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**2005 Annual Report: Appendix  
Center for Biofilm Engineering  
Reporting Period: June 1, 2004–May 31, 2005**

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## RESEARCH : PUBLICATIONS

### 2004 Publications

Anderson, J.M., G. Cook, J.W. Costerton, S.R. Hanson, A. Hensten-Petersen, N. Jacobsen, R.J. Johnson, R.N. Mitchell, M. Pasmore, F.J. Schoen, M. Shirtliff and P. Stoodley, "Host Reactions to Biomaterials and Their Evaluation," In: Biomaterials Science: An Introduction to Materials in Medicine, Ratner, B.D., Hoffman, A.S., Schoen, F.J., and Lemons, J.E. (eds.) pp. 345–354, Elsevier Academic Press (2004). **Abstract 04-043**

Beyenal, H. and Z. Lewandowski, "Dynamics of Lead Immobilization in Sulfate Reducing Biofilms," Water Res., 38:2726–2736 (2004). **Abstract 04-018**

Beyenal, H., C. Yakymyshyn, J. Hyungnak, C.C. Davis and Z. Lewandowski, "An Optical Microsensor to Measure Fluorescent Light Intensity in Biofilms," J. Microbiol. Methods., 58(3):367–374 (2004). **Abstract 04-022**

Beyenal, H., C. Donovan, Z. Lewandowski and G. Harkin, "Three-Dimensional Biofilm Structure Quantification," J. Microbiol. Methods, 59:395–413 (2004). **Abstract 04-032**

Borriello, G., E. Werner, F. Roe, A.M. Kim, G.D. Ehrlich and P.S. Stewart, "Oxygen Limitation Contributes to Antibiotic Tolerance of *Pseudomonas aeruginosa* in Biofilms," Antimicrob. Agents Chemother., 48(7):2659–2664 (2004). **Abstract 04-019**

Butterfield, P.W. and A.K. Camper, "Development of a Toolbox to Assess Microbial Contamination Risks in Small Water Systems," J. Water Health, 2(4):217–232 (2004). **Abstract 04-033**

Campbell, S., G. Geesey, Z. Lewandowski and G. Jackson, "Influence of the Distribution of the Manganese-Oxidizing Bacterium, *Leptothrix discophora*, on Ennoblement of Type 316L Stainless Steel," Corrosion, 60(7):670–680 (2004). **Abstract 04-017**

Camper, A.K., "Involvement of Humic Substances in Regrowth," Int. J. Food Microbiol. 92(3):355–364 (2004). **Abstract 04-016**

Costerton, J.W., "A Short History of the Development of the Biofilm Concept," In: Microbial Biofilms, Ghannoum, M.A. and G. O'Toole (eds.) ASM Press, Washington, D.C., pp. 4–19 (2004). **Abstract 04-013**

Costerton, J.W., P. Stoodley, M.E. Shirtliff, M. Pasmore and G. Cook, "Biofilms, Biomaterials and Device-Related Infections," In: Biomaterials Science: An Introduction to Materials in Medicine, Ratner, B.D., Hoffman, A.S., Schoen, F.J., and Lemons, J.E. (eds.) pp. 345–354, Elsevier Academic Press (2004). **Abstract 04-029**

Foreman, C.M., C.F. Wolf and J.C. Priscu, "Impact of Episodic Warming Events on the Physical, Chemical and Biological Relationships of Lakes in the McMurdo Dry Valleys, Antarctica," Aquatic Geochemistry, 10:239–268 (2004). **Abstract 04-042**

Francolini, I., P. Norris, A. Piozzi, G. Donelli and P. Stoodley, "Usnic Acid, a Natural Antimicrobial Agent Able to Inhibit Bacterial Biofilm Formation on Polymer Surfaces," Antimicrob. Agents Chemother., 48(11):4360–4365 (2004). **Abstract 04-044**

Franklin, M.J., S.A. Douthit and M.A. McClure, "Evidence that the *algI/algJ* Gene Cassette, Required for O Acetylation of *Pseudomonas aeruginosa* Alginate, Evolved by Lateral Gene Transfer," J. Bacteriol., 186(14):4759–4773 (2004). **Abstract 04-021**

Fux, C.A., S. Wilson and P. Stoodley, "Detachment Characteristics and Oxacillin Resistance of *Staphylococcus aureus* Biofilm Emboli in an In Vitro Catheter Infection Model," J. Bacteriol., 186(14):4486–4491 (2004). **Abstract 04-020**

Haag, A.P., R.M. Maier, J. Combie and G.G. Geesey, "Bacterially Derived Biopolymers as Wood Adhesives," Int. J. Adhes. Adhes., 24:495–502 (2004). **Abstract 04-036**

Hunt, S.M., E.M. Werner, B. Huang, M.A. Hamilton and P.S. Stewart, "Hypothesis for the Role of Nutrient Starvation in Biofilm Detachment," Appl. Environ. Microbiol., 70(12):7418–7425 (2004). **Abstract 04-034**

Goeres, D.M., T. Palys, B.B. Sandel, and J. Geiger, "Evaluation of Disinfectant Efficacy Against Biofilm and Suspended Bacteria in a Laboratory Swimming Pool Model," Water Res., 38:3103–3109 (2004). **Abstract 04-023**

## RESEARCH : PUBLICATIONS

Jardine, P.M., D.B. Watson, D.A. Blake, L.P. Beard, S.C. Brooks, J.M. Carley, C.S. Criddle, W.E. Doll, M.W. Fields, S.E. Fendorf, G.G. Geesey, et al., "Techniques for Assessing the Performance of In Situ Bioreduction and Immobilization of Metals and Radionuclides in Contaminated Subsurface Environments," <http://www.cistems.fsu.edu/PDF/jardine.pdf> (2004). **Abstract 04-038**

Lewandowski, Z., H. Beyenal and D. Stookey, "Reproducibility of Biofilm Processes and the Meaning of Steady State in Biofilm Reactors," Water Sci. Technol., 49(11-12):359–364 (2004). **Abstract 04-030**

Lisle, J.T., M.A. Hamilton, A.R. Willse and G.A. McFeters, "Comparison of Fluorescence Microscopy and Solid-Phase Cytometry Methods for Counting Bacteria in Water," Appl. Environ. Microbiol., 70(9):5343–5348 (2004). **Abstract 04-024**

Magnuson, T.S., A.L. Neal, B.M. Peyton and G.G. Geesey, "Combining In Situ Reverse Transcriptase Polymerase Chain Reaction, Optical Microscopy and X-ray Photoelectron Spectroscopy to Investigate Mineral Surface-Associated Microbial Activities," Microb. Ecol., 48:578-588 (2004). **Abstract 04-035**

Mikucki, J.A., C.M. Foreman, B. Sattler, W.B. Lyons and J.C. Priscu, "Geomicrobiology of Blood Falls: An Iron-Rich Saline Discharge at Terminus of the Taylor Glacier, Antarctica," Aquatic Geochemistry, 10:199-220 (2004). **Abstract 04-041**

Neal, A.L., J.E. Amonette, B.M. Peyton and G.G. Geesey, "Uranium Complexes Formed at Hematite Surfaces Colonized by Sulfate-Reducing Bacteria," Environ. Sci. Technol. 38(11):3019–3027 (2004). **Abstract 04-015**

Rayner, J., R. Veeh and J. Flood, "Prevalence of Microbial Biofilms on Selected Fresh Produce and Household Surfaces," Int. J. Food Microbiol. 95:29–39 (2004). **Abstract 04-025**

Sani, R.K., B.M. Peyton, J.E. Amonette and G.G. Geesey, "Reduction of Uranium (VI) Under Sulfate-Reducing Conditions in the Presence of Fe(III)-(hydr)oxides," Geochimica et Cosmochimica Acta 68(12):2639–2648 (2004). **Abstract 04-014**

Seymour, J.D., S.L. Codd, E.L. Gjersing and P.S. Stewart, "Magnetic Resonance Microscopy of Biofilm Structure and Impact on Transport in a Capillary Bioreactor," J. Magn. Reson., 167:322-327 (2004). **Abstract 04-045**

Seymour, J.D., J.P. Gage, S.L. Codd and R. Gerlach, "Anomalous Fluid Transport in Porous Media Induced by Biofilm Growth," Phys. Rev. Lett., 93:198103 (2004). **Abstract 04-046**

Shaw, T., M. Winston, C.J. Rupp, I. Klapper and P. Stoodley, "Commonality of Elastic Relaxation Times in Biofilms," Phys. Rev. Lett., 93(9):098102 1–4 (2004). **Abstract 04-026**

Stewart, P.S., K. Mukherjee and M.A. Ghannoum, "Biofilm Antimicrobial Resistance," In: Microbial Biofilms, Ghannoum, M.A. and G. O'Toole, (eds.), ASM Press, Washington, DC pp. 250–268 (2004). **Abstract 04-031**

Towler, B.E., J.E. Cahoon and O.R. Stein, "Evapotranspiration Coefficients for Broadleaf Cattail and Hardstem Bulrush," J. Hydrologic Engineering – American Society of Civil Engineers, 9(3):235-239 (2004). **Abstract 04-040**

Werner, E., F. Roe, A. Bugnicourt, M.J. Franklin, A. Heydorn, S. Molin, B. Pitts and P.S. Stewart, "Stratified Growth in *Pseudomonas aeruginosa* Biofilms," Appl. Environ. Microbiol., 70(10):6188–6196 (2004). **Abstract 04-027**

Wilson, S., M.A. Hamilton, G.C. Hamilton, M.R. Schumann and P. Stoodley, "Statistical Quantification of the Detachment Rates and Size Distribution of Cell Clumps from Wild Type (PAO1) and Cell Signaling Mutant (JP1) *Pseudomonas aeruginosa* Biofilms," Appl. Environ. Microbiol., 70(10):5847–5852 (2004). **Abstract 04-028**

### 2005 Publications

Abdul Rani, S., B. Pitts and P.S. Stewart, "Rapid Diffusion of Fluorescent Tracers into *Staphylococcus epidermidis* Biofilms Visualized by Time Lapse Microscopy," Antimicrob. Agents Chemother., 49(2):728–732 (2005). **Abstract 05-004**

Christner, B., J.A. Mikucki, C.M. Foreman, J. Denson and J.C. Priscu, "Glacial Ice Cores: A Model System for Developing Extraterrestrial Decontamination Protocols," Icarus, 174:572-584 (2005). **Abstract 05-010**

## RESEARCH : PUBLICATIONS

Fux, C.A., J.W. Costerton, P.S. Stewart and P. Stoodley, "Survival Strategies of Infectious Biofilms," Trends Microbiol., 13(1):34-40 (2005). **Abstract 05-002**

Fux, C.A., M. Shirliff, P. Stoodley and J.W. Costerton, "Can Laboratory Reference Strains Mirror 'Real-World' Pathogenesis?" Trends Microbiol., 13(2):58-63 (2005). **Abstract 05-003**

Geesey, G.G. and F. Van Ommen Kloeke, "Extracellular Enzymes Associated with Microbial Floccs from Activated Sludge of Wastewater Treatment Systems," In: Flocculation in Natural and Engineered Environmental Processes, Droppo, I.G., Leppard, G.G., Milligan, T.M., and Liss, S.N. (eds.), CRC Press, Boca Raton, FL, pp. 295-316 (2005). **Abstract 05-007**

Gjersing, E.L., S.L. Codd, J.D. Seymour and P.S. Stewart, "Magnetic Resonance Microscopy Analysis of Advective Transport in a Biofilm Reactor," Biotechnol. Bioeng., 89(7):822-834 (2005). **Abstract 05-011**

Goeres, D.M., L.R. Loetterle, M.A. Hamilton, R. Murga, D.W. Kirby and R.M. Donlan, "Statistical Assessment of a Laboratory Method for Growing Biofilms," Microbiology, 151:757-762 (2005). **Abstract 05-005**

Gonzalez-Gil, G., J.E. Amonette, M.F. Romine, Y.A. Gorby and G.G. Geesey, "Bioreduction of Natural Specular Hematite Under Flow Conditions," Geochim. Cosmochim. Acta., 69(5):1145-1155 (2005). **Abstract 05-006**

Kjellerup, B.V., R.H. Veeh, P. Sumithraratne, T.R. Thomsen, K. Buckingham-Meyer, B. Frølund and P. Sturman, "Monitoring of Microbial Souring in Chemically Treated, Produced-Water Biofilm Systems Using Molecular Techniques," J. Indust. Microbiol. Biotechnol., (32)4:163-170 (2005). **Abstract 05-012**

Komlos, J., A.B. Cunningham, A.K. Camper and R.R. Sharp, "Interaction of *Klebsiella oxytoca* and *Burkholderia cepacia* in Dual-Species Batch Cultures and Biofilms as a Function of Growth Rate and Substrate Concentration," Microb. Ecol., 49:114-125 (2005). **Abstract 05-012**

Purevdorj-Gage B., W.J. Costerton, and P. Stoodley, "Phenotypic Differentiation and Seeding Dispersal in Non-mucoid and Mucoid *Pseudomonas aeruginosa* Biofilms," Microbiology, 151(Pt 5):1569-1576 (2005). **Abstract 05-015**

Riley, K.A., O.R. Stein and P.B. Hook, "Ammonium Removal in Constructed Wetland Microcosms as Influenced by Presence and Species of Plants and Organic Carbon Load," J. Environmental Science and Health Pt. A., 40(6-7):1109-1121 (2005). **Abstract 05-009**

Roberts, M.E. and P.S. Stewart, "Modeling Protection from Antimicrobial Agents in Biofilms Through the Formation of Persister Cells," Microbiol.-UK, 151:75-80 (2005). **Abstract 05-001**

Rupp C.J., C.A. Fux, and P. Stoodley, "Viscoelasticity of *Staphylococcus aureus* Biofilms in Response to Fluid Shear Allows Resistance to Detachment and Facilitates Rolling Migration," Appl. Environ. Microbiol., 71(4):2175-2178 (2005). **Abstract 05-014**

Sanders, P.F. and P.J. Sturman, "Biofouling in the Oil Industry," In: Petroleum Microbiology, Olivier, B. and Magot, M. (eds.), ASM Press, Washington, DC, pp. 171-198 (2005). **Abstract 05-013**

Stein, O.R., and P.B. Hook, "Temperature, Plants and Oxygen: How Does Season Affect Constructed Wetland Performance?" J. Environmental Science and Health Pt.A., 40(6-7):1109-1121 (2005). **Abstract 05-008**

## RESEARCH : PUBLICATIONS

### Undergraduate Authors, 2004–05

*Abdul Rani, S.*, B. Pitts and P.S. Stewart, "Rapid Diffusion of Fluorescent Tracers into *Staphylococcus epidermidis* Biofilms Visualized by Time Lapse Microscopy," Antimicrob. Agents Chemother., 49(2):728–732 (2005). **Abstract 05-004**

Beyenal, H., *C. Donovan*, Z. Lewandowski and G. Harkin, "Three-Dimensional Biofilm Structure Quantification," J. Microbiol. Methods, 59:395–413 (2004). **Abstract 04-032**

Borriello, G., *E. Werner*, F. Roe, *A.M. Kim*, G.D. Ehrlich and P.S. Stewart, "Oxygen Limitation Contributes to Antibiotic Tolerance of *Pseudomonas aeruginosa* in Biofilms," Antimicrob. Agents Chemother., 48(7):2659–2664 (2004). **Abstract 04-019**

Hunt, S.M., *E.M. Werner*, B. Huang, M.A. Hamilton and P.S. Stewart, "Hypothesis for the Role of Nutrient Starvation in Biofilm Detachment," Appl. Environ. Microbiol., 70(12):7418–7425 (2004). **Abstract 04-034**

Lewandowski, Z., H. Beyenal and *D. Stookey*, "Reproducibility of Biofilm Processes and the Meaning of Steady State in Biofilm Reactors," Water Sci. Technol., 49(11-12):359–364 (2004). **Abstract 04-030**

*Roberts, M.E.* and P.S. Stewart, "Modeling Protection from Antimicrobial Agents in Biofilms Through the Formation of Persister Cells," Microbiol.-UK, 151:75–80 (2005). **Abstract 05-001**

*Rupp C.J.*, C.A. Fux, and P. Stoodley, "Viscoelasticity of *Staphylococcus aureus* Biofilms in Response to Fluid Shear Allows Resistance to Detachment and Facilitates Rolling Migration," Appl. Environ. Microbiol., 71(4):2175-2178 (2005). **Abstract 05-014**

Shaw, T., *M. Winston*, *C.J. Rupp*, I. Klapper and P. Stoodley, "Commonality of Elastic Relaxation Times in Biofilms," Phys. Rev. Lett., 93(9):098102 1–4 (2004). **Abstract 04-026**

Vinogradov, A.M., *M. Winston*, *C.J. Rupp*, and P. Stoodley, "Rheology of Biofilms formed from the dental plaque pathogen *Streptococcus mutans*," Biofilms 1(1):49-56 (2004). **Abstract 04-008**

*Werner, E.*, F. Roe, *A. Bugnicourt*, M.J. Franklin, A. Heydorn, S. Molin, B. Pitts and P.S. Stewart, "Stratified Growth in *Pseudomonas aeruginosa* Biofilms," Appl. Environ. Microbiol., 70(10):6188–6196 (2004). **Abstract 04-027**

## RESEARCH : CURRENT RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Biofilm Control/Antimicrobials	Control of Biofilms by Natural Products	Costerton James	NIH via SBIR with Sequoia Sciences
Biofilm Control/Antimicrobials	Modeling Antibiotic Resistance of Biofilm Bacteria	Stewart	NIH
Biofilm Control/Antimicrobials	Prevention and Remediation of Biofilms in Dental Units	Stewart	NIH via SBIR with Lynntech
Biofilm Control/Antimicrobials	Kodak Antimicrobial Surface Patent Development	Camper Stewart	Kodak
Biofilm Control/Antimicrobials	Antibiotic Resistance of Detached Biofilm Particulates	Stoodley	NIH
Biofilm Control/Antimicrobials	Ultrasonic Release of Antibiotics from Hydrogels for Biofilm Control	Stoodley Costerton	NSF
Biofilm Control/Antimicrobials	Ablation of Biofilms from Metal Surfaces	Costerton James	Atmospheric Glow Technologies
Biofilm Control/Antimicrobials	Testing Anti-Biofilm Enzymes	Stewart	NSF via SBIR with Diversa
Biofilm Control/Antimicrobials	Cumbre Phase I Project	Stewart	Cumbre
Biofilm Control/Antimicrobials	Testing a Novel Oxidizing Biocide	Stewart	Rohm and Haas
Biom mineralization	Biogeochemistry of Uranium Under Reducing and Re-oxidizing Conditions: An Integrated Laboratory and Field Study	Lewandowski	DOE
Biom mineralization	Microbial Fuel Cells	Lewandowski	ONR
Bioremediation	Development of an Oxygen-Consuming Biological Barrier to Prevent Oxidation of Pyritic Mine Tailings	Cunningham	MTBRC
Bioremediation	Evaluating Hyporheic Zone Biodegradation of MTBE and Other Oxygenates	Cunningham Veeh	API
Bioremediation	Control of Iron Sulfide and Microbial Sourcing in Oil/Gas-Bearing Formations using Nitrite, Nitrate and Molybdate	Sturman	Saudi Aramco
Bioremediation	Microbial and Geotechnical Responses in Acid-Producing Mine Tailings to <i>In Situ</i> Stimulation of Sulfate Reducing Bacteria	Sturman	MSE Technology Applications
Bioremediation	Nuclear Magnetic Resonance Imaging of Biofouling: Fluid Motion and Distribution in Porous Media and the Impact of Biofilm Growth on Transport <sup>*2</sup>	Seymour	ACS PRF

## RESEARCH : CURRENT RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Bioremediation	Resolving the Impact of Biological Processes on Water Transport in Unsaturated Porous Media through Nuclear Magnetic Resonance Micro-Imaging*2	Seymour/Codd	DOE
Bioterrorism	Health Implications of Biofilms in Drinking Water Systems	Camper	US Army
Bioterrorism	Biofilm Trap for Use in Counter-Terrorism	Costerton	US Army, NIH, DARPA
Cell-Cell Communication	Influence of Hydrodynamics and Cell Signals on Structure and Virulence Expression in <i>P. aeruginosa</i> Biofilms	Stoodley	Keck, NSF
Cell-Cell Communication	Use of Peptide Analogues to Prevent Biofilm Formation by <i>Staphylococci</i>	Costerton	NIH via UC Davis
Industrial and Drinking Water Treatment	Towards Sustainable Materials for Drinking Water Infrastructure	Camper	NSF
Industrial and Drinking Water Treatment	International: Modeling the Survival and Potential Proliferation of Microbial Agents in Drinking Water Distribution Systems	Camper	NSF
Medical Biofilms	The Role of Biofilms in the Pathogenesis of Otorrhea	Costerton Veeh	NIH via Allegheny-Singer
Medical Biofilms	Pneumococcal Biofilms in Otitis Media	Costerton Veeh	NIH via Allegheny-Singer
Medical Biofilms	Molecular Analysis of Pathogens in Otitis Media by PCR	Costerton Veeh	NIH via Allegheny-Singer
Medical Biofilms	<i>Staphylococcus aureus</i> and Production of Toxic Shock Syndrome Toxin	Lewandowski	Procter & Gamble
Standardized Biofilm Methods	Antimicrobial Test Methodology: Statistical Support to the Antimicrobials Division, EPA	Hamilton	EPA
Standardized Biofilm Methods	Parallel Testing of Selected Antimicrobials Against Suspended, Dried Surface, and Biofilm Bacteria	Hamilton	EPA
Standardized Biofilm Methods	Research Support for the Manufacturing and Marketing of the Drip-Flow Biofilm Reactor	Goeres	MTBRC
Structure-Function	On-line Biofilm Probe	Costerton James	NIH via SBIR with Intelligent Optical Systems
Structure-Function	Microbial Biofilm Development	Stewart	Keck
Structure-Function	Confocal Scanning Laser Probe	Costerton Dickensheets	NSF

## RESEARCH : CURRENT RESEARCH PROJECTS

Research Area	Title	Principal Investigator	Funding Agency
Structure-Function	A Mobile Biofilm Observation Unit	Suci	Keck through Portland State University
Structure-Function	Gene Expression in <i>Pseudomonas aeruginosa</i> During Biofilm Development <sup>*1</sup>	Franklin	NIH
Structure-Function	ADVANCE Fellows Award - NMR Microscopy of Structure-Function Relationships and Microfluidics in Biofilms and Cellular Suspensions <sup>*2</sup>	Codd	NSF
Bioremediation	Seasonal, Operational, and Plant Effects on Oxygen Potential and Microbial Responses Influencing Constructed Wetland Performance	Stein	USDA
Biofouling	Subsurface Biofilm Barriers for Enhanced Geologic Sequestration of Supercritical CO <sub>2</sub>	Cunningham	DOE/ZERT
Bioremediation	Biofilm Restoration of Contaminated Army Sites	Gerlach	DOD through Center for Innovation
Bioremediation	Long-term Stewardship of Mixed Wastes: Passive Reactive Barriers for Simultaneous <i>In Situ</i> Remediation of Chlorinated Solvent, Heavy Metal, and Radionuclide Contaminants	Gerlach	DOE
Natural Organic Matter	Collaborative Proposal: Biogeochemistry of Dissolved Organic Matter in Pony Lake, Ross Island <sup>3</sup>	Foreman	NSF
Natural Organic Matter	Paleorecords of Biotic and Abiotic Particles in Polar Ice Cores	Foreman	NSF
Industrial and Drinking Water	STTR	Camper	NIH
Microbial Ecology Biofouling	Microbial Ecology of Swimming Pool Biofilms	Sturman Veeh	Arch Chemicals, Inc.
Microbial Ecology Biofouling	Analysis of Flexhose-Associated Biofilms	Pyle Sturman Veeh	NASA

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

<sup>1</sup>MSU Department of Microbiology

<sup>2</sup>MSU Department of Chemical and Biological Engineering

<sup>3</sup>MSU Department of Land Resources & Environmental Sciences

## **RESEARCH : CURRENT RESEARCH PROJECTS**

### **List of Acronyms**

**ACS PRF** – American Chemical Society Petroleum Research Fund  
**API** – American Petroleum Institute  
**AWWARF** – American Water Works Association Research Foundation  
**DARPA** – Defense Advanced Research Projects Agency  
**DOE** – US Department of Energy  
**EPA** – US Environmental Protection Agency  
**INRA** – Inland Northwest Research Alliance  
**Keck** – W. M. Keck Foundation  
**MTBRC** – Montana Board of Research and Commercialization  
**NIH** – National Institutes of Health  
**NORAL** – Naval Ocean Research Laboratory  
**NSF** – National Science Foundation  
**ONR** – Office of Naval Research  
**USDA** – United States Department of Agriculture  
**ZERT** – Zero Emissions Research and Technology  
**CFI – DOD** – Center For Innovation - Department of Defense  
**SBIR** – Small Business Innovation Research

**Agenda**  
**Technical Advisory Conference**  
**June 29–July 1, 2004**  
**Montana State University–Bozeman**

**Monday**  
**June 28**

**6:00–7:30 p.m.**  
**Pre-registration and**  
**Welcome Reception**  
GranTree Inn  
North 7<sup>th</sup> Ave, Bozeman

**Tuesday**  
**June 29**

**7:45–8:45 a.m.**  
**Registration and**  
**Continental Breakfast**  
Strand Union Building (SUB)  
Room 275 / 276

**8:45–9:00**  
**Introductory Remarks**  
SUB Ballroom D  
Paul Sturman, CBE Industrial  
Coordinator  
Bobby Orr, C.R. Bard, Inc.,  
TAC Chair

**Invited Presentation:**  
**9:00–10:00**  
**Defining the *Vibrio harveyi***  
**Quorum Sensing Network**  
Bonnie Bassler, Professor,  
Molecular Biology,  
Princeton University, New Jersey

**10:00–10:20 Break**

**State of the CBE Address:**  
**10:20–11:10**  
Bill Costerton, CBE Director

**SESSION 1:**  
**Biofilm Methods**

**11:10–11:20**  
**Session Introduction**  
Darla Goeres, CBE Research  
Engineer

**11:20–11:35**  
**Standard Method Development:**  
**Efficacy Testing in Dental Unit**  
**Water Lines**  
Shannon Goeres, BSTL  
Undergraduate Intern

**11:35–11:55**  
**Parallel Testing to Determine the**  
**Influence of Biofilm Growth**  
**Conditions on Antimicrobial Log**  
**Reduction**  
Kelli Buckingham-Meyer, CBE  
Laboratory Specialist

**11:55–12:10**  
**Long Term Monitoring of an Oilfield**  
**Bacterial Consortium**  
Brandon Brooks, Recent MSU B.S.  
Graduate, Chemical & Biological  
Engineering

**12:10–1:30**  
**Lunch, Catered**  
SUB Ballroom C

**SESSION 2:**  
**Environmental Biofilms**

**1:30–1:40**  
**Session Introduction**  
Anne Camper, Associate Professor,  
Civil Engineering, CBE

**1:40–2:00**  
**Influence of Siderophores on Metal**  
**Mobility and Transport**  
Abigail M. Aiken, Visiting PhD  
Student, Chemical Engineering  
Washington State University

**2:00–2:20**  
***Escherichia coli* Capture by**  
**Established *Pseudomonas***  
***aeruginosa* Biofilm in a Capillary**  
**Flow Cell**  
Benjamin Klayman, PhD Candidate,  
Environmental Engineering

**2:20–2:40**  
**Biofilms in the Environment:**  
**Understanding Pathogens in**  
**Drinking Water Distribution**  
**Systems**  
Stewart Clark, PhD Candidate,  
Microbiology

**2:40–3:00**  
**Modeling Drinking Water System**  
**Biofilms Using Cellular Automata**  
Al Cunningham, Professor,  
Civil Engineering, CBE

**3:00–3:20**  
**Discovering the Microbial Diversity**  
**in Natural Biofilms:**  
**The forest or the trees?**  
Mark Burr, Senior Research  
Associate, CBE

**3:20–3:30**  
**Wrap-Up and Industry Comment**

**3:30–3:50 Break**

**3:50–4:45**  
**FDA Regulatory Outlook**  
Janine Morris, Branch Chief,  
Urology and Lithotripsy Devices  
Branch, Division of Reproductive,  
Abdominal, and Radiology Devices,  
Office of Device Evaluation, Center  
for Devices and Radiological Health,  
US Food and Drug Administration

**5:00–6:30**  
**Poster Session**

**Wednesday**  
**June 30**

**7:30–8:20 a.m.**  
**Registration and**  
**Continental Breakfast**  
Strand Union Building (SUB)  
Room 275 / 276

**SESSION 3:**  
**Biofilm Structure-Function**

**8:20–8:30**  
**Session Introduction**  
Zbigniew Lewandowski, Professor,  
Civil Engineering, CBE

**8:30–8:50**  
**Importance of Electron Shuttling**  
**Compounds in Biological Systems**  
Robin Gerlach,  
Assistant Research Professor, CBE

## RESEARCH : TAC AGENDA SUMMER 2004

8:50–9:10

### Bacterially Derived Environmentally Compatible Adhesives

Gill Geesey, Professor,  
Microbiology, CBE

9:10–9:30

### Modeling Interactions between Fluid Forces and Biofilm Deformation

Brett Towler, Postdoctoral  
Researcher, Civil Engineering

9:30–9:50

### Predicting Biofilm Structural Parameters Using Artificial Neural Networks

Raaja Raajan Angathevar  
Veluchamy, MS Candidate,  
Environmental Engineering

9:50–10:10

### Magnetic Resonance Microscopy of the Impact of Biofilm Growth on Mass Transport in Bioreactors and Porous Media

Joe Seymour, Assistant Professor,  
Chemical & Biological Engineering,  
CBE

10:10–10:30 Break

## SESSION 4:

### The CBE Imaging Facility

10:30–10:40

#### Session Introduction

Betsy Pitts, CBE Research  
Associate and Facilities Manager,  
Microscopy

10:40–11:00

#### Flow Cytometry: A Complement to the Biofilm Imaging Facility

Jennifer Sestrich,  
CBE Research Assistant

11:00–11:20

#### Fluorescent Stains and Probes Used at the CBE

Betsy Pitts

11:20–11:40

#### Imaging Biofilms on Alternative Surfaces

Steve Fisher, CBE Research  
Assistant

11:40–12:00

#### Image Analysis Using MetaMorph: Quantitative Techniques

Willy Davison, PhD Candidate,  
Chemical & Biological Engineering

12:00–12:20

#### Qualitative Image Analysis Using Imaris

Patrick Norris, MS Candidate,  
Mechanical Engineering

12:20–1:20

#### Lunch, Catered

SUB Ballroom C

#### Imaging Forum:

1:20–1:50

#### A Discussion of Imaging Issues in Industrial Applications

Betsy Pitts

1:50–2:10

#### Education Initiative Overview

Rocky Ross, Professor,  
Computer Science, CBE

3:00–5:00

#### TAC Business Meeting

Springhill Pavilion

6:00–8:00

#### Dinner

Springhill Pavilion

## Thursday July 1

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7:30–8:30 a.m.

#### Registration and Continental Breakfast

Strand Union Building (SUB)  
Room 275 / 276

#### Special Presentations:

8:30–9:10

#### Linking Identity and Function of Uncultured Bacteria in Biofilms

Per Nielsen, Professor,  
Environmental Engineering  
University of Aalborg,  
Aalborg, Denmark

9:10–9:50

#### Biomedical Applications of Viruses as Templates for Nanomaterials Synthesis

Mark Young, Associate Professor,  
Plant Sciences and Plant  
Pathology, MSU

## SESSION 5:

### Biofilm Control—Medical

9:50–10:00

#### Session Introduction

Phil Stewart, Professor, Chemical  
& Biological Engineering, CBE

10:00–10:20

#### Multicellular Nature of Biofilm Antimicrobial Tolerance

Phil Stewart

10:20–10:40 Break

10:40–11:00

#### Virulence Factors Associated with *Pseudomonas aeruginosa* Biofilms

Mike Franklin, Assistant Professor,  
Microbiology, CBE

11:00–11:20

#### Is the Nasopharyngeal Colonization with *Streptococcus pneumoniae* a Biofilm-Related Process ?

Christoph Fux, MD, Visiting  
Researcher, University of Bern,  
Bern, Switzerland

11:20–11:40

#### Growth Limitation of *Staphylococcus epidermidis* in Biofilms Contributes to Rifampin Tolerance

Phil Stewart

11:40–11:50

#### Wrap-Up and Industry Comment

11:50–12:00

#### Meeting Wrap-Up

Agenda  
CBE Technical Advisory Conference  
February 2–4, 2005  
Montana State University, Bozeman

Wednesday  
February 2

6:00–8:00 p.m.  
Pre-registration and  
Welcome Reception  
GranTree Inn  
North 7<sup>th</sup> Ave, Bozeman

Thursday  
February 3

8:00–8:45 a.m.  
Registration and  
Continental Breakfast  
Strand Union Building (SUB)  
Room 275 / 276

8:45–9:00  
Introductory Remarks  
SUB Ballroom D  
Paul Sturman, CBE Industrial  
Coordinator  
Mel Czechowski, Church & Dwight,  
TAC Chair  
Phil Stewart, CBE Interim Director

Keynote Presentation  
9:00–9:50  
Resistance, persistence and  
consistence in biofilm communities  
Peter Gilbert, Professor of Microbial  
Physiology, University of  
Manchester

SESSION 1:  
Biofilm Control

9:50–10:00  
Session Introduction  
Phil Stewart, MSU-CBE Professor,  
Chemical & Biological Engineering

10:00–10:20  
Patterns of DNA synthesis in  
*Staphylococcus epidermidis*  
biofilms  
Suriani Abdul Rani, CBE MS  
Candidate, Chemical & Biological  
Engineering

10:20–10:40  
A coupled fluid-biofilm finite  
element model and its potential  
applications  
Brett Towler, MSU-CBE Assistant  
Professor, Civil Engineering

10:40–11:00 Break

11:00–11:20  
Adaptive responses to antimicrobial  
agents in biofilms  
Phil Stewart and Barbara Szomolay,  
MSU PhD Candidate, Mathematical  
Sciences

11:20–11:30  
Session Conclusion and Comment

Special Presentation  
11:30–12:00  
Person to person: A historical look  
at CBE-Industry partnerships  
Al Cunningham & friends

12:00–1:00  
Lunch, Catered  
SUB Ballroom C

SESSION 2:  
Biofilm Methods

1:00–1:10  
Session Introduction  
Marty Hamilton, MSU-CBE  
Professor Emeritus, Statistics

1:10–1:30  
Biofilms: Regulatory challenges  
Melba Morrow, Special Assistant to  
the Director, Antimicrobials Division,  
Office of Pesticide Programs,  
US EPA

1:30–1:50  
Multi-species oral biofilm model  
Garth James, CBE Medical  
Projects Manager

1:50–2:10  
PCR-based community analysis of  
environmental biofilms:  
Competence and caveats  
Mark McBroom, Recent MSU-CBE  
MS Graduate, Environmental  
Engineering

2:10–2:30  
What is the "detection limit" when  
using dilution series methods for  
counting bacteria?  
Julia Sharp, PhD Candidate in  
Statistics, and Marty Hamilton

2:30–2:40  
Session Conclusion and Comment

2:40–3:00 Break

SESSION 3:  
Biological Fuel Cells

3:00–3:10  
Session Introduction  
Zbigniew Lewandowski, MSU-CBE  
Professor, Civil Engineering

3:10–3:30  
Sustainable power in microbial fuel  
cells  
Joseph Menicucci, CBE Ph.D.  
Candidate, Chemical & Biological  
Eng.

3:30–3:50  
Power management in microbial  
fuel cells  
Avinash Shantaram, CBE MS  
Candidate, Environmental Eng.

3:50–4:00  
Session Conclusion and Comment

Special Presentations  
4:00–4:30  
Biofilms: Clinical communities are  
asking us to support clinical  
management: Are we ready for  
reduction to practice?  
Bill Costerton, Director, Dental  
Biofilm Center, University of  
Southern California

4:30–5:00  
Diffusion in Biofilms:  
Now in hypertext  
Al Cunningham, MSU-CBE  
Professor, Civil Engineering  
Rocky Ross, MSU-CBE Professor,  
Computer Science  
Phil Stewart

## RESEARCH : TAC AGENDA WINTER 2005

**5:00 – 6:00**  
**Poster Session**  
SUB Room 275-276

**6:00**  
**Dinner**  
Catered, Ballroom C

### Friday February 4

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**8:00–8:45 a.m.**  
**Registration and  
Continental Breakfast**  
Strand Union Building (SUB)  
Ballroom C

#### **SESSION 4:** **Water Treatment**

**8:45–8:50**  
**Session Introduction**  
Anne Camper, MSU-CBE Associate  
Professor, Civil Engineering

**8:50–9:10**  
**Control of biofilms and  
microbiological water quality in  
water distribution systems**  
Raymond Hozalski, CBE Visiting  
Researcher, Associate Professor of  
Civil Engineering, University of  
Minnesota

**9:10–9:30**  
**Microbial biofilms as indicators of  
estuarine ecosystem condition**  
Andreas Nocker, MSU-CBE  
Research Assistant Professor

**9:30–9:50**  
**Biofilm challenges in the  
international space station**  
Monsi Roman, Chief Microbiologist,  
Environmental Control and Life  
Support, NASA/Marshall Space  
Flight Center

**9:50–10:00**  
**Session Conclusion and Comment**

**10:00–10:20 Break**

#### **SESSION 5:** **Cell-Cell Signaling**

**10:20–10:25**  
**Session Introduction**  
Tim Ford, Department Head,  
Microbiology, MSU

**10:25–10:45**  
**Influence of quorum sensing and  
hydrodynamics on *Pseudomonas  
aeruginosa* biofilm structure and  
behavior**  
Laura Purevdorj-Gage, recent MSU-  
CBE PhD graduate, Microbiology

**10:45–11:05**  
**Influence of the quorum sensing  
signal autoinducer-2 on  
*Mycobacterium avium* biofilm  
formation**  
Henriette Geier, MSU-CBE  
PhD Candidate, Microbiology

#### **SESSION 6:** **Environmental Biofilms**

**11:05–11:10**  
**Session Introduction**  
Al Cunningham, MSU-CBE  
Professor, Civil Engineering

**11:10–11:30**  
**Use of solid phase iron oxide  
minerals as terminal electron  
acceptors in anaerobic respiration:  
A selective pressure for surface-  
associated bacterial growth during  
early life on Earth**  
Gill Geesey, MSU Professor,  
Microbiology

**11:30–11:50**  
**Exploring microbial capabilities  
through biochemical network  
analysis**  
Ross Carlson, MSU-CBE  
Assistant Research Professor

**11:50–12:20**  
**Biofilms on plant surfaces: Impacts  
on plant production, biology and  
ecology**

Cindy Morris, visiting researcher,  
INRA-Avignon Plant Pathology  
Research Station, Montfavet,  
France

**Biofilms on Plant Roots: Impacts  
on Plant Production, Biology, and  
Ecology in the Underworld**  
Rick Veeh, MSU-CBE  
Senior Research Associate

**12:20–12:30**  
**Session/Meeting Wrap-up and  
Industry Comment**

**12:30–2:00**  
**TAC Business Meeting**

## EDUCATION : STUDENT STATISTICS

### 2004-2005 Undergraduate Students

Discipline	Male	Female	Total
Biological Science		1	1
Biomedical Science		4	4
Biotechnology		1	1
Cell Biology & Neuroscience	1	2	3
Chemical & Biological Engineering	6	5	11
Chemistry	3		3
Civil Engineering	1	1	2
Computer Science	2	1	3
Environmental Engineering	3		3
Mechanical Engineering	1		1
Microbiology		3	3
Statistics	1		1
<b>Total</b>	<b>18</b>	<b>18</b>	<b>36</b>

### 2004-2005 Graduate Students

Discipline	MS/PhD	Male	Female	Total
Chemical & Biological Engineering				<b>11</b>
	MS	3	2	5
	PhD	5	1	6
Chemistry				<b>1</b>
	PhD	1		1
Civil & Environmental Engineering				<b>8</b>
	MS	5	1	6
	PhD	2		2
Computer Science				<b>1</b>
	PhD	1		1
Electrical Engineering				<b>2</b>
	MS	1		1
	PhD	1		1
Mathematics				<b>3</b>
	PhD	1	2	3
Mechanical Engineering				<b>2</b>
	MS	2		2
Microbiology				<b>4</b>
	PhD	2	2	4
<b>Total</b>		<b>24</b>	<b>8</b>	<b>32</b>

## EDUCATION : FALL 2004 SEMINAR SERIES

Date	Speaker	Title
09 Sep 2004	Pradeep Singh, M.D. University of Iowa	Self-Generated Diversity Produces “Insurance Effects” in Biofilm Communities
16 Sep 2004	CBE Executive Committee	The Center's People and Research: A Look at the Past and the Future
23 Sep 2004	Ross Carlson CBE Post-Doc	Identification and Quantification of the Intracellular Rate Structure of <i>E. coli</i> with Elementary-Mode Analysis
30 Sep 2004	Jeff Leid Dept. Biological Sciences Northern Arizona University	Human Immune System Components
07 Oct 2004	Brent Peyton Associate Director, Center for Multiphase Environmental Research, Dept. Chemical Engineering, Washington State University	Interactions of <i>Desulfovibrio desulfuricans</i> G20 and Toxic Heavy Metals (Pb, Cu, and U)
14 Oct 2004	Dr. Recep Avci Director of ICAL	Atomic Force Microscopy as a Tool in the Determination of Nano-scale Adhesion and Elastic Properties of Materials from Single Molecules to Live Microorganisms
21 Oct 2004	Cindy Morris Visiting Scientist INRA - Avignon, France	Biofilm on Plant Surfaces
28 Oct 2004	Mike Franklin MSU-Microbiology	<i>Pseudomonas aeruginosa</i> and Alginate Characteristics
04 Nov 2004	Volker Brozel Dept. of Biology and Microbiology South Dakota State University	Multicellular Behavior of <i>Bacillus cereus</i> Growing as a Biofilm in Soil
18 Nov 2004	Paul Stoodley, Ph.D. Associate Professor Center for Genomic Sciences Allegheny-Singer Research Institute	Imaging Biofilms on Host Tissue in Animal Models and Clinical Specimens
02 Dec 2004	CBE Executive Committee	CBE Update
09 Dec 2004	Special Seminar	Social event and feedback session on seminar series

## EDUCATION : SPRING 2005 SEMINAR SERIES

Date	Speaker	Title
13 Jan 2005	Brenda Little, Senior Scientist Naval Research Laboratory Stennis Space Center, MS	A Director Candidate Biofilm Research: Past, Present and Future
20 Jan 2005	CBE Executive Committee	In preparation for TAC
27 Jan 2005	Mark Dolan Professor of Civil, Construction & Environmental Engineering Oregon State University	Field Bioaugmentation of a Butane- Utilizing Culture to Co-metabolize a Mixture of Problematic Chlorinated Solvents
10 Feb 2005	Ray Hozalski Associate Professor, Civil Engineering University of Minnesota	Development and Application of a Micro-Cantilever Method for Measuring the Cohesive Strength of Biofilms
17 Feb 2005	Elinor Pulcini Research Associate CBE Medical Biofilm Laboratory	Shuttle Flight Simulations: Modeled Microgravity, Clinorotation and Virulence Effects
24 Feb 2005	Joao Xavier Postdoctoral scholar University of Delft, The Netherlands	Investigating the Activity and Structure of Biofilms Using Mathematical Modeling
03 Mar 2005	Mark Shirliff, Assistant Professor Department of Biomedical Sciences, Dental School University of Maryland-Baltimore	Detachment Properties and Host Antibody Response to <i>S. aureus</i> Biofilm Infections
10 Mar 2005	Christine Foreman Assistant Research Professor, CBE	Environmental Biofilms
31 Mar 2005	Thomas Borch Postdoctoral Stanford University	Role of Microbes and Oxyanions in Iron Mineralization Processes Studied by X-ray Absorption Spectroscopy (XAS) and Soft X-ray Spectromicroscopy (STXM)
07 Apr 2005	Cystic Fibrosis Movie produced by Sara Shier	The Battle Against Biofilms
14 Apr 2005	Garth Ehrlich Center for Genomic Sciences Pittsburgh, PA	Developing Experimental Systems to Test Predictions of Bacterial Plurality with respect to Chronic Infections
21 Apr 2005	Dr. Garth Olds Surgeon, Bozeman, MT	Vascular Graft Infections

**TECHNOLOGY TRANSFER : INDUSTRIAL ASSOCIATE MEMBERSHIP**

**Industrial Associate Membership  
(June 1, 2004–May 31, 2005)**

<b>Organization</b>	<b>Type of Industry</b>	<b>Number of Years of Support</b>
Aramco Services Company	Petroleum	87,88,89,90,91,92,93,94,95,96,97,98,99,00,01,02,03,04,05
Church & Dwight Co., Inc.	Household Products	02,03,04,05,06
Colgate-Palmolive	Household Products	00,01,02,03,04,05
C.R. Bard, Inc.	Healthcare	04,05
Cumbre Inc.	Healthcare	04,05
DePuy, Inc.	Healthcare	02,03,04
Diversa Corporation	Healthcare	04,05
Dow Chemical Company	Specialty Chemicals	90,91,92,93,94,95,98,99,00,01,02,03,04,05
DuPont	Specialty Chemicals	95,96,97,98,00,03,04,05
Eastman Kodak Company	Other	91,92,97,98,99,00,01,02,03,04
Ecolab Inc.	Specialty Chemicals	05,06
Edstrom Industries, Inc.	Water Treatment	03,04,05
Electric Power Research Institute (EPRI)	Other	04,05
Gambro Corporate Research	Healthcare	02,03,04
Genencor International, Inc.	Healthcare	02,03,04,05
GlaxoSmithKline	Pharmaceutical	04,05
Idaho National Laboratory (INL)	Government Lab	87,88,89,90,91,92,93,94,95,96,97,98,99,00,01,02,03,04
Masco	Household Products	05,06
NASA	Government Lab	05,06

**TECHNOLOGY TRANSFER : INDUSTRIAL ASSOCIATE MEMBERSHIP**

Organization	Type of Industry	Number of Years of Support
Novozymes North America Inc.	Healthcare	05
Philips Oral Healthcare	Healthcare	02,03,04
S. C. Johnson & Son (formerly S. C. Johnson Wax)	Household Products	93,94,95,96,97,98,99,00,01,02,03,04,05
Smith & Nephew, Inc.	Healthcare	03,04,05
Tyco Healthcare (formerly Kendall Healthcare Products Company)	Healthcare	98,99,00,01,02,03,04,05
U. S. Bureau of Reclamation	Drinking Water	98,99,00,01,02,03,04,05
W. L. Gore & Associates	Healthcare	97,98,99,00,01,02,03,04,05

**TECHNOLOGY TRANSFER : COLLABORATIONS OVER HISTORY OF THE CBE**

**Industrial and Government Collaborators over the History of the CBE**

Organization	Size of Organization			Foreign	Industrial Associate	Years as Industrial Associate
	Small <500	Medium 500-1000	Large >1000			
3M Corporation			X	NO	NO	
ADA Technologies, Inc.°	X			NO	NO	
Affinity, Inc.°	X			NO	NO	
Albemarle Corporation			X	NO	YES	98,99,00
Allied Tube & Conduit		X		NO	NO	
American Petroleum Institute	X			NO	NO	
American Water Works Association Research Foundation (AWWARF)	X			NO	YES	91,92,93,94,95,96,97,98
American Water Works Service Company	X			NO	NO	
Aramco Services Company			X	YES	YES	87,88,89,90,91,92,93,94,95,96,97,98,99,00,01,02,03,04,05
Arbor Surgical Technologies°	X			NO	NO	
Arch Chemicals (formerly Olin Chemicals)			X	NO	YES	93,94,95,96,97,98,99,00,01,02
Arco Exploration & Production Technology			X	NO	YES	86,87,88,89,90,91,92,93,94,95,97,98
Army Research Office (ARO)*			X	NO	NO	
Atmospheric Glow Technologies°	X			NO	NO	
Atrium Medical Corporation°			X	NO	NO	
Australian Water Technologies	X			YES	NO	
Bayer Chemical Company			X	NO	NO	
Becton Dickinson Technologies			X	NO	YES	98,99,00,01
Betz Dearborn Inc.		X		NO	YES	99,00,01,02
Betz PaperChem			X	NO	YES	91,92,93,94,95,96
BHP Copper (formerly Magma Copper)		X		NO	YES	96,97,98
Biolab		X		NO	YES	99,00,01
Bioquatic Supply	X			NO	NO	
Biomedical Development Corporation°	X			NO	NO	
Biosurface Technologies Corporation	X			NO	NO	
Bitterroot Restoration, Inc.	X			NO	NO	
Black & Veatch			X	NO	NO	
BP - Amoco Corporation (formerly Amoco Corporation)			X	NO	YES	87,88,89,90,91,92,93,94,95,96,97,98,99,00,01
Brentwood Industries	X			NO	NO	
British Petroleum Research			X	NO	YES	91,92,93

**TECHNOLOGY TRANSFER : COLLABORATIONS OVER HISTORY OF THE CBE**

Organization	Size of Organization			Foreign	Industrial Associate	Years as Industrial Associate
	Small <500	Medium 500-1000	Large >1000			
Calgon Corporation		X		NO	YES	92,93,94,95,96,97,98
Canon Communications, Inc.		X		NO	NO	
Centers for Disease Control (CDC)			X	NO	NO	
Center for Innovation (CFI)	X			NO	NO	
Chevron Petroleum Technology Company			X	NO	YES	88,89,90,91,92,93,94,95,96,97,98,99,00
Church & Dwight Co., Inc.°			X	NO	YES	02,03,04,05,06
Ciba Vision			X	NO	YES	99
Cincinnati Water Works	X			NO	NO	
City of Laval		X		YES	NO	
Clearwater Systems	X			NO	NO	
Clorox Company			X	NO	YES	94,95,96,97,98,99
Colgate-Palmolive Company			X	NO	YES	01,02,03,04,05
Compagnie Générale des Eaux (CGE)		X		YES	NO	
Conductive Medical Devices			X	NO	NO	
Conoco, Inc.			X	NO	YES	87,88,89,90,91,92,93,94,95,96,97,98
C.R. Bard, Inc.			X	NO	YES	04,05
Cumbre Inc.	X			NO	YES	04,05
Cytery, LLC	X			NO	NO	
Defense Advanced Research Projects Agency (DARPA)*			X	NO	NO	
Demeter, Inc.	X			NO	NO	
DePuy, Inc.			X	NO	YES	02,03,04
Diversa Corporation	X			NO	YES	04,05
Dow Chemical U.S.A.			X	NO	YES	90,91,92,93,94,95,98,99,00,01,02,03,04,05
DuPont			X	NO	YES	95,96,97,98,00,03,04,05
Eastman Kodak Company			X	NO	YES	91,92,97,98,99,00,01,02,03,04
Ecolab Inc.			X	NO	YES	05,06
Ecole Polytechnique de Montréal		X		YES	NO	
Economic & Engineering Service Inc.		X		NO	NO	
Edstrom Industries, Inc.	X			NO	YES	03,04,05
Electric Power Research Institute (EPRI)			X	NO	YES	88,89,90,04,05
Engineering & Economic Development	X			NO	NO	
Environmental Protection Agency (EPA)*			X	NO	NO	
EPA/Kansas State University*		X		NO	NO	
Ethicon Endo-Surgery, Inc.			X	NO	NO	
Exponent, Inc.°		X		NO	NO	

**TECHNOLOGY TRANSFER : COLLABORATIONS OVER HISTORY OF THE CBE**

Organization	Size of Organization			Foreign	Industrial Associate	Years as Industrial Associate
	Small <500	Medium 500-1000	Large >1000			
Exxon Production Research			X	NO	YES	89,90,91,92,93,94,95,96,97,98
Fine Particle Society		X		NO	NO	
FMC Corporation	X			NO	NO	
Gambro Corporate Research			X	YES	YES	02,03,04
Genencor International, Inc.°			X	NO	YES	02,03,04,05
Genome Therapeutics Corp.		X		NO	YES	02,03
GlaxoSmithKline°			X	NO	YES	04,05
Glycomimetics, Inc.°	X			NO	NO	
Idaho National Laboratory (INL) (formerly INEL, EG&G and INEEL)*			X	NO	YES	87,88,89,90,91,92,93,94,95,96,97,98,99,00,01,02,03,04
Inland Northwest Research Alliance, Inc. (INRA)	X			NO	NO	
Intelligent Optical Systems (IOS)°		X		NO	NO	
International Copper Association			X	NO	YES	89,90,91
Kurita Water Industries Ltd.			X	YES	YES	01,02,03
Little Bear Labs	X			NO	NO	
Los Alamos National Laboratory*			X	NO	NO	
Lovelace Medical Foundation			X	NO	NO	
Lynntech	X			NO	NO	
Masco			X	NO	YES	05,06
Matney-Frantz Engineering, P.C.			X	NO	NO	
MBI		X		NO	NO	
Mentor Urology Inc.°		X		NO	NO	
Metropolitan Water District of Southern California		X		NO	NO	
Microbia, Inc.			X	NO	YES	01,02,03
MIOX Corporation	X			NO	NO	
Montana Biotech	X			NO	NO	
Montana Power Company		X		NO	YES	89,90,91,92,93,94,95
Montana Tech	X			NO	NO	
MSE, Inc.		X		NO	YES	96,97,98,99
National Institutes of Health (NIH)*			X	NO	NO	
National Science Foundation (NSF)*			X	NO	NO	
National Water Research Institute (NWRI)	X			NO	NO	
Neopoxy	X			NO	NO	
Novozymes North America Inc.	X			NO	YES	05
Office of Naval Research*				NO	NO	
Ondeo Nalco Chemical Corporation (formerly Nalco Chemical Corporation)			X	NO	YES	90,91,92,93,94,95,96,97,98,99,00,01,02
Orange County Water District		X		NO	YES	91,92,93,94,95

**TECHNOLOGY TRANSFER : COLLABORATIONS OVER HISTORY OF THE CBE**

Organization	Size of Organization			Foreign	Industrial Associate	Years as Industrial Associate
	Small <500	Medium 500-1000	Large >1000			
Osel		X		NO	NO	
Pacific Northwest National Labs (PNNL) (formerly Battelle)*			X	NO	YES	92,93,94,95,96,97,98
Philips Oral Healthcare, Inc.			X	NO	YES	02,03,04
Procter & Gamble Company			X	NO	YES	91,92,93,94,95,96,97,98,99,00
Reckitt Benckiser Inc.			X	NO	YES	01,02,03
Rohm & Haas Company			X	NO	YES	96,97,98
S.C. Johnson & Son (formerly S.C. Johnson Wax)			X	NO	YES	93,94,95,96,97,98,99,00,01,02,03,04
Sequoia Sciences°	X			NO	NO	
Shell Development Company			X	NO	NO	
Smith & Nephew, Inc.			X	NO	YES	03,04,05
SmithKline Beecham			X	NO	NO	
South Central Connecticut Regional Water Authority	X			NO	NO	
Southern Company Services Inc.		X		NO	YES	86,87,88,89,90,91,92
Southwest Regional Wound Care Center°	X			NO	NO	
Space Hardware Optimization Technology (SHOT)		X		NO	NO	
S.S. Papadopoulos & Associates, Inc.	X			NO	NO	
St. Jude			X	NO	NO	
Sulzer Carbomedics Inc.			X	NO	YES	98,99,00
Surmodics	X			NO	NO	
Swiss Federal Institute for Water Resources & Water Pollution Control		X		NO	NO	
Texaco			X	NO	YES	98,00,01,02
Tyco Healthcare (formerly Kendall Healthcare Products Company)			X	NO	YES	98,99,00,01,02,03,04,05
Unilever Research			X	YES	YES	92,93,94,95,98,99,00
Union Carbide Corporation			X	NO	YES	87,88,89,90,91,92,94,95,96,97,98,99,00,01,02,03,04
U.S. Army Research Office*			X	NO	NO	
U.S. Bureau of Reclamation*			X	NO	YES	98,99,00,01,02,03,04,05
U.S. Department of Agriculture*			X	NO	NO	
U.S. Department of Defense*			X	NO	NO	
U.S. Department of Energy*			X	NO	NO	
U.S. Department of the Interior*			X	NO	NO	
U.S. Department of the Navy*			X	NO	NO	
U.S. Filter/Everpure, Inc.			X	NO	YES	00
U.S. Geological Survey*		X		NO	NO	

**TECHNOLOGY TRANSFER : COLLABORATIONS OVER HISTORY OF THE CBE**

Organization	Size of Organization			Foreign	Industrial Associate	Years as Industrial Associate
	Small <500	Medium 500-1000	Large >1000			
U.S. National Park Service*			X	NO	NO	
University of New Mexico	X			NO	NO	
Unocal Corporation			X	NO	NO	
Vivendi Water			X	YES	YES	02,03
Warner-Lambert Company			X	NO	YES	99,00
Westinghouse Savannah River Company*			X	NO	YES	95,96,97,98,99,00,01,02
Westvaco			X	NO	YES	88,89,90,91,92,93,94,95
Weyerhaeuser			X	NO	YES	89,90
Wilson-Cook Medical GI Endoscopy			X	NO	NO	
W. L. Gore & Associates			X	NO	YES	97,98,99,00,01,02,03,04,05
Yellowstone Environmental Science, Inc.	X			NO	NO	

\*Indicates a Government Organization

°Indicates a Medical Biofilm Lab Collaborator

## TECHNOLOGY TRANSFER : FACULTY AND STAFF VISITS TO INDUSTRY

### Faculty and Staff Visits to Industry (June 1, 2004–May 31, 2005)

Date(s)	Name/Title	Corporation (Location)	Purpose of Visit
7/13/04	Randy Hiebert, Staff Research Engineer	Atmospheric Glow Technologies, Knoxville, TX	Randy visited with research personnel at Atmospheric Glow for a project meeting.
9/1/204	Marty Hamilton, CBE Professor, Statistics	Environmental Protection Agency (EPA), Antimicrobials Division, Office of Pesticide Programs, Arlington, VA	Marty was invited speaker and presented "Parallel Testing to Determine the Influence of Biofilm Growth Conditions on Antimicrobial Log Reduction: Preliminary Report." Marty also presented "A Laboratory Hot Tub Model: Engineering Design, Standard Operating Procedure, and Performance Characteristics."
9/10/04	Phil Stewart, CBE Deputy Director and Professor of Chemical Engineering	Ecolab, Mendota Heights, MN	Phil was invited to present "Center for Biofilm Engineering Overview and Biofilm Antimicrobial Tolerance."
11/10-11/12/04	Paul Sturman, CBE Industrial Coordinator	Shell Exploration and Production Company, New Orleans, LA	Paul visited with Bob Prince-Wright and John Walsh and discussed the souring work the CBE has done and how it could be applied to one of their oil fields.
11/17/04	Bill Costerton, CBE Professor Emeritus, Microbiology	National Science Foundation (NSF), Washington, DC	Bill was invited to present "Strategies for Survival After Graduation" as part of a Graduation Planning Workshop at the Engineering Research Centers (ERC) 2004 Annual Meeting.
12/1-12/3/04	Paul Sturman, CBE Industrial Coordinator	Procter & Gamble, Cincinnati, OH	Paul met with Benjamin Sierra, Tom Ward, Neil Lewis, Frank Backus, Don Flanagan, and James Kain of Procter & Gamble to discuss biofilm prevention in industrial water systems and CBE membership.
1/28/05	Linda Loetterle, CBE Research Specialist	W.L. Gore & Associates, Inc., Flagstaff, AZ	Linda went to Gore with Patrick Norris and met with researchers soliciting for Graduate Students into the Product Specialist role. Linda and Patrick also toured the facilities.
4/6-4/8/05	Phil Stewart, CBE Interim Director	Dow Biocides, Buffalo Grove, IL	Phil was invited by Dow (a CBE Industrial Associate Company) to present a seminar titled "Biocides and Biofilms."
4/11-4/12/05	Al Cunningham, CBE Professor, Civil Engineering	Transport, Inc., Billings, MT	Al went to Transport, Inc. to investigate groundwater contamination sites and develop a research proposal.

## TECHNOLOGY TRANSFER : FACULTY AND STAFF VISITS TO INDUSTRY

Date(s)	Name/Title	Corporation (Location)	Purpose of Visit
5/17/05	Al Cunningham, CBE Professor, Civil Engineering	Idaho National Laboratory (INL), Idaho Falls, ID	Al met with INL researchers for a research collaboration update. Al presented "The Center for Biofilm Engineering - Collaborative Opportunities in Energy & Environmental Research and Technology Development."
5/17/05	Robin Gerlach, CBE Research Engineer	Idaho National Laboratory (INL), Idaho Falls, ID	Robin met with INL researchers for a research collaboration update. Robin presented "Biotic and Abiotic Reductive Transformation of Heavy Metals, Chlorinated Aliphatics, and Nitroaromatics - Role of Bacteria, Biofilms, Iron Minerals, Temperature, Natural & Synthetic Organic Matter, and Mixed Contaminants."
5/18-5/25/05	Robin Gerlach, CBE Research Engineer	Army Research Office (ARO), Cashiers, NC	Robin visited with research personnel for the ARO Annual Project Meeting.
5/22-5/25/05	Anne Camper, CBE Associate Professor, Civil Engineering	Army Research Office (ARO), Cashiers, NC	Anne visited with research personnel for the ARO Annual Project Meeting.

**TECHNOLOGY TRANSFER : INDUSTRY & GOVERNMENT VISITS TO CBE**

**Industry and Government Visits to CBE**  
(June 1, 2004–May 31, 2005)

Date(s)	Name of Participant Corporation (Location)	Foreign Company		Description
		Yes	No	
6/29-7/1/04	Summer 2004 Technical Advisory Conference (TAC) had 44 participants, representing 32 different organizations.	X	X	Attended the Summer 2004 Technical Advisory Conference (TAC) at the CBE.
9/22-9/23/04	Jonathan Leder, Sarah McHattan, Michael Bullock, Michelle Arnold, James Luo, Greg DeLozier, Debbie Yaver, and Randy Deinhammer from Novozymes North America, Inc.		X	These individuals attended the Biofilm Methods Workshop and later became members of the Industrial Associate Program.
10/19/04	Roy Davis and David Moll, Dow Chemical, Midland, MI		X	Roy and David met with Paul Sturman to discuss collaboration and the Industrial Associate program.
10/30/04	Jim McHale and Zheng Chen, American Standard Co., Piscataway, NJ		X	Jim and Zheng attended a Biofilm Workshop at the CBE.
1/12-1/13/05	Suzanne South, Director of Biodevelopment and Alan Wintenberg, Director of Engineering from Atmospheric Glow Technologies, Knoxville, TX		X	Suzanne and Alan met with Garth James and the BBL group to discuss collaboration.
2/2/05	Bracha Limoni-Relis, Pini Littman, Guri Shaanan, and Erich Shaw from the Mekorot National Water Company, Ramla, Israel	X		Anne Camper met with these members of the Israeli water company Mekorot regarding water quality issues in their drinking water distribution system.
2/3-2/4/05	Winter 2005 Technical Advisory Conference (TAC) had 42 participants, representing 26 different organizations.	X	X	Attended the Winter 2005 Technical Advisory Conference (TAC) at the CBE.
2/18/05	Bob Strom and Michael Inbasekaran, Dow Chemical, Midland, MI		X	Bob and Michael visited with Paul Sturman and Anne Camper to discuss sponsored research and testing work for Dow.
5/11/05	John Magnani, GlycoMimetics, Inc., Gaithersburg, MD		X	John met with Garth James and his research team to discuss their research project. John also gave a seminar to the CBE titled: "Novel Therapeutic Approach for <i>Pseudomonas aeruginosa</i> Infection Using GlycoMimetics."

## OUTREACH : PRESENTATIONS

### PRESENTATIONS:

May 15, 2004–December 31, 2004

**Phil Stewart**, as invited speaker, presented “Multicellular Protection from Antimicrobial Agents in Biofilms,” Biocomplexity VI Conference, Bloomington, IN, May 15, 2004.

**Bill Costerton**, as invited speaker, presented “Biofilm—A New Perspective in Dialysis,” Symposium on Infection and Inflammation in Dialysis Patients sponsored by Gambro, Lisbon, Portugal, May 16, 2004.

**Bill Costerton**, as invited speaker, presented “Biofilms in Dental Disease,” USC School of Dentistry Board Retreat, Rancho Sante Fe, CA, May 21–23, 2004.

**Anne Camper** presented “Critical Issues for the Use of Chloramine vs. Free Chlorine in Controlling Distribution System Biofilm Problems,” IWA LET 2004 meeting, Prague, Czech Republic, June 2–4, 2004.

**Thomas Borch** presented “Iron (Hydr)Oxides and Electron Shuttles Govern the Fate of 2,4,6-Trinitrotoluene by a Soil Bacterium,” Goldschmidt Conference—Processes in Geochemistry, Copenhagen, Denmark, June 5–11, 2004.

**Zbigniew Lewandowski**, as invited speaker, presented a plenary lecture at *Biofilms: Their Structure, Activity, and Effect on Membrane Processes*, IWA Conference: Water Environment, Membrane Filtration, Seoul, Korea, June 7–9, 2004.

**Bill Costerton**, as invited speaker, made two presentations titled “*Pseudomonas* and Biofilms in CF” and “Bacterial Biofilms in Nature and Disease,” 27th European Cystic Fibrosis Conference, Birmingham, UK, June 13–16, 2004.

**Bill Costerton**, as invited speaker, presented “Biofilms: The Functional and Evolutionary Units by Which Microbes are Integrated into Natural and Pathogenic Ecosystems,” 10th International Symposium on Microbial Ecology (ISME-10), Cancun, Mexico, August 23–27, 2004.

**Marty Hamilton** presented “Sporicide Efficacy Testing: Statistical Analysis of the Collaborative Study” to the Interagency Expert Panel on Anthrax Test Methods and Surrogates, Ft. Meade, MD, August 31, 2004.

**Marty Hamilton** presented “Parallel Testing to Determine the Influence of Biofilm Growth Conditions on Antimicrobial Log Reduction: Preliminary Report,” Antimicrobials Division, Office of Pesticide Programs, USEPA, September 1, 2004.

**Marty Hamilton** presented “A Laboratory Hot Tub Model: Engineering Design, Standard Operating Procedure, and Performance Characteristics,” Antimicrobials Division, Office of Pesticide Programs, USEPA, September 1, 2004.

**Phil Stewart** presented “Center for Biofilm Engineering Overview and Biofilm Antimicrobial Tolerance,” Ecolab, Mendota Heights, MN, September 10, 2004.

**Joe Seymour**, as invited speaker, presented “Magnetic Resonance Microscopy of Scale Dependent Transport Phenomena in Bioreactors and Polymer Electrolyte Membranes,” 1st International Symposium on Micro- & Nano-scale Sensing Techniques for Energy and Bio System, Keio University, Yokohama, Japan, September 14, 2004.

**Justin Gage** presented “Biofilm Growth Induced Transformation of Porous Media Dynamics,” 4th Inland Northwest Research Alliance Environmental & Subsurface Science Symposium, Spokane, WA, September 20–22, 2004.

**Robin Gerlach** made two presentations: “Reductive Transformation of Cr(VI) and 2,4,6-Trinitrotoluene (TNT) in Batch and Flow Systems—Scale-up Considerations” and “Influence of Carbon Sources, Electron Shuttling Compounds, and Iron Minerals on the Reduction of Oxidized Contaminants,” 4th Inland Northwest Research Alliance Environmental & Subsurface Science Symposium, Spokane, WA, September 20–22, 2004.

**Mark McBroom** presented “A Molecular View of Microbial Communities Inhabiting Mine Tailings,” Inland Northwest Research Alliance Subsurface Science Symposium, Spokane, WA, September 20–22, 2004.

**Al Cunningham**, with Professor Rainer Helmig of the Universität Stuttgart, directed a short course titled “Multiphase Flow, Transport and Bioremediation in the Subsurface,” Institut für Wasserbau Universität Stuttgart, Stuttgart, Germany, September 21–25, 2004.

## OUTREACH : PRESENTATIONS

**Avinash Shantaram and Raaja Raajan Angathevar Veluchamy** presented a poster titled “Low Power Microcontroller-Based Potentiostat for Remote Metal Monitoring,” Peaks in Plating: Conference on Electrochemical Deposition for Microelectronics hosted by Semitool, Whitefish, MT, September 23, 2004.

**Marty Hamilton**, as invited speaker, presented “Standard Antibiofilm Disinfectant Test Methods,” AOAC Symposium on Disinfectant Test Methods, St. Louis, MO, September 23, 2004.

**Bill Costerton**, Pradeep Singh and Mike Gilmore presented a biofilm symposium, “Microbial Pathogenesis: Biofilms in Infections—Disease and Therapeutic Impact,” Annual Meeting of the Infectious Disease Society of America, Boston, MA, October 2, 2004.

**Bill Costerton and Patrick M. Norris** presented “New Methods for the Control of the Biofilms that Cause Device-Related Infections,” The 7th New Jersey Symposium on Biomaterials Science, New Brunswick, NJ, October 21, 2004.

International Water Association (IWA) **Biofilms 2004 Conference** in Las Vegas, NV on October 24–26, 2004. The Organizing Committee of this conference was: Zbigniew Lewandowski, Haluk Beyenal, Paul Sturman, Diane Williams and Susan Cooper, from the Center for Biofilm Engineering, and Eugene Cloete and Luis Melo from outside the CBE. There were several CBE presenters at this conference. **Zbigniew Lewandowski**, Conference Chair, presented the Introduction; **Enrico Marsili** presented “Immobilizing Uranium in Sulfate-Reducing Biofilms;” **Phil Stewart** presented “A 3D Model of Antimicrobial Action on Biofilms;” **Haluk Beyenal** presented “Image Structure Analyzer-2 (ISA-2) for Quantifying Biofilm Structure;” and **Suriani Abdul Rani** presented “Rapid Diffusion of Fluorescent Tracers into Biofilms Visualized by Time Lapse Microscopy.” There were also several CBE research poster presentations.

**Bill Costerton** presented “Biofilms: Historical Perspectives and Overview,” Association of Bone and Joint Surgeons: Carl T. Brighton Annual Workshop, Tampa, FL, November 11–14, 2004.

**Anne Camper**, as invited speaker, presented “Pathogenic Bacteria in Distribution Systems,” University of Aalborg, Aalborg, Denmark, November 11, 2004.

**Phil Stewart** presented “Penetration of Disinfectants into Biofilm,” American Water Works Association Water Quality Technology Conference, San Antonio, TX, November 14, 2004.

**Anne Camper**, as invited speaker, presented “Suspended versus Fixed Biomass: Effect of Disinfectants,” American Water Works Association Water Quality Technology Conference, San Antonio, TX, November 14, 2004.

**Bill Costerton** was invited by NSF members Court Lewis and Lynn Preston to present “Strategies for Survival after Graduation” as part of a Graduation Planning Workshop at the ERC 2004 Annual Meeting. Washington, D.C., November 17, 2004.

**Robin Gerlach** presented “Biofilm Growth Induced Transformation of Porous Media Dynamics,” at the Poster Presentation, 2004 American Geophysical Union Fall Meeting, San Francisco, CA, December 13–17, 2004.

**Robin Gerlach** presented “Use of Bioluminescence to Study Reactive Solute Transport and Biofilm Growth and Activity in Porous Media,” Platform Presentation at the 2004 American Geophysical Union Fall Meeting, San Francisco, CA, December 13–17, 2004.

### PRESENTATIONS: January 1–May 31, 2005

**Marty Hamilton** presented “Using a Minimum Anderson-Darling Discrepancy fit of a Three-Parameter Pareto Distribution to Estimate the Rate at Which Large Cell Clumps Detach from a Bacterial Biofilm,” Hawaii International Statistics Conference, Honolulu, HI, January 9–11, 2005.

**Anne Camper**, as invited speaker, gave two presentations: “Fundamentals of Bacterial Re-growth” and “Practical Implication of Disinfection for Controlling Re-growth,” American Water Works Association, South Carolina Branch, Greenville, SC, January 27, 2005.

**Linda Loetterle**, along with CBE interns **Andrew Anacker, Shannon Goeres, Alex Hilyard, David Stepler** and **Taylor Thomas**, presented posters at a research poster session for Montana legislators in Helena, MT, February 3, 2005.

## OUTREACH : PRESENTATIONS

**Linda Loetterle, Al Cunningham** and **Alex Hilyard** presented research posters at the Capitol Rotunda Poster Session in Helena, MT, February 9, 2005.

**Phil Stewart** presented “Sustainability Themes at the Center for Biofilm Engineering” EPSCoR University Research Leadership Retreat on Centers Development, Washington, DC, February 23, 2005.

**Phil Stewart** was the keynote speaker and presented “Undergraduate Researchers—Wow!” Undergraduate Scholars Conference, Montana State University, Bozeman, MT, March 30, 2005.

**Paul Sturman**, as an invited speaker, presented “Case Studies in Antimicrobial Efficacy in Industrially Relevant Biofilm Systems,” Society for Industrial Microbiology (SIM) Conference, Crystal City, VA, April 10–13, 2005.

**Al Cunningham**, as invited speaker, presented “Microbially Enhanced Geologic Sequestration of Supercritical CO<sub>2</sub>,” Fourth Annual Conference on Carbon Capture and Sequestration, Alexandria, VA, May 2–5, 2005.

## OUTREACH : WORKSHOPS

### CBE Workshops (June 1, 2004–May 31, 2005)

Date(s)	Name of Participant Corporation (Location)	Description
6/28/04	Basic Biofilm Methods and Research Overview	Paul Sturman, Coordinator of Industrial Development hosted this workshop at the CBE for Industrial participants.
6/28-7/16/04	NSF/DOE-sponsored Pan-American Advanced Studies Institutes (PASI) Program (Bozeman, MT)	The primary objective of this workshop is to familiarize students with techniques that allow microscale investigation of microbial biofilms. Several CBE personnel were instructors: Bill Costerton, Zbigniew Lewandowski, Anne Camper, Rick Veeh, Linda Loetterle and Ben Klayman.
7/22-7/23/04	Biofilm Structure Quantification and Image Analysis Workshop - CBE (Bozeman, MT)	Zbigniew Lewandowski and Haluk Beyenal held this workshop at the CBE.
8/9-8/12/04	Microsensors: Manufacture and Applications Workshop - CBE (Bozeman, MT)	Zbigniew Lewandowski and Haluk Beyenal held this workshop at the CBE.
9/22-9/23/04	Biofilm Methods Workshop for Novozymes North America, Inc. (Bozeman, MT)	Linda Loetterle organized and helped teach at this workshop for Novozymes, who eventually became Industrial Associate Members.
10/28-10/29/04	Indiana University School of Dentistry workshop on Oral Biofilm Techniques (Bozeman, MT)	Oral biofilm techniques, using flow cells and other basic biofilm research techniques.
10/30/04	American Standard Biofilm Workshop (Bozeman, MT)	Linda Loetterle organized and helped teach at this workshop for American Standard.
2/2/05	Biofilm Methods Workshop - CBE (Bozeman, MT)	Both basic and advanced biofilm techniques are covered, taught by instructors who are actively engaged in biofilm research.

## **OUTREACH : MEDIA COVERAGE**

### ***Biophotonics International***

A cool confocal picture created from the CBE's new equipment and software made the cover (and inside article) of this journal, illustrating just how compelling microscope images can be. Recent Control Lab undergraduate Amber Harrer, Phil Stewart and Betsey Pitts collected the image on a Leica confocal scanning laser microscope. The article, "Dealing with Bacterial Attachments," describes how photonics is helping scientists understand and remove biofilms. *Biophotonics International* presents the latest global developments and techniques to the leaders in fields from cardiology to neurosurgery, from pharmaceuticals to animal science, and from agriculture to cell biology. It has a circulation of 33,000.

Dealing with Bacterial Attachments  
by Hank Hogan, contributing editor  
*Biophotonics International* August 2004; 11(8):48-50

### ***Horizon Air Magazine***

The development of the CDC Biofilm Reactor was featured as one of the most promising prospects of state supported research projects. A commercialization grant made it possible for BioSurface Technologies Corp. and the CBE to develop a biofilm reactor based on a design by the Centers for Disease Control and Prevention in Atlanta. The biofilm reactor is responsible for more than 10 percent of the total sales made by BioSurface Technologies, the only licensed manufacturer of this product. Since this article was written, the reactor has been accepted for review by the American Society for Testing and Materials, and if approved, it may become a standard tool used by agencies such as the FDA and the EPA.

Promising Prospects  
by Mary Pat Murphy  
*Horizon Air Magazine* July 2004; M7

### **Television Production**

Sara Shier, a former MSU Film and TV Masters student, produced a film titled "Fighting for Life: Emelia's Story" that is aired on Montana PBS Tuesday, May 19, 2005 at 7:30 p.m. and repeated Monday, May 23, 2005 at 11:30 a.m. Emelia, a young girl with cystic fibrosis, endures many treatments to control her symptoms. Her story also takes viewers to the MSU Center for Biofilm Engineering, where scientists work to understand bacteria in a new way—as multi-cellular organisms—in order to better treat some of the complications of Emelia's disease.

Produced by Sara Shier for TERRA. Distributed by KUSM/MontanaPBS, MSU Bozeman.  
TERRA: <http://www.montanapbs.org/Terra/episode103/>

### **Bioglyphs continue to capture attention and pique curiosity**

*BioTechniques*: The International Journal of Life Science Methods (circulation of 85,000) published an article, "Living Canvas," about the CBE web site's artistic bioglyph images. The article praises Bioglyphs as "the most unusual amalgams of art and biology to be found."

Living Canvas  
by Kevin Ahern  
*BioTechniques* January 2005; Vol 38(1):21

See full article at: <http://www.erc.montana.edu/Res-Lib99-SW/newsarchives/HTML/2005/BioTechniques.htm>

## OUTREACH : COMMUNITY

### Community Outreach (June 1, 2004–May 31, 2005)

Date(s)	Organization/Event	Description
6/04	Montana Apprenticeship Program (MAP), Bozeman, MT	Shannon Goeres was a MAP mentor for a high school girl. The MAP program lasted for 6 weeks.
7/04	NSF/DOE-sponsored Pan-American Advanced Studies Institutes (PASI) Program Participants toured Bozeman Water Treatment Plant, Bozeman, MT	Rick Veeh and Warren Jones took PASI program participants on a tour of the Bozeman Water Treatment Plant as part of their research education.
9/23/04	Home School Network, Bozeman, MT	Ben Klayman gave a lecture to the Home School Network (~65 kids) about engineering. This was followed by a tour of the CBE labs, and a look under the microscope at some bacteria.
10/04	Science Classes of Rachael Chiariello and Gustin Guyer at Chief Joseph Middle School, Bozeman, MT	Cindy Morris lectured four classes about bacteria on plants and their role in plant disease, frost and rainfall. She also gave a demonstration of bacterial ice nucleation activity.
11/04	Montana Science Olympiad, Bozeman, MT	Joseph Menicucci and Zbigniew Lewandowski's lab volunteered their space and time for the Montana Science Olympiad. The event name was Science Crime Busters. About 60 seventh and eighth graders participated in this event.
11/04	Women in Science and Engineering (WISE), Bozeman, MT	Joseph Menicucci worked on an event directed by Sarah Codd in which middle school-aged girls had the opportunity to operate a fluidized bed and to put a plastic coating on the handle of a fork. Approximately 36 students attended this workshop.
11/10/04	Senior Members of Local Businesses, Bozeman, MT	More than 20 owners and senior members of local businesses toured the CBE as part of an ongoing internship program with the Bozeman Chamber of Commerce.
3/05	Gallatin Valley Ladies Gardening Club, Bozeman, MT	Cindy Morris gave a lecture about the history and origin of some common vegetables.
3/2/05	Montana Legislators, Helena, MT	Linda Loetterle, along with CBE interns Andrew Anacker, Shannon Goeres, Alex Hilyard, David Steppler and Taylor Thomas, presented posters at a research poster session for Montana Legislators.
3/9/05	Capitol Rotunda Poster Session for Montana Legislators, Helena, MT	Linda Loetterle, Al Cunningham, and Alex Hilyard presented research posters.
3/30/05	Undergraduate Scholars Conference, Montana State University, Bozeman, MT	Phil Stewart was the keynote speaker at this conference to recognize students who participate in the Undergraduate Scholars Program (USP). Phil presented "Undergraduate Researchers – Wow!"

## OUTREACH : COMMUNITY

Date(s)	Organization/Event	Description
4/05	Belgrade Intermediate School Career Fair, Belgrade, MT	Joseph Menicucci talked with students about being a scientist. About 20 students attended his presentation.
4/8/05	Joliet High School, Joliet, MT	Ben Klayman went to Joliet High School to talk to freshman-senior students in chemistry, physics and earth science classes about his research and research in general at the CBE.
4/16/05	Middle school girls from the community attended the Horizons Workshop - CBE, Bozeman, MT	Linda Loetterle and Anne Camper organized and taught this workshop to young middle school girls to encourage career paths in math and science.

## PEOPLE : FACULTY

Name	Department	Specialty
Haluk Beyenal	Chemical & Biological Engineering	Biochemical engineering
Anne Camper	Civil Engineering	Biofilms in environmental systems
Ross Carlson	Chemical & Biological Engineering	Metabolic engineering, metabolic network analysis
Sarah Codd	Chemical & Biological Engineering	Magnetic resonance imaging
Bill Costerton	Microbiology	Biofilms in microbial pathogenicity
Al Cunningham	Civil Engineering	Subsurface biotechnology and bioremediation
David Dickensheets	Electrical & Computer Engineering	MEMs, confocal microscopy
Jack Dockery	Mathematical Science	Mathematical models of biofilms
Tim Ford	Microbiology	Drinking water, public health microbiology, pollutant fate and transport
Michael Franklin	Microbiology	Molecular genetics, gene expression, alginate biosynthesis
Gill Geesey	Microbiology	Molecular and cellular interactions at interfaces
Marty Hamilton	Statistics	Applied biostatistical thinking
Warren Jones	Civil Engineering	Water distribution systems
Isaac Klapper	Mathematical Science	Mathematical modeling
Zbigniew Lewandowski	Civil Engineering	Microsensors, chemical gradients, biofilm structure, hydrodynamics
Tom Livinghouse	Chemistry & Biochemistry	Organic synthesis, signaling analogues
Timothy McDermott	Land Resources & Environmental Sciences	Biofilms in extreme environments
Bruce McLeod	Electrical & Computer Engineering	Bioelectric effect
Barry Pyle	Microbiology	Environmental, water & food microbiology
Rocky Ross	Computer Science	Web-based, active learning education; design and analysis of algorithms for practical problems; information technology
Joseph Seymour	Chemical & Biological Engineering	Magnetic resonance imaging
Otto Stein	Civil Engineering	Engineered waste remediation
Phil Stewart	Chemical & Biological Engineering	Biofilm control strategies
Paul Stoodley	Microbiology	Biofilm mechanics, cell-cell communication
Paul Sturman	Civil Engineering	Biofilms in waste remediation and industrial systems
Peter Suci	Microbiology	Biofilm mechanics
Brett Towler	Civil Engineering	Biofilm mechanics
Rick Veeh	Land Resources & Environmental Sciences	Bacterial identification using oligonucleotide probes
Aleksandra Vinogradov	Mechanical & Industrial Engineering	Biofilm mechanics

## PEOPLE : VISITING RESEARCHERS

### CBE Visitors (June 1, 2004–May 31, 2005)

Name	Sex	Institution	Country	Dates at CBE	Title	Description
Agostinho, Alessandra Marçal	F	University of São Paulo	Brazil	3/21/05-2/28/06	Visiting Scientist/Ph.D. Candidate, Dentistry-Prosthodontics	Alessandra is working with Paul Sturman and Anne Camper on a SBIR concerning the antimicrobial efficacy of mixed oxidants in prevention of dental water line contamination.
Aktas, Nahit	M	Yuzinci Yil University	Turkey	8/1/04-1/20/05	Visiting Faculty, Chemical Engineering	Nahit worked with Zbigniew Lewandowski on microbial fuel cells.
Behnke, Sabrina	F	University of Duisburg-Essen	Germany	4/5/05-7/31/05	Visiting Student, Undergraduate in Microbiology	Sabrina is working with Anne Camper on "Biofilms in Drinking Water" as directed by Dr. Hans-Curt Flemming at the University of Duisburg-Essen.
Deligianni, Elena	F	University of Ulster	Ireland	10/4/04-1/31/05	Visiting Student, Ph.D. Candidate, Microbiology	Elena worked with Phil Stewart on <i>Pseudomonas aeruginosa</i> clinical isolates from cystic fibrosis patients.
Demir, Goksel	M	Istanbul University	Turkey	1/20/05-8/28/05	Visiting Scientist, Environmental Engineering	Goksel is working with Zbigniew Lewandowski on microbial fuel cells.
Fux, Christoph	M	University Hospital, Bern, Switzerland	Switzerland	1/1/03-7/31/04	Visiting Scientist, MD	Christoph is an M.D. specializing in Internal Medicine and Infectious Disease. His project at the CBE was supported by the Swiss National Science Foundation and concentrates on the development of an <i>in vitro</i> biofilm model for the study of pneumococcal nasopharyngeal colonization.

## PEOPLE : VISITING RESEARCHERS

Name	Sex	Institution	Country	Dates at CBE	Title	Description
Hozalski, Ray	M	University of Minnesota	USA	11/8/04-7/15/05	Visiting Faculty, Environmental Engineering	Ray is on sabbatical from the University of Minnesota and is working with Anne Camper's group. His research involves biofilms in water distribution systems and rheological properties of biofilms.
Jacobs, Albert	M	Lyon 1 University, Unité de Microbiologie et Génétique	France	4/1/04-6/30/04	Visiting Scientist/Ph.D. Candidate	Albert worked with Phil Stewart on biofilm research and confocal microscopy. He constructed reporter strains in <i>E. coli</i> and grew them in biofilms to investigate spatial patterns of activity.
Lennox, John	M	Penn State University - Altoona	USA	6/1/04-6/30/04	Visiting Faculty, Professor Emeritus, Microbiology	John collaborated on education initiatives with the CBE and Dept. of Computer Science.
Maczek, Volker	M	University of Duisburg	Germany	4/16/04-8/16/04	Visiting Student, MS Student in Microbiology	Volker worked with Anne Camper on the detachment of biofilms in response to enzyme treatment.
Mandahar, Nishma	F	University of Duisburg	Germany	8/1/04-12/31/04	Visiting Student, Undergraduate in Microbiology	Nishma worked with Anne Camper's group on the attachment of bacteria to porous media particles.
Marsili, Enrico	M	University of Rome "La Sapienza"	Italy	3/1/03-10/31/04	Visiting Scientist/Ph.D. Candidate, Chemical Engineering of the Environment	Enrico worked with Zbigniew Lewandowski and his research team on the study of biofilm systems, including reactors from uranium bioremediation and microbial fuel cells.
Morris, Cindy	F	Institut National de la Recherche Agronomique (INRA), Avignon	France	8/9/04-8/9/05	Visiting Faculty, Plant Science & Plant Pathology	Cindy is on sabbatical from INRA and is working with Anne Camper and Dave Sands on aerial dissemination of bacterial biofilms from plant surfaces.

## PEOPLE : VISITING RESEARCHERS

Name	Sex	Institution	Country	Dates at CBE	Title	Description
Peyton, Brent	M	Washington State University	USA	8/30/04-12/10/04	Associate Professor, Chemical Engineering	Brent spent a sabbatical here at the CBE. He worked with Gill Geesey to characterize microbial communities from alkaline hot springs in Yellowstone, and with Robin Gerlach to screen these cultures for the ability to transform renewable biomass compounds and degrade hazardous contaminants.
Richard, Jessica	F	University of Duisburg-Essen	Germany	4/5/05-7/31/05	Visiting Student, Undergraduate in Microbiology	Jessica is working with Anne Camper on "Biofilms in Drinking Water" as directed by Dr. Hans-Curt Flemming at the University of Duisburg-Essen.
Russo, Patrizia	F	La Sapienza University, Rome	Italy	11/4/04-11/5/04	Visiting Student	Patrizia worked with Rick Veeh and Patrick Norris to learn about confocal and epifluorescence microscopy, primarily as it applies to studying the colonization of contact lenses by gfp-strains of various bacterial species.
Sharma, Deepak	M	University of Ottawa	Canada	1/27/05-11/30/05	Visiting Scientist, Chemical Engineering	Deepak is working with Zbigniew Lewandowski on using the CSLM in order to understand the structure of biofilm formation in rock apparatus.
Syron, Eoin	M	University College, Dublin	Ireland	11/01/04 - 11/05/04	Visiting Research Scholar	Eoin worked with Phil Stewart on membrane bioreactors.
Wittstock, Bastian	M	Universität Stuttgart	Germany	10/28/03-9/30/04	Visiting Student/Intern for Bachelors Degree in Civil Engineering	Bastian worked with Al Cunningham on a bioremediation project—a gasoline contaminated site—located in Ronan, MT, trying to evaluate past efforts and suggesting ways to enhance the gasoline degradation.

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Name	Sex	Institution	Country	Dates at CBE	Title	Description
Xavier, Joao	M	Delft University of Technology	The Netherlands	1/11/05-4/31/05	Visiting Scientist, Chemical & Biological Engineering	Joao worked with Phil Stewart on a mathematical model of biofilm dynamics.
Yeon, Kyung-Min	M	Seoul National University	Korea	3/1/05-10/1/05	Visiting Scientist, Chemical Engineering	Kyung-Min is working with Zbigniew Lewandowski's research group.