (Camper)	M	Civil Engineering	Hill City, ID
27.	Orr, Danielle (Walker)	F	Microbiology	Bozeman, MT
28.	Pabst, Breanna (Stewart)	F	Chem & Bio Eng	Great Falls, MT
29.	Pankratz, Elle (Peyton)	F	Mech & Ind Eng	Clancy, MT
30.	‡Paulson, Steven (Carlson)	M	Chem & Bio Eng	Cut Bank, MT
31.	Pedersen, Todd (Peyton)	M	Chem & Bio Eng	Poulsbo, WA
32.	*Penic, Melis (Franklin)	F	Microbiology (USP)	Turkey
33.	Purdy, Kim (Richards)	F	Chem & Bio Eng	Buffalo, WY
34.	Ramos, Luis (Carlson)	M	Chem & Bio Eng	Mexico
35.	Rao, Varsha (Seymour)	F	Chem & Bio Eng	Canada
36.	Rothman, Adam (Gerlach)	M	Chem & Bio Eng (USP)	Anchorage, AK
37.	Schmit, Amber (Foreman)	F	Chem & Bio Eng (USP)	Sheridan, WY
38.	Sen, Emel (Peyton)	F	Chem & Bio Eng	Turkey
39.	Sherick, Matthew (Seymour)	M	Chem & Bio Eng (INBRE)	Hudson, WI
40.	Smith, Erin (Franklin)	F	Chemistry (INBRE)	Evergreen, CO
41.	Solomon, Benjamin (Peyton)	M	Chem & Bio Eng	Lone Tree, CO
42.	Speakman, Keila (Fields)	F	Microbiology	Bozeman, MT
43.	Stabio, Katie (Fields)	F	Microbiology	Billings, MT
44.	*Stringam, Joshua (Gerlach)	M	Chem & Bio Eng (USP)	Bozeman, MT
45.	Toussaint, Jean-Paul (Carlson)	M	Chem & Bio Eng (USP)	Charlo, MT
46.	Vadheim, Bryan (Heys)	M	Chem & Bio Eng	Miles City, MT
47.	Warthen, Katherine (Gerlach)	F	Chem & Bio Eng (USP)	Laurel, MT
48.	Whitney, Erika (Fields)	F	Microbiology	Issaquah, WA
49.	Zambare, Neerja (Lauchnor)	F	Chem & Bio Eng	India

Undergraduates Summary: 2011–2012

Department (Program)	Male	Female	Total
Cell Biology & Neuroscience		2 F	2
Chemical & Biological Engineering	12 M	14 F	26
Chemistry & Biochemistry		1 F	1
Civil Engineering	4 M	2 F	6
Ecology	1 M		1
Health & Human Development		1 F	1
Land Resources & Environmental Sciences	1 M		1
Mechanical & Industrial Engineering		2 F	2
Microbiology	3 M	5 F	8
Nursing (Bridges)		1 F	1
Totals	21 M	28 F	49

EDUCATION:

Graduate Students: Summer 2011, Fall 2011, Spring 2012

*****Graduating

Masters Candidates

1.	*Barnhart, Elliott (Fields/Cunningham)	M	Microbiology	Broadus, MT
2.	Blaskovich, John (Gerlach)	M	Chem & Bio Eng	Butte, MT
3.	*Eustance, Everett (Peyton)	M	Chem & Bio Eng	Great Falls, MT
4.	Felicia, Dayle "Candy" (Camper)	F	Health & Human Dev	Wyola, MT
5.	Lerch, Michael (Parker)	M	Mathematics	Spring City, PA
6.	Markwardt, Stephen (Camper)	M	Environ Eng	Ely, MN
7.	Moll, Karen (Peyton)	F	Microbiology	Fairport, NY
8.	Schoen, Heidi (Peyton, Carlson)	F	Chem & Bio Eng	Geneva, IL
9.	Staven, Ari (Peyton)	F	Chem & Bio Eng	Georgetown, TX
10.	*Vo, Garret (Heys)	M	Mech Eng	San Francisco, CA
11.	Weeks, Lisa (Peyton)	F	Chem & Bio Eng	Fort Fairfield, ME

PhD Candidates

1.	Allen, Chris (Stein)	M	Civil Eng	Eldorado Hills, CA
2.	Barnhart, Elliott (Fields/Cunningham)	M	Microbiology	Broadus, MT
3.	Beck, Ashley (Carlson)	F	Microbiology	Corning, IA
4.	*Behnke, Sabrina (Camper)	F	Microbiology	Germany
5.	Bell, Tisza (Peyton)	F	Microbiology	Littleton, CO
6.	Bernstein, Hans (Carlson)	M	Chem & Bio Eng	Kalispell, MT
7.	Brileya, Kristen (Fields)	F	Microbiology	Bozeman, MT
8.	Camilleri, Laura (Fields)	F	Microbiology	Ukiah, CA
9.	Connolly, James (Gerlach)	M	Environ Eng	Post Falls, ID
10.	De León, Kara (Fields)	F	Microbiology	Bozeman, MT
11.	Eggers, Margaret (Camper)	F	Microbiology	California
12.	*Encarnacion, Gem (Camper)	F	Microbiology	The Philippines
13.	Franco, Lauren (Fields)	F	Microbiology	Moorpark, CA
14.	Gardner, Robert (Peyton)	M	Chem & Bio Eng	Afton, WY
15.	Hunt, Kristopher (Carlson)	M	Chem & Bio Eng	Thorp, WI
16.	Jackson, Benjamin (Klapper)	M	Mathematics	Sheridan, OR
17.	Jennings, Ryan (Carlson)	M	LRES	Lexington, SC
18.	Krantz, Gregory (Fields)	M	Microbiology	Tinmouth, UT
19.	Langr, Cassandra (Carlson)	F	Cell Biol & Neurosci	Bozeman, MT
20.	Lohman, Egan (Gerlach)	M	Chem & Bio Eng	Pine, CO
21.	Loudermilk, Derrick (Fields)	M	Microbiology	St. Louis, MO
22.	Mallette, Natasha (Peyton)	F	Chem & Bio Eng	Fayetteville, AR
23.	Plaggemeyer, Sara (Camper)	F	Microbiology	Big Timber, MT
24.	Sanderlin, Alexis (Codd/Seymour)	F	Chem & Bio Eng	Atlanta, GA
25.	Sandvik, Elizabeth (McLeod)	F	Chem & Bio Eng	Rapid City, SD
26.	Schwarz, Benjamin (Richards)	M	Chem & Bio Eng	Bend, OR
27.	Serrano Figueroa, Luis (A Richards)	M	Microbiology	Puerto Rico
28.	Severson, Grant (James)	M	Microbiology	Claremore, OK
29.	Smith, Heidi (Foreman)	F	LRES	Westford, VT
30.	Taffs, Reed (Carlson)	M	Civil Engineering	Helena, MT
31.	Tigges, Michelle (Foreman)	F	Chem & Biochem	Battle Lake, MN
32.	Valenzuela, Jacob (Fields)	M	Chem & Biochem	San Luis Obispo, CA
33.	VanKempen-Fryling, Rachel (Camper)	F	Microbiology	Grand Rapids, MI
34.	Vogt, Sarah (Seymour)	F	Chem & Bio Eng	Rolla, MO
35.	Zelaya, Anna (Camper)	F	Microbiology	Russellville, AR

*Received degree

Graduate Students, 2011–2012

1: Cell Biology & Neuroscience

PhD: 1

1 F Langr, Cassandra: PhD, *Carlson*

14: Chemical & Biological Engineering

MS: 5

2 M Blaskovich, John: MS, *Gerlach*
Eustance, Everett: MS, *Peyton*

3 F Staven, Ari: MS, *Peyton*
Schoen, Heidi: PhD, *Peyton, Carlson*
Weeks, Lisa: MS, *Peyton*

PhD: 9

5 M Bernstein, Hans: PhD, *Carlson*
Gardner, Robert: PhD, *Peyton*
Hunt, Kristopher: PhD, *Carlson*
Lohman, Egan: PhD, *Gerlach*
Schwarz, Benjamin: PhD, *Richards*

4 F Mallette, Natasha: PhD, *Peyton*
Sanderlin, Alexis: PhD, *Codd/Seymour*
Sandvik, Elizabeth: PhD, *McLeod*
Vogt, Sara: PhD, *Seymour*

2: Chemistry & Biochemistry

PhD: 2

1 M Valenzuela, Jacob: PhD, *Fields*

1 F Tigges, Michelle: PhD, *Foreman*

4: Civil / Environmental Engineering

MS: 1

1M Markwardt, Stephen: MS, *Camper*

PhD: 3

3 M Allen, Chris: MS, *Stein*
Connolly, James: PhD, *Gerlach*
Taffs, Reed: PhD, *Carlson*

1: Health & Human Development

MS: 1

1 F Felicia, Dayle (Candy): MS, *Camper*

2: Land Resources & Environmental Sciences

PhD: 2

1F Heidi Smith: PhD, *Foreman*

1M Jennings, Ryan: PhD, *Carlson*

2: Mathematical Sciences

MS: 1

1 M Lerch, Michael: MS, *Parker*

PhD: 1

1 M Jackson, Benjamin: PhD, *Klapper*

1: Mechanical & Industrial Engineering

MS: 1

1 M Vo, Garret: MS, *Heys*

19: Microbiology

MS: 2

1 M Barnhart, Elliott: MS, *Fields*/*Cunningham*

1 F Moll, Karen: MS, *Peyton*

PhD: 17

5 M Barnhart, Elliott: PhD, *Fields/Cunningham*
Krantz, Gregory: PhD, *Fields*
Loudermilk, Derrick: PhD, *Fields*
Serrano Figueroa, Luis: PhD, *Richards*
Severson, Grant: PhD, *James*

12 F Beck, Ashley: PhD, *Stein*
Behnke, Sabrina: PhD, *Camper*
Bell, Tisza: PhD, *Peyton*
Brileya, Kristen: PhD, *Fields*
Camilleri, Laura: PhD, *Fields*
De León, Kara: PhD, *Fields*
Eggers, Margaret: PhD, *Camper*
Encarnacion, Gem: PhD, *Camper*
Franco, Lauren: PhD, *Fields*
Plaggemeyer, Sara: PhD, *Camper*
VanKempen-Fryling, Rachel: PhD, *Camper*
Zelaya, Anna: PhD, *Camper*

TOTALS

Total Grads: 46

Total MS:	6 M / 5 F
Total PhD:	16 M / 19 F
Total Male:	22
Total Female:	24

EDUCATION:

Graduating with advanced degrees: June 2011–May 2012

Sabrina Behnke, PhD, Microbiology, June 2011
Disinfection susceptibilities of detached biofilm clusters compared to planktonic cells and biofilms in single species and dual species

Everett Eustance, MS, Chemical and Biological Engineering, July 2011
Nitrogen removal from wastewater: Improving growth on ammonium

Elliott Barnhart, MS, Microbiology, August 2011
Analysis of methane producing communities within underground coal beds

Gem Encarnacion, PhD, Microbiology, February 2012
Microbial ecology of nitrifying simulated premises plumbing

Garret Vo, MS, Mechanical Engineering, April 2012
Comparison of continuous and discontinuous Galerkin finite element methods for parabolic partial differential equations with implicit time stepping

EDUCATION:
2012 MSU Student Research Celebration: CBE Participants

MSU's undergraduate and graduate students shared their research at the annual Student Research Celebration in April. Among the 250 students presenting their research were numerous students presenting results of their biofilm research connected with the Center for Biofilm Engineering. To read the abstracts, go to MSU's Research Celebration page, http://www.montana.edu/usp/pages/conference.html

Topical Sessions

Poster viewing

Sarah Johnson, Civil Engineering
"Soil redox potential in constructed wetlands for wastewater treatment"
Faculty mentor: **Otto Stein**, Civil Engineering

Dayla Morris, Chemical and Biological Engineering
"Optimization and kinetics of ureolysis by *Sporosarcina pasteurii*"
Faculty mentor: **Robin Gerlach**, Chemical and Biological Engineering

Presentation

Amber Schmit, Chemical and Biological Engineering
"Microbial isolates from Antarctica"
Faculty mentor: **Christine Foreman**, Land Resources and Environmental Sciences

Morning Poster Presentations

Erin Smith: Chemistry & Biochemistry
"Alginate epimerization by AlgG"
Faculty mentor: **Michael Franklin**, Center for Biofilm Engineering

Melis Penic: Chemical & Biological Engineering
"Visualization and characterization of the *Pseudomonas aeruginosa* biofilm matrix with fluorescent staining"
Faculty mentor: **Michael Franklin**, Center for Biofilm Engineering

Matthew Sherick: Chemical & Biological Engineering
"Analysis of homogeneous and inhomogeneous gelation of alginate derived from *Pseudomonas aeruginosa*"
Faculty mentors: **Joseph Seymour**, **Jennifer Brown**, Chemical & Biological Engineering; **Sarah Codd**, Mechanical & Industrial Engineering

Jean-Paul Toussaint: Chemical & Biological Engineering
"Metabolic analysis of lipid accumulation in a microalga"
Faculty and staff mentors: **Ross Carlson**, Chemical & Biological Engineering; **Florence Mus**, Center for Biofilm Engineering

Hannah Newhouse: Chemical & Biological Engineering
"Optimization of lipid accumulation in green algae using a photobioreactor and connections between algal DNA"
Faculty mentor: **Brent Peyton**, Chemical & Biological Engineering

Bridget Bergin: Mechanical & Industrial Engineering
"NMR technologies for monitoring biological and geochemical processes in the subsurface"
Faculty mentor: **Sarah Codd**, Mechanical & Industrial Engineering

Blaine Fritz: Cell Biology & Neuroscience
"Evaluation of 3M Petrifilm™ as an equivalent alternative to drop-plating on agar plates in a biofilm system"
Faculty mentor: **Darla Goeres**, Center for Biofilm Engineering

Alissa Bleem: Chemical & Biological Engineering
"The design and characterization of artificial biofilms: Microbial catalyst platforms based on photo-autotrophic syntrophy"
Faculty and student mentors: **Ross Carlson** and **Hans Bernstein**, Chemical & Biological Engineering

Amanda Durch: Chemical & Biological Engineering
"Three-species chronic wound model: Targeting specific species with antibiotics"
Faculty mentor: **Garth James**, Center for Biofilm Engineering

Joshua Stringam: Chemical & Biological Engineering
"Continued development of an injection strategy for homogenous calcium carbonate distribution by *Sporosarcina pasteurii*"
Faculty and staff mentors: **Robin Gerlach**, **Ellen Lauchnor**, **Adrienne Phillips**, Center for Biofilm Engineering, Environmental Engineering

Katherine Warthen: Chemical & Biological Engineering
"The effectiveness of various herbal kidney medications"
Faculty and staff mentors: **Ellen Lauchnor**, **Robin Gerlach**, Center for Biofilm Engineering

Afternoon Poster Presentations
Thomas Bogen: Land Resources & Environmental Sciences
"Towards standardized methods for the analysis of algal lipids: Total lipid content"
Faculty mentor: **Rich Macur**, Center for Biofilm Engineering

Gregory Krantz: Molecular Biosciences
"Field scanning electron microscopy and growth modeling of a *Desulfovibrio alaskansis* G20 biofilm"
Faculty mentor: **Matthew Fields**, Center for Biofilm Engineering

Maxwell Moran: Land Resources & Environmental Sciences
"Biofuel production using an acidophilic fungus"
Faculty and staff mentors: **Rich Macur**, Center for Biofilm Engineering; Mark Kozubal, Land Resources & Environmental Sciences

Adam Rothman: Chemical & Biological Engineering
"Modeling kinetics of ureolytic bacteria in flow systems"
Faculty and student mentors: **James Connolly**, **Robin Gerlach**, Center for Biofilm Engineering

Anna Zelaya: Microbiology
"Microbial community analyses between groundwater and sediments injected with nitrate for biostimulation of chromium reduction at the Hanford Site"
Faculty mentor: **Matthew Fields**, Molecular Biosciences

EDUCATION AWARDS AND NEWS:
2011–2012 Student Awards

MSU graduate awarded prestigious Gates Cambridge fellowship

Hilary Fabich, a December 2011 MSU graduate in chemical engineering, was recently awarded a Gates Cambridge fellowship. Funded by the Bill and Melinda Gates Foundation, the University of Cambridge awards this fellowship to outstanding applicants outside the United Kingdom to pursue a post graduate degree in any subject at the University of Cambridge in Cambridge, England. The program is comparable in prestige to Oxford University's Rhodes Scholars program. Hilary is the first Montana recipient of this fellowship. She will pursue her PhD in chemical engineering at Cambridge University next fall 2012.

As a CBE undergraduate student, Hilary spent summer 2011 in the Research Experiences for Undergraduates (REU) program in the lab of Dave Weitz, professor, physics, Harvard University. Hilary's project applied techniques using confocal microscopy, optical tweezers, and traction force microscopy to study the effects of vimentin intermediate filament on the structure and material properties of cells. Research on vimentin is relevant in the medical field. A mutation in the filament is known to cause dominant cataracts and is present in several muscle diseases. Understanding the role of intercellular vimentin is useful in better understanding these conditions. At the conclusion of the program, Hilary presented her work to the Weitz lab group at Harvard and returned to MSU where she graduated in December 2011.

2012 Betty Coffey Graduate Engineering Award

CBE PhD candidate, **Natasha Mallette**, chemical and biological engineering, was recently honored with the 2012 Betty Coffey Graduate Engineering Award. The award was created to honor the memory of Betty Coffey, an outstanding teacher, pioneering professor, and the first woman to achieve tenure in the College of Engineering at Montana State University. The selection committee commended Natasha on her exemplary academic achievement and service to the community. Through leadership and dedication, Natasha demonstrates a meaningful contribution to the diversity of the college of engineering and the advancement of the engineering profession.

Under the direction of CBE associated faculty **Brent Peyton**, chemical and biological engineering, Natasha is studying *Ascocoryne sarcoides*, which produces volatile hydrocarbons like those found in liquid petroleum fuel on a relatively carbon neutral substrate, cellulose. Natasha's research focuses on characterizing the volatiles produced and finding efficient processes for producing fuel compounds from *A. sarcoides*. Given the environmental impact of petroleum, if researchers are able to develop an alternative liquid fuel source, it would reduce carbon emission and eventually the US' dependence on foreign oil.

2012 W.G. Characklis Outstanding Student Award

The CBE selected two students to receive the 2012 W.G. Characklis Outstanding Student Award: **Gem Encarnacion** and **Rob Gardner.**

Gem Encarnacion, PhD candidate, microbiology, was awarded in recognition of her dedication in pursuit of her goals to improve education and research in the field of water quality in the Philippines, her commitment to interdisciplinary teamwork, and service to the CBE in laboratory leadership, student mentoring, and assistance at CBE seminars and conferences.

Rob Gardner, PhD candidate, chemical and biological engineering, was awarded in recognition of his dedicated leadership in interdisciplinary teamwork, his persistence and success in research—including publications and patent submission on biodiesel production—and service to the CBE through industrial interactions, student mentoring, and assistance at CBE conferences.

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

Inaugural CBE Student Citizen Award

Reed Taffs, PhD student, chemical and biological engineering, received the inaugural CBE Student Citizen Award in July. The award is presented in honor of John Neuman, the CBE's Technical Operations Manager from 1994–2008, and recognizes a student who exhibits exceptional responsibility and good citizenship in his or her work at the CBE. This year's recipient, Reed Taffs, was nominated by numerous CBE faculty, staff, and students for demonstrating genuine concern for laboratory safety, attentiveness to the needs of co-workers, willingness to help, and his inspiring work ethic.

CBE PhD student studies coal bed methane production to help hometown economy

MSU News Web Feature, November 1, 2011

Talk to the people of Broadus, and you'll hear lots of fond stories about **Elliott Barnhart**, the native son who played football for Montana State University from 2004 to 2007. Talk to Barnhart, and you'll hear plenty of affection for his home town.

It's no surprise then that Barnhart says he hopes his research as an MSU graduate student will benefit Broadus and the rest of southeast Montana. Barnhart is studying the microorganisms that produce coal bed methane, hoping that his findings will help stabilize the area's economy.

"I have always been looking to work on a project that deals with my home town. It's a great place to grow up," Barnhart said.

Barnhart grew up on a ranch about 10 miles from Broadus, the son of two teachers and brother to two sisters. Living about 80 miles from Miles City, Belle Fourche, S.D. and Gillette, Wyo., he was a stellar student and athlete who played football and whatever sport was in season at Powder River County District High School. He belonged to 4-H. For a time, he was the youngest member of the Broadus pingpong club, joining grown-ups at the tables in the Pastime Theatre.

Barnhart graduated with 27 classmates in 2004, then headed to MSU where he was recruited to play football. Part of the last team to play on grass (He still remembers being a muddy mess after a Bobcat-Grizzly game), he was team captain in 2007 and Offensive Player of the Year in 2006. Among his many honors are ESPN Academic All-American, Montana Athletes in Service, the MSU Award of Excellence and the Torlief Aasheim Community Involvement award.

"When Elliott played for MSU, he was not just the son of Jesse and Connie Barnhart. He was a native son of the Broadus area, and we all claimed him. He's really an incredible person besides being an outstanding athlete and scholar," said Laura Lee Ullrich, board member for the Broadus Chamber of Chamber of Commerce and owner of the Copper Moon where Barnhart still stops for ice cream.

Doug Wilbert, owner of Seabeck Pizza and Subs, said, "Even if he wasn't outstanding at sports, he would still be outstanding in his treatment of other people. Everybody likes him."

Wilbert and his employees, in fact, made a pizza before every MSU home game and sent it to Barnhart for luck. Enough people drive the 310 miles between Broadus and Bozeman that he had no shortage of couriers, Wilbert said.

At the same time as he played football, Barnhart conducted research and published his results. He - like Abbey Potterf of Helena whom he married this summer - was a Montana INBRE scholar. He started studying the production of coal bed methane as an undergraduate student, continued as a master's degree student and now studies it as a doctoral student in microbiology at MSU's Center for Biofilm Engineering.

He wants to know how the microorganisms that live in coal bed seams work together to produce methane, Barnhart said. If he can figure that out, he figures industry should be able to produce more methane and create more jobs.

"The Powder River Basin in southeastern Montana and northeast Wyoming is the largest source of coal mined in the United States, but most of the coal contained in the basin is buried too deeply to be economically accessible. These remote coal beds are dynamic zones where biogeochemical processes work to sustain life," Barnhart wrote in his master's degree thesis.

"Previous work has shown that a direct by-product of these life processes is biogenic methane, the principal component of natural gas that can be used as an energy source for electricity generation, heat and transportation fuel," he continued.

The only known organisms on the planet that are able to produce methane are microorganisms called methanogens classified as *Archaea*, Barnhart said. However, little is known about the microorganisms responsible for producing methane, coal bed conditions that contribute to methane production and the way microbial communities interact to produce methane. Research so far suggests that microbes called *Clostridia* are involved with the breakdown of coal, and that *Acetobacterium* use those by-products to produce metabolites that cross-feed the methane-producing *Archaea*. Coal and yeast extract each seem to contribute important nutrients in methane-yielding laboratory experiments. More research needs to be done, however.

Ullrich said Broadus is sitting on the cusp of three projects that relate to the development of natural resources, and one involves coal bed methane.

"We all hope some of that will go," Ullrich said.

Doing his part to make it happen, Barnhart designed a sampling tool in collaboration with senior research hydrogeologist John Wheaton and other experts at the Montana Bureau of Mines and Geology. Barnhart's uncle - Donald LaPlant of Bozeman - helped build it. His MSU mentors include microbiologist Matthew Fields, civil engineer Al Cunningham and chemical engineer Robin Gerlach, all in the Center for Biofilm Engineering.

Barnhart planned this fall to lower the sampling tool into the coal beds of the Tongue River area of northern Wyoming, about 1 ½ hours from Broadus. While the microbes eat coal and produce methane, they'll migrate into his sampler. After about three months, Barnhart will close the sampler and pull it up to the surface. Then he'll carry it and the microorganisms it contains to the Center for Biofilm Engineering for analysis.

"It's kind of like fishing for microbes," Barnhart commented.

Designing and using the sampler are both challenging, however. Wheaton said the wells that penetrate the coal beds are often hundreds of feet deep and filled with water that ranges from 50 feet to hundreds of feet deep. To lower his sampler down to the coal, Barnhart has to manipulate a single wire without tangling it. He also has to keep the sampler closed until it reaches its destination so it only collects methane-producing microbes and not microorganisms that live in the water.

Wheaton is confident of Barnhart's abilities, though. He described Barnhart as a highly creative researcher, persistent and a typical southeast Montanan who gets things done.

"He just has that, 'Let's go at it' kind of attitude," Wheaton said. "'Let's figure out how to make more gas down there in an environmentally friendly way.'"

Conducting research takes up much of Barnhart's time nowadays, but he said football is still part of his life. He watches Bobcat football games from a seat in the new end zone. On Saturday mornings and throughout the week, he helps coach the Packers - a team of Bozeman fifth and sixth graders who play Midget football.

And visiting his family and friends is important to him, too.

"Eastern Montana, small towns, are hard to beat," Barnhart said.

MSU receives national award recognizing student efforts to bring clean water to Kenya

November 14, 2011 -- Anne Cantrell, MSU News Service

[ed. Note: several CBE undergraduate students—including Kiera McNelis, Bryan Vadheim, Hilary Fabich, and Joseph Theil—and faculty adviser Otto Stein are among the MSU people who have taken an active role in the Montana chapter of Engineers Without Borders organization]

Montana State University has been named the winner of the prestigious C. Peter Magrath University Community Engagement Award, which recognizes a public university for its outreach and community engagement efforts. MSU was recognized for the contributions its students have made in bringing clean water to a region in Kenya.

The Magrath award was presented at the APLU's annual meeting in San Francisco. Given just once a year, the award recognizes a four-year public university that embraces outreach and community engagement and comes with a $20,000 prize.

"It's a tremendous honor to be recognized by your peers as having an outstanding engagement program," said Paul F. Hassen, vice president of public affairs at the APLU. "This is a unique award and the only one presented at our annual meeting."

MSU competed for the award against three other finalists: Michigan State's 10-year effort to help epilepsy patients in Zambia; the redevelopment projects of Penn State architecture students in Pittsburgh and the efforts of faculty and students at the University of Tennessee to help a Burundian immigrant community adapt to Knoxville. The three finalist schools have significantly larger enrollments than MSU: Michigan State enrolls nearly 48,000 students; Penn State has more than 45,000 on its flagship campus and more than 95,000 system-wide; and the University of Tennessee enrolls approximately 27,500 students. MSU's fall enrollment is 14,153.

The award is both meaningful and significant, said MSU President Waded Cruzado.

"I am extremely proud of our students, who have shown tremendous dedication to their work in Kenya," Cruzado said. "Their efforts are an inspiring example of how outreach and service can impact the lives of others in a truly meaningful way.

"Receiving the Magrath award indicates that Montana State University is fulfilling its land-grant mission," Cruzado continued. "It is a great privilege and responsibility to serve as Montana's original land-grant university, and we will continue to work hard to honor this tradition."

MSU plans to use the $20,000 that comes with the award to pilot new programs. Those programs will enable faculty teams from many different disciplines to develop outreach-focused coursework and mentor students, according to the award application.

"EWB's (Engineers Without Borders') primary mission necessitates a long-term commitment and cultural exchange between MSU students and the Khwisero region in Kenya," said Doug Steele, MSU vice president for external affairs and director of Extension. EWB's work differs significantly from many development projects in that it is committed to working with a region in Africa for what could be decades.

MSU students and EWB members Katie Ritter and **Kiera McNelis** traveled to San Francisco to attend the awards ceremony. They said the award is a great vote of confidence and the accompanying funds will help further EWB's work.

"The students in our group have such a passion for development work and for helping people," Ritter said. "To be nationally recognized for what we do is amazing."

McNelis explained that the $20,000 prize that will go to MSU may be used for a wider range of purposes than money EWB raises through fundraisers. Those funds are limited due to tax restrictions and other considerations.

"We view this as a really big step for our organization," McNelis said. "The funds will allow us to develop new courses and expand opportunities here at MSU, which will further our work in Kenya. It will also provide a platform for more professors to get involved."

EWB is recognized as being one of the most ambitious and most successful student-led organizations in the university's history, with more than 60 active students representing every college within the university. To date, the group has raised nearly $500,000 to further its efforts -- including more than $200,000 in grants, awards or donations this year alone.

EWB at MSU is committed to bringing clean drinking water to 61 schools in Khwisero, Kenya, a project that could take decades. Since 2004, more than 80 MSU students from many disciplines and majors have traveled to the region in western Kenya, where they have built seven deep-water wells and 10 composting latrines in an effort to decrease the rate of waterborne illnesses. The students have designed a distribution pipeline to link one of the wells to additional schools, a health clinic and a market, and they have surveyed thousands of individuals and families about their water habits and needs. EWB at MSU estimates that more than 3,500 students and teachers in Kenya have been impacted by the efforts.

The group's work helps empower young students, especially girls, who are forced to spend hours each day collecting water for their families. As a result of the new wells, students spend less time walking to get water and more time in the classroom.

In addition, EWB at MSU has developed peripheral projects benefiting various communities in Montana, including Native American tribes.

"The work these students do is humbling," said **Otto Stein**, one of EWB at MSU's faculty advisers. "They are dedicated and hard working -- literally devoting thousands of volunteer hours to improving the lives of people in Kenya. I am continually amazed and impressed by their efforts."

Among several letters of support that accompanied the group's award application was one from Ronald Omyonga, an architect from Nairobi, Kenya, who wrote an initial proposal to the national Engineers Without Borders organization in 2003 and visited MSU in 2009. Omyonga wrote that he has been impressed by the dedication and hard work of MSU students and faculty.

"To say the least, I was amazed at just how much work the students and faculty put in every week to ensure that the life-changing work in Khwisero continues," Omyonga wrote. "I felt very challenged that such young people and busy people...could dedicate so much time.... I felt challenged to encourage my community and myself to do more to assist these dedicated people who have come to our aid. And most importantly, to do some more for ourselves."

EWB at MSU has received numerous recognitions for its efforts, including the EWB-USA Premiere Chapter Award and the Community Mediation Peacekeeper Award. Earlier this fall, EWB at MSU also was selected as one of four regional winners of the 2011 Outreach Scholarship/W.K. Kellogg Foundation Engagement Award. The award was given by the APLU at the 12th Annual National Outreach Scholarship Conference in East Lansing, Mich., and was accompanied by a $5,000 prize.

EWB at MSU was one of 15 MSU projects that helped the university earn the Carnegie Foundation's community engagement classification in January. The classification brings national recognition to MSU's commitment to teaching that encourages volunteer service in communities and the spreading of knowledge that benefits the public.

MSU currently enjoys two Carnegie classifications. It is one of only 311 universities with the community engagement classification and is one of only 108 universities with a "very high level of research activity" out of roughly 4,400 colleges and universities nationally.

Established in 2006, the Outreach Scholarship and Magrath University Community Engagement Awards recognize four-year public universities that have redesigned their learning, discovery and engagement functions to become more closely and productively involved with their communities. The Magrath Award is made possible by a grant from the W.K. Kellogg Foundation and is named for C. Peter Magrath, APLU president from 1992-2005 and a leading advocate for public universities embracing the concept of outreach and community engagement.

APLU is the nation's oldest higher education association, dedicated to research and advocacy for public research universities, land-grant institutions, and state university systems. Member campuses enroll more than 3.6 million undergraduate and 1.1 million graduate students, employ more than 670,000 faculty and administrators, and conduct nearly two-thirds of all university-based research, totaling more than $34 billion annually. For more information, visit www.aplu.org.

EDUCATION:
CBE Seminar Series | Fall 2011

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

Date	Speaker	Affiliation	Topic
August 23	Dr. Raymond M. Hozalski	Professor, Director of Graduate Studies, Civil Engineering, University of Minnesota	Fate of petroleum hydrocarbons in bioretention cells: Are rain gardens the solution to storm water pollution?
September 1	No seminar: First week of classes		
September 8	Dr. Jonathan Hilme	Director, Mass Spectrometry Facility, Department of Chemistry and Biochemistry, MSU	MSU mass spectrometry and proteomics facility: An overview of available instrumentation and services
September 15	Dr. Christina Cheng	Associate Professor, Animal Biology, School of Integrative Biology, University of Illinois Urbana-Champaign	Freezing avoidance by means of cold adaptive physiological processes and their responsible protein molecules
September 22	Hans Bernstein	PhD candidate, Chemical & Biological Engineering, CBE, MSU	Forced to get along: Advantages of synthetic microbial consortia engineered for syntrophy
September 29	Dr. Mark LeChevallier	Director, Innovation & Environmental Stewardship, American Water Company	Susceptibility of distribution systems to contamination from negative pressure
October 6	Dr. Joshua Obar	Assistant Professor, Immunology and Infectious Diseases, MSU	Regulation of memory CD8 T-Cell differentiation and reactivation
October 13	No seminar		
October 20	Dr. James Wilking	Postdoctoral scientist, Dr. David A. Weitz Laboratory, Engineering and Applied Sciences-Physics, Harvard University	The mechanics of *Bacillus subtilis* biofilms
October 27	Dr. Garth James	Associate Research Professor, Chemical & Biological Engineering, CBE, MSU	The role of biofilms in delayed healing of chronic wounds
November 3	Dr. Yuri Gorby	Associate Professor, Marine Environmental Biology, University of Southern California	Bacterial nanowires and extracellular electron transfer in diverse microbial biofilm communities
November 10	No seminar: Veteran's Day		
November 17	Dr. Corby Anderson	Professor, Metallurgical and Materials Engineering, Colorado School of Mines	Biohydrometallurgical processing in the mining industry
November 24	No seminar: Thanksgiving Day		
December 1	Irina Khilyas	Visiting doctoral student, Kazan State University, Russia	TNT biotransformation by yeasts
December 8	No seminar: Finals week		

EDUCATION:
CBE Seminar Series: Spring 2012

Montana State University, Roberts Hall 210, 4:10pm

Date	Speaker	Affiliation	Topic
January 12	No seminar: First week of classes		
January 19	Sarah Vogt	PhD Candidate, Chemical & Biological Engineering, Montana State University	Observe the impact on transport of biofouling and biofilm induced precipitation in porous materials with MR
January 26	No seminar: Pre-Montana Biofilm Meeting (Wednesday, January 25th, 2012)		
February 2	Dr. Martin Teintze	Associate Professor, Chemistry & Biochemistry, Montana State University	Broad-spectrum antibacterial activity in novel Phenylguanide and Biguanide compounds
February 9	No seminar: Montana Biofilm Science & Technology Meeting		
February 16	Dr. John Dutcher	Professor, Department of Physics, University of Guelph; Canada Research Chair, Soft Matter Physics	Probing the mechanical properties of individual bacterial cells
February 23	Dr. Timothy Bigelow	Assistant Professor, Electrical and Computer Engineering, Iowa State University	Use of high-intensity focused-ultrasound to destroy bacterial biofilms
March 1	No seminar		
March 8	Dr. Masaki Uchida	Research Faculty, Chemistry & Biochemistry, Montana State University	Protein cage nanoparticles; Some recent examples of their biomedical applications
March 15	No seminar: Spring Break		
March 22	Betsey Pitts	Research Scientist and Microscope Facilities Manager, CBE, Montana State University	A new flow cell for time-lapse microscopy
March	Liz Sandvik	PhD Candidate, Chemical and Biological Engineering, Montana State University	Electric current and magnetic field effects in biofilms
April 5	No seminar: University Day, April 6		
April 12	Dr. Colleen Hansel	Associate Professor, Harvard University's Center for the Environment & Microbial Sciences Initiative	Homology in fungal and bacterial Mn(II) oxidation pathways: The role of reactive oxygen species
April 19	Dr. Nicholas J. Bouskill	Research Scientist, Earth Sciences Division, Lawrence Berkeley National Laboratory	Uncovering the mechanistic response of soil microbial communities to altered precipitation patterns
April 26	No seminar: Last week of classes		

TECHNOLOGY TRANSFER:
Industrial Associates, 2011–12

*New members in reporting period

3M
Agile Sciences
***Bard Access Systems**
BASF
Bausch & Lomb
Baxter Healthcare
***BCG Solutions**
***Bend Research**
BRIDGE Pre-clinical Testing
CareFusion *(formerly Cardinal Health)*
Church & Dwight Company
Colgate-Palmolive
Covidien
***Dow Corning Corporation**
Dow Microbial Control
Embro
ExxonMobil
ICU Medical
Johnson & Johnson
Kane Biotech
***KCI**
Kimberly-Clark
Masco Corporation
NASA
***NCH Corporation**
Novozymes A/S
Procter & Gamble
Reckitt Benckiser
***Sample6 Technologies**
Semprus BioSciences
STERIS
The Sherwin-Williams Company
Unilever
W.L. Gore & Associates
WuXi AppTec

TECHNOLOGY TRANSFER:
Montana Biofilm S&T Meeting
July 12–14, 2011

Monday, July 11

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

Tuesday, July 12

7:30–8:00 a.m.
Registration and continental breakfast
Larkspur Foyer, Hilton Garden Inn

8:00–8:15
Introductory remarks
Larkspur Ballroom
Paul Sturman, CBE Industrial Coordinator
Harsh Trivedi, IA Chair, Colgate-Palmolive
Phil Stewart, CBE Director

SESSION 1:
Biofilm Dispersion

8:15–9:00
Escape from the matrix!
Richard Losick, Professor, Biology, Harvard University

9:00–9:40
Marine alkaloid derivatives that inhibit and disperse bacterial biofilms
Christian Melander, Co-Founder & Chief Research Officer, Agile Science Associate Professor, Chemistry, North Carolina State University

9:40–10:10
Imaging biofilm dispersion…or not!
Betsey Pitts, Research Associate & Microscope Facilities Manager, CBE

10:10–10:40 Break

10:40–11:20
Dispersal of methicillin-resistant *Staphylococcus aureus* biofilms
Alex Horsill, Associate Professor, Microbiology, University of Iowa

11:20–11:50
Immersed boundary model of biofilm deformation and detachment in response to fluid flow
Jeff Heys, Assistant Professor, Chemical & Biological Engineering, MSU

11:50–1:00
Lunch catered at the Hilton Garden Inn

CBE Open House
CBE Laboratories, 3rd Floor EPS Building, MSU

1:50–3:30
Lab demonstrations

3:30–5:00
Poster session
*Detailed schedule provided at registration

Wednesday, July 13

7:30–8:00 a.m.
Registration and continental breakfast
Larkspur Foyer, Hilton Garden Inn

SESSION 2:
Metals, Microbes & Microbially Influenced Corrosion (MIC)

8:00–8:30
Methods for the study of extracellular electron transfer in electrode-associated biofilms using *Geobacter sulfurrenducens* as a model
Ashley Franks, Research Assistant Professor, University of Massachusetts Amherst; Senior Lecturer, La Trobe University, Australia

8:30–9:00
Chromium (VI) reduction by environmental microbes – Influence of common soil constituents and carbon sources on chromium (VI) reduction and toxicity
Robin Gerlach, Associate Professor, Chemical & Biological Engineering, CBE

9:00–9:30
In situ microbial reduction of selenium in backfilled phosphate mine overburden, S.E. Idaho
Lisa Kirk PhD, Land Resources & Environmental Science, CBE

9:30–10:00
Treatment of mine water using MBBR technology
Caroline Dale, Biological Principal Engineer, Veolia Water
Scott Benowitz, P.E., President, Water Engineering Technologies, Inc.

10:00–10:30 Break

10:30–11:00
Investigating biofilm-influenced corrosion using molecular tools
Iwona Beech, Professor, Botany & Microbiology, University of Oklahoma

11:00–11:30
Special Presentation:
Bacteria in the food industry—biofilm, survival, control
Trond Møretrø, PhD, Research Scientist, Nofima Food, Norway

11:30–12:00
State of the CBE address
Phil Stewart

12:00–1:00
Lunch catered at the Hilton Garden Inn

SESSION 3:
Systems Biology

1:00–1:30
Transcriptome analysis of biofilm physiology
Phil Stewart

1:30–2:00
Characterization of biofilm heterogeneity using transcriptome approaches
Michael Franklin, Associate Professor, Microbiology, CBE

2:00–2:30
Proteomic and physiological support for the stoichiogenomic analysis of metabolic networks under nutrient limitation
Reed Taffs, PhD Candidate, Chemical & Biological Engineering, CBE

2:30–3:15
Medical devices: The changing FDA landscaper
Craig Coombs, President, Coombs Medical Device Consulting

3:15–3:30 Break

3:30–4:30
CBE Industrial Associates Business Meeting

6:00–9:00
Banquet
Rockin TJ Ranch, Bozeman

Thursday, July 14

7:30–8:00 a.m.
Continental breakfast
Hilton Garden Inn reception area

SESSION 4:
Biofilm Methods

8:00–8:30
Standard biofilm methods: A roadmap to anti-biofilm claims for medical devices
Nick Allan, Contract Research Manager, Innovotech, Inc.

8:30–9:00
Using equivalence testing in microbiology
Al Parker, Statistician & Research Engineer, CBE

SESSION 5:
Medical Biofilms
9:00–9:30
Selective killing of biofilm pathogens
Peter Suci, Research Assistant Professor, Plant Sciences & Plant Pathology, CBE

9:30–10:00 Break

10:00–10:30
Biofilms, oxygen, and wound healing
Garth James, CBE Medical Projects Manager, Associate Research Professor, Chemical & Biological Engineering, MSU

10:30–11:00
Intracellular pathogens and host cytoskeletal structures
Kelly Kirker, Research Scientist, CBE

11:00–11:30
Electric current effects on biofilm
Liz Sandvik, PhD Candidate, Chemical & Biological Engineering, CBE

11:30-11:45
Meeting Wrap Up

WORKSHOP:
Standardized Biofilm Methods
July 11, 2011

9:00 – 9:15	**Welcome** – *Phil Stewart, CBE Director* Group introductions	EPS 323
9:15 – 9:30	**Introduction to Biofilms** – *Paul Sturman*	EPS 323
9:30 –10:00	**Experimental Design** – *Al Parker*	EPS 323
10:00 – 10:15	*Morning Refreshments*	EPS 323
10:15 – 11:45	**Biofilm Basics: Reactor theory & set-up** – *Diane Walker, Kelli Buckingham-Meyer, Lindsey Lorenz, SBML Interns*	EPS 301
11:45 - 1:00	LUNCH – MSU Strand Union Building	SUB 233
1:00 - 2:30	**Hands-on Biofilms!** – *Diane Walker, Kelli Buckingham-Meyer, Lindsey Lorenz, SBML Interns*	EPS 337
2:30 - 2:45	*Afternoon Refreshments*	EPS 323
	***Laboratory Rotations**:*	
	Group 1 / *Group 2*	
2:45 – 3:15	A / B	
3:15 – 3:45	B / A	
	A. **Scanning Electron Microscopy** – *Laura Bickle*	ICAL EPS 339
	B. **Data Analysis** – *Al Parker*	EPS 333
3:45 – 4:00	**Wrap-Up/Discussion**	EPS 323

TECHNOLOGY TRANSFER:
Montana Biofilm S&T Meeting
February 7–8, 2012

Monday, February 6

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

Tuesday, February 7

7:30–8:00 a.m.
Registration and continental breakfast
Hilton Garden Inn—Larkspur Foyer

8:00–8:10
Introductory remarks
Larkspur Ballroom
Tom McCoy, Vice President, Research, Creativity, & Technology Transfer, MSU
Paul Sturman, CBE Industrial Coordinator
Harsh Trivedi, IA Chair, Colgate-Palmolive
Phil Stewart, CBE Director

SESSION 1:
Oral Biofilms

8:10–8:20
Session introduction
Garth James, CBE Medical Projects Manager; Associate Research Professor, Chemical & Biological Engineering, MSU

8:20–8:50
Antimicrobial penetration and efficacy in an in vitro oral biofilm model
Phil Stewart

8:50–9:20
Photodynamic therapy for dental biofilms
Alessandra Agostinho, CBE Research Scientist

9:20–9:50
The drip-flow reactor as a test system for oral care products
Garth James

9:50–10:20 Break

10:20–10:50
Investigations into mobile genetic elements and horizontal gene transfer within oral biofilms
Adam Roberts, Lecturer, Microbial Diseases, UCL Eastman Dental Institute, London

SESSION 2:
Thermal Biofilms

10:50–11:00
Session introduction
Brent Peyton, Professor, Chemical and Biological Engineering; Associate Director, Thermal Biology Institute, MSU

11:00–11:30
Transport & microbial consumption of oxygen in acidic geothermal iron-oxide mats
Hans Bernstein, PhD student, Chemical & Biological Engineering, CBE

11:30–12:00
Extremophilic fungi for sustainable energy
Rich Macur, Research Assistant Professor, Department of Chemical and Biological Engineering, MSU

12:00–1:00
Lunch catered at the Hilton Garden Inn

SESSION 3:
Industrial Biofilms

1:00–1:10
Session introduction
Paul Sturman

1:10–1:45
Innovative use of biofilms in industrial water and wastewater treatment
Zbigniew Lewandowski, Professor, Civil Engineering, CBE

1:45–2:15
Metabolic cooperation in methanogenic biofilms: Cellular biomass or cellular energy
Kristen Brileya, PhD student, Microbiology, CBE

2:15–2:40
Special Presentation
Highlights from recent European biofilm meetings
Phil Stewart

Poster Session, laboratory open house, and live video presentation
3:20–5:20
CBE Laboratories, 3rd Floor EPS Building, MSU

3:30-4:00
Live video presentation: Analytical challenges of microbial biofilms on medical devices (Location: 1st Floor EPS 126 & 127)
K. Scott Phillips, Regulatory Research Scientist, US FDA

Wednesday, February 8

7:30–8:00 a.m.
Registration and continental breakfast
Hilton Garden Inn—Larkspur Foyer

SESSION 4:
Green Biofilm Control Strategies

8:00–8:05
Session introduction
Phil Stewart

8:05–8:50
Biofilm shielding: the role of quorum sensing, rhamnolipids and eDNA
Mike Givskov, Professor of International Health, Immunology and Microbiology, University of Copenhagen; Singapore Centre on Environmental Life Sciences Engineering

8:50–9:20
Bioinspired topographies for bacterial inhibition strategy
Rhea May, Microbial Research Associate, Sharklet Technologies

9:20–9:50
Microbe-microbe interactions and application to MBR flux enhancement
Jonathan Leder, Technical Director, Novozymes, Biologicals, Inc.

SESSION 5:
Biofilms and Host Response

10:20–10:30
Session introduction
Garth James

10:30–11:00
Considering the host immune response for vaccine development against *Staphylococcus aureus* biofilms
Mark Shirtliff, Assistant Professor, Dental Surgery, University of Maryland, Baltimore

11:00–11:30
Application of the Nematode *Caenhorabditis elegans* as a model for multi-kingdom interactions of *Staphylococcus/Candida Biofilms*
Birthe Kjellerup, Assistant Professor Microbiology, Goucher College

11:30–12:00
Animal models useful for efficacy screening of antimicrobial and anti-biofilm drugs and coatings
Paul Attar, President, Bridge Preclinical Testing Services

WORKSHOP:
Basic Biofilm Methods
February 6, 2012

9:00 – 9:15	Welcome – Phil Stewart, CBE Director *Group introductions*	EPS 323
9:15 – 9:30	An Introduction to Biofilms – Paul Sturman	EPS 323
9:30 –10:00	Standardized Biofilm Methods – Darla Goeres	EPS 323
10:00 – 10:15	Morning Refreshments	EPS 323
10:15 – 10:45	Experimental Design – Al Parker	EPS 323
10:45 – 11:45	Biofilm Basics & Hands-on Biofilms! *Diane Walker, Kelli Buckingham-Meyer, Lindsey Lorenz, SBML Interns*	EPS 301
11:45 - 1:00	LUNCH – MSU Strand Union Building	SUB 235

Laboratory Rotations:

	Group 1	Group 2	Group 3
1:00 – 1:30	A	B	C
1:35 – 2:05	B	C	A
2:10 – 2:40	C	A	B

A.	Scanning Electron Microscopy – Laura Bickle	EPS 339
B.	Microscopy – James Connelly, Liz Sandvik	EPS 326/327
C.	Data Analysis – Al Parker	EPS 333

2:40 - 3:00	Afternoon Refreshments	EPS 323
3:00 - 3:15	Reactor systems for biofilm studies in porous media *Adie Phillips, Ellen Lauchnor*	EPS 302
3:20 - 3:35	Algal biofuels–Karen Moll, Rob Gardner, Lisa Weeks	EPS 115
3:40 – 4:00	Wrap-Up/Discussion	EPS 323

TECHNOLOGY TRANSFER:
NEWS

Knowledge Sharing Articles on Standardized Methods

Since May 2010, the Center for Biofilm Engineering has been publishing a series of articles written by Professor Marty Hamilton, professor emeritus of statistics, and Al Parker, CBE research engineer and biostatistician. This series of Knowledge Sharing Articles is being written with the purpose of disseminating information that is the topic of presentations, posters, workshops or discussions that occur at the CBE. Each Knowledge Sharing Article is a concise discussion on a specific topic. The information is not peer reviewed, in the traditional sense, but these concepts have been debated, tested, refined and used at the CBE. Within one series, the terms and concepts will build on each other, similar to the way concepts are presented in a college course, implying that it is best to read the articles sequentially. These articles will be a part of the CBE newsletter and archived on the CBE web site.

The first series is titled **Testing Surface Disinfectants**. The articles are listed below, in their logical order.

1. An introduction
2. Quantitative, semi-quantitative, qualitative, and alternative methods
   KSA-SM-02_rev102511.pdf (229.75 kB)
3. Desirable attributes of a standardized method
   KSA-SM-03.pdf (114.69 kB)
4. Method development phases
   KSA-SM-04.pdf (51.71 kB)
5. How the differences between disinfectant tests and chemical assays affect method evaluation criteria
   KSA-SM-05.pdf (71.33 kB)
6. Enumerating viable cells by pooling counts for several dilutions
   KSA-SM-06.pdf (194.16 kB)
7. The log reduction (LR) measure of disinfectant efficacy
   KSA-SM-07.pdf (64.24 kB)
8. The P/N formula for the log reduction when using a semi-quantitative disinfectant test of type SQ1
   KSA-SM-08.pdf (85.29 kB)
9. Importance of checking whether the harvesting and disaggregating steps bias the results of a surface disinfectant test
   KSA-SM-09.pdf (83.08 kB)
10. Assessing resemblance, repeatability, and reproducibility for quantitative methods
    KSA-SM-10_rev012312.pdf (322.68 kB)
11. How to decide whether the reproducibility standard deviation is small enough
    KSA-SM-11_rev_103011.pdf (876.77kB)
12. The importance of concurrent control carriers in laboratory tests of surface disinfectants
    KSA-SM-12.pdf (274.17kB)

ASTM Committee approves fifth biofilm method

Method E2871-12, titled "Standard Test Method for Evaluating Disinfectant Efficacy against *Pseudomonas aeruginosa* Biofilm Grown in the CDC Biofilm Reactor using the Single Tube Method," was approved by ASTM Committee E35 during the April 2012 committee meeting in Phoenix, Arizona. This method was originally developed in the US EPA's Office of Pesticide Programs (OPP) Microbiology Laboratory Branch. The method uses *Pseudomonas aeruginosa* ATCC 15442 biofilm grown on borosilicate glass coupons in the CDC Biofilm Reactor. The ASTM method was a collaboration between the EPA and the Standardized Biofilm Methods Laboratory. The method's performance was first tested in a pilot study conducted at the EPA and CBE. Although the initial study provided useful and promising results, further analysis through an interlaboratory study (IS) is necessary to determine the method's performance when conducted in more than two laboratories using different classes of disinfectants. The precision of Method E2871-12 will be evaluated following ASTM guidelines.

This is the 5th method approved by ASTM that the Center for Biofilm Engineering has helped develop since 2002. The previous four methods include:

E2799 MBEC^{TM} Assay Method, approved in 2011
E2647 Drip Flow Reactor Method, approved in 2008
E2562 CDC Biofilm Reactor Method, approved in 2007
E2196 Rotating Disk Reactor Method, approved in 2002

OUTREACH:
Visitors

Visiting Student Researchers

The MSU Algal Biofuels Group worked with five Native American students and staff from Little Bighorn College (LBHC) during a ten-week summer project titled "Cultivation and Characterization of Oil Producing Algae." The project was funded by a collaboration of commercial, state, federal, and tribal entities focusing on the development of "Green Coal to Transportation Fuel Technology." The project with LBHC involved training students in the use of algae as a means to capture carbon dioxide and produce biofuels. The specific objectives included collection of algae from natural field sites, isolation of pure cultures, building photo-bioreactor systems, characterizing algal growth in these systems, and measuring oil productivity. The participants from LBHC, located in Crow Agency, Montana, were: **Jonah Morsette**, staff member, and undergraduates: **Zachary Cummins**, **Elaine Stone**, **Miranda Rowland**, and **Amanda Not Afraid**. CBE mentors on the project were **Brent Peyton**, professor, and **Rich Macur**, research assistant professor, both of MSU's Department of Chemical and Biological Engineering.

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Three undergraduate students worked at the CBE in the summer of 2011 as part of the American Indian Research Opportunities (AIRO) BRIDGES program. The program's objective is to build a seamless educational experience between reservation-based colleges and Montana State University and, in the process, to increase the number of underrepresented Native American students successfully transferring from the two-year tribal colleges to MSU and pursuing academic studies in the biomedical and other health-related sciences. The students worked at the CBE for eight weeks and then traveled to Old Greenwich, Connecticut, to present posters of their work at the Leadership Alliance National Symposium.

Adrianna Collazo Ortiz, undergraduate, University of Puerto Rico San Juan, studied pathogens and constructed wetlands with CBE faculty **Mark Burr**, Research Assistant Professor, Land Resources and Environmental Sciences.

Jeremy Richey participated in a dentistry project titled "Testing of denture base materials Incorporated with silver nanoparticles to prevent *Candida* colonization" under the supervision of CBE Research Scientist **Alessandra Agostinho.** Jeremy is an undergraduate student from Fort Belknap College in Harlem, Montana.

Kendra Teague worked with **Heidi Smith**, CBE PhD candidate, Land Resources and Environmental Sciences, on a project that characterizes Antarctic isolates based on different carbon source utilization. Kendra is an undergraduate student from Fort Peck Community College in Wolf Point, Montana.

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Irina Khilyas, PhD student in microbiology at Kaszan State University in Russia visited the CBE from December 2010–December 2011. Irina was working with Ayrat Ziganshin on research investigating the transformation of TNT by yeasts. Ayrat was a visiting Fulbright Scholar at the CBE from 2004–2005; Irina is continuing and expanding some of Ayrat's work. Irina worked as a member of Robin Gerlach's research group in chemical and biological engineering.

Dayle "Candy" Felicia, undergraduate in health and human development from Little Big Horn College, Crow Agency, Montana, worked in Anne Camper's lab from May 2011–August 2011. Candy assisted with research on surface and groundwater contamination on the Crow Reservation in the southeast Montana.

Carole Nagant, a doctoral student from the Université Libre de Bruxelles in Belgium, arrived at the CBE September 1, 2011. She worked with Phil Stewart and Mike Franklin in the Control/Genetics lab for three months. Carole's work focused on the action of antimicrobial peptides against *Pseudomonas aeruginosa*.

2011-2012 Visiting Researchers

Mijeong Jang, a postdoctoral research scientist from Seoul, Korea worked in Anne Camper's Lab from January 2010–July 2011. Dr. Jang's research focus was on the effects of humics on biofilms in drinking water distributions systems.

Trond Møretrø, research scientist on sabbatical leave from Nofima Food (formerly the Norwegian Food Research Institute), worked in the CBE's Biofilm Control and Antimicrobials lab September 2010–July 2011. Trond is a food microbiologist and was interested in expanding his capabilities in working with biofilms.

Lucy Qi, attending medical doctor at the Chongqing Medical University and Children's Hospital in Chongqing, China is working with Phil Stewart and Mike Franklin on the role of protein repair mechanisms in maintaining bacteria dormancy in biofilms. Dr. Qi works with newborns in the neonatal unit at the Children's Hospital. She arrived at the CBE on October 25, 2011 and will stay for one year.

Shoji Takenaka arrived at the CBE in March 2012 for a three month stay as a visiting scientist. Dr. Takenaka is a dentist and faculty member in the division of cariology at Niigata University in Japan. He is working with Phil Stewart and Mike Franklin to learn micro dissection and polymerase chain reaction (PCR) techniques as well as making good use of the Center's microscopy facility. Dr. Takenaka spent one year at the CBE (2005-2006) with his research during that stay resulting in two journal publications.

Dr. Vincent Wang, MD, on sabbatical from Mackay Memorial Hospital in Taipei, Taiwan, arrived at the CBE June 20, 2011. He is the senior attending physician in the Division of Infectious Disease at Mackay Memorial and will be working at the CBE for one year. Dr. Wang is learning more about biofilms and collaborating on several papers. He is working in the Biofilm Control Lab as well as the Medical Biofilm Lab.

Lucy Qi, attending medical doctor at the Chongqing Medical University and Children's Hospital in Chongqing, China is working with Phil Stewart and Mike Franklin on the role of protein repair mechanisms in maintaining bacteria dormancy in biofilms. Dr. Qi works with newborns in the neonatal unit at the Children's Hospital. She arrived at the CBE on October 25, 2011 and will stay for one year.

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Tours

MSU Provost **Martha Potvin** toured the CBE with Center director Phil Stewart. This was her first opportunity since joining MSU to visit the CBE and get acquainted with the Center's programs and participants. She heard directly from students and staff, in their laboratories, about diverse projects related to algal biofuels, chronic wounds, and standardized biofilm methods. Dr. Potvin also had the opportunity to view a flow cell system through one of the CBE's newly acquired state-of-the-art confocal microscopes. Throughout the tour, she learned about the Center's commitment to student education, interdisciplinary teamwork, and industrial interaction. July 28, 2011.

Seventeen Japanese high school students touring Yellowstone and Glacier National Parks with Yellowstone Glacier Adventures visited the CBE in July. **Gem Encarnacion**, CBE PhD student, microbiology, led the group on a lab tour, highlighting the various environmental and medical applications of CBE research, including using algae to produce biofuels. The group was interested to see the types of biofilm we work with, and how we grow and test them. July 29, 2011.

Ann Willis, CBE technical operations manager, led a lab tour for **Makiko Diehl**, MSU Office of International Programs, and two international visitors—**Mr. Daiju Tsuya** and **Mr. Yoshikazu Watanabe** from the National Institute for Material Sciences (NIMS) in Tsukuba, Japan. The group was impressed by the interaction of the CBE's interdisciplinary team of students, faculty, and staff. NIMS is a public institute that is committed to the globalization of material research and establishment of research networks targeting the realization of a sustainable society by reinforcing relationships and exchanges with other research institutes around the world as a core research institute of material science. November 10, 2011.

The CBE provided three lab tour rotations to **middle school students** from Browning, Montana. The tours are part of MSU's prospective student program, MSU Fridays, that includes campus tours and activities for prospective students. January 27, 2012.

Ann Willis, CBE Technical Operations Manager, led a CBE lab tour for fifteen advanced placement biology students from **Belgrade** and **Three Forks high schools**. The students asked lots of questions as they toured the bioprocess and algal biofuel labs and viewed biofilm images and cryosectioning through CBE microscopes. February 17, 2012.

Clayton Christian, Montana Commissioner of Higher Education toured the CBE's algal biofuels lab as part of a visit to MSU's Energy Research Institute (ERI). The commissioner was accompanied by MSU President **Waded Cruzado**, Provost **Martha Potvin**, Vice President of Research **Tom McCoy**, and Associate Vice President of Research **Lee Spangler**. CBE associated faculty **Al Cunningham**, professor, civil engineering, and **Brent Peyton**, professor, chemical and biological engineering, demonstrated the lab's projects related to Montana's biodiesel initiatives and carbon sequestration. Dr. Cunningham also summarized CBE's microbially enhanced coal bed methane project for the group. May 16, 2012.

Thembela Hillie, professor of physics at Free State University in Bloemfontein, South Africa, toured the CBE with Ann Willis, CBE technical operations manager. Thembela is a nanotechnology principle researcher with the Council of Scientific and Industrial Research (CSIR). May 4, 2012

A group of students from **Colstrip High School** toured the Center with Ann Willis and two CBE PhD students—Chris Allen, civil engineering, and Luis Serrano, microbiology. With an interest in studying science at the college level, the high school students were full of questions and observations as they toured the bioprocess and algal

biofuel labs and viewed biofilm images and cryosectioning through CBE microscopes. April 23, 2012.

A group of students from two Montana tribal colleges—**Little Big Horn College** (LBHC) in Hardin and **Stone Child College** (SCC) in Box Elder—toured the Center with Ann Willis. The students are performing research as part of the IDeA Networks of Biomedical Research Excellence (INBRE) program. LBHC has three research projects including the West Nile Research Project. At SCC, students are working on one project—improving the college's health enhancement program—which is beginning a new phase of research for the visiting students. April 20, 2012.

Web image library use

Our automated image request system saw **486** image downloads; **53 out of 54 images** were downloaded.

There were **203** Academic [general K-12 & Higher Ed] downloads, **143** Academic [medical/dental], **84** Industry/Business, and the rest were Federal or State Agency or Other requests. A huge majority of requests were for image use in **presentations**, followed by use in **theses**. These submission results are consistent with the intent that the images are posted for educational use.

Requests for CBE graphics use were submitted from **42** of the United States, by **111** requesters:

Alabama
Alaska
Arizona
Arkansas
California
Connecticut
Colorado
Delaware
Florida
Georgia
Idaho
Illinois
Indiana
Kentucky
Louisiana
Maine
Maryland
Massachusetts
Michigan
Minnesota
Missouri
Montana
Nebraska
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oregon
Pennsylvania
Rhode Island
South Carolina
Tennessee
Texas
Washington
Wisconsin
Utah
Virginia
Washington, D.C.
Puerto Rico

There were **133** requests from an additional **39** countries:

Afghanistan
Algeria
Australia
Austria
Belgium
Brazil
Canada
China
Chile
Columbia
Czech Republic
Denmark
Estonia
Finland
France
Germany
Greece
India
Iran
Ireland
Israel
Italy
Japan
Jordan
Mexico
The Netherlands
New Zealand
Norway
Poland
Portugal
Singapore
South Africa
South Korea
Spain
Sweden
Switzerland
Turkey
United Kingdom (England)
Venezuela

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 ft^2 facility includes offices and conference rooms for faculty, staff, and students; two computer laboratories; and thirteen fully equipped research laboratories. The full-time CBE Technical Operations Manager oversees the research laboratories, provides one-on-one training for students, ensures safe laboratory practices, and maintains equipment. State-of-the-art instruments and equipment are available for use by all CBE faculty, staff, and students. General use areas include a microbiology lab, a media kitchen, an instrument lab, and an isolated radioactive isotope lab. Facilities of particular note are described below.

Mass spectrometry facility

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

Microsensor Laboratory

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

Microscope Facilities

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

> The **Optical Microscopy Lab** houses two Nikon Eclipse E-800 research microscopes which are used for transmitted light and epi-fluorescent imaging. Both microscopes are equipped with cooled CCD cameras from Photometrics (we have a CoolSnapfx, and a CoolSnapEZ) and use Universal Imaging Corporation's MetaVue software (v 7.4.6) for digital image acquisition. We have a large collection of fluorescence filter cubes for the Nikons, including those optimized for the following fluorescent stains: FITC (gfp), TRITC (propidium iodide), DAPI, CTC, ELF-97, CY5, cfp, and we also have a B2E cube. Both Nikons are equipped with Nomarski/DIC. Other equipment in the Optical Microscopy Lab includes a Nikon SMZ-1500 barrel zoom stereomicroscope equipped with a color camera, a Leica CM1800 cryostat, a Zeiss Palm Laser Capture Dissection microscope and a dry ice maker.
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> The **Confocal Microscopy Lab** contains two brand-new (2011) Leica SP5 Confocal Scanning Laser Microscopes (CSLMs).
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> One is an inverted confocal microscope with 405, 488, 561 and 633 nm laser excitation lines. It is equipped with a tandem scanner, so it can be switched from standard scanning mode to operate in Resonant Scanner mode, which enables scanning at exceptionally high frequencies for fluorescent imaging. This faster

scanning is necessary for most live cell imaging (note: "live cell imaging" doesn't generally refer to imaging bacterial cells, but rather mammalian cells and processes). This inverted SP5 also includes a heated stage with an environmental control chamber (i.e. it can be used to provide an enclosed CO2 atmosphere), and a motorized stage with Mark-and-Find and image tiling capabilities.

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

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

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

Flow Cytometry Facility

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

The facility is equipped with a Becton Dickinson FACSAria flow cytometer. Housed with three lasers, a 405 nm, 488 nm and a 633 nm, the FACSAria is able to detect up to seven different fluorochromes, plus forward and side scatter simultaneously. High-speed sorting is also a feature of the 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 workstations connected to the MSU College of Engineering computer network. A student computer laboratory offers ten state-of-the-art PCs along with scanning and printing services. In addition, the COE maintains computational PCs and a computational cluster for data manipulation, mathematical modeling, and graphic image analysis.

SPECIALIZED CBE LABORATORIES

Ecology/Physiology Laboratory

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

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

Medical Biofilm Laboratory

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

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

Standardized Biofilm Methods Laboratory

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

OTHER nearby Montana State University facilities available for collaborative research

MSU Nuclear Magnetic Resonance (NMR) Facility

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

MSU Magnetic Resonance Microscopy (MRM) Facility

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

MSU ICAL Laboratory

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

Current Instrumentation

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

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