

**MICROBIAL DIVERSITY: a Summer Course at the Marine Biological Laboratory,  
Woods Hole, MA**

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"Microbial Diversity" is an intensive 6.5-week lecture and laboratory-based course designed for graduate students, postdoctoral fellows and established investigators. The value of the course lies in its historical success in training scientists to recognize and take advantage of the incredible metabolic diversity of microbes as a means of generating fundamental and applied knowledge. Over the years, this internationally recognized course has trained many of today's leading microbiologists and is commonly cited as a "life-changing" event by course participants.

The Microbial Diversity course takes advantage of the diverse natural environments found near Woods Hole: microbial mats in salt water marshes, anaerobic communities in freshwater bogs, pelagic and benthic communities in marine ecosystems, and the many marine animals and plants that harbor microbial symbionts. The sheer magnitude of this natural diversity provides ample opportunities for participants with minor or extensive prior experience in microbiology to discover and study novel microbes. Participants learn both classical and contemporary methods to isolate and cultivate microbes, including anaerobes and the primary producers in many environments - photosynthetic microbes.

**Progress in the last year.** The Microbial Diversity 2003 course at the Marine Biological Laboratory took place from June 15 to August 1, 2003. The nineteen students who comprised the course included 11 from American institutions, as well as students from Israel, Switzerland, Germany, Peru and Denmark. One of the students is a faculty member at the University of Cincinnati. In addition, seventeen students are doctoral students with one student a master's degree candidate. There are 9 men and 10 women. A list of the students and their affiliations and as well as lists of the Microbial Diversity course faculty, staff and lecturers is attached. The resident faculty were the co-directors of the course: Caroline Harwood (University of Iowa) and Alfred Spormann (Stanford University) as well as Jane Gibson from Cornell University and

Terrance Marsh from Michigan State University. An excellent staff of six graduate students and postdoctoral fellows assisted the faculty. Tom Schmidt of Michigan State University served as the Course Director designee. In 2004 he and William Metcalf of the University of Illinois will begin their term as the new Course Directors, continuing the rich tradition of excellence in this course.

The students, faculty and staff worked and studied intensively for six-and-a-half-weeks. Our common aim was to become competent in microbiological techniques for working with a broad range of microbes, and in approaches for recognizing the metabolic, phylogenetic and genomic diversity of cultivated and as yet uncultivated bacteria.

The students isolated and cultivated characteristic microbial types from various marine, fresh water, animal, and plant habitats and they initiated individual research projects with selected isolates. Emphasis was placed on the isolation and cultivation of organisms that are distinguished by their physiological, biochemical, and morphological properties. Techniques for cultivation of strict anaerobes were particularly emphasized. Examples of some of the microbial types that the students isolated are methanogens, acetogens, sulfate-reducing anaerobes, fermentative anaerobes and phototrophs, as well as bacteria involved in the geochemical cycling of various metals. Magnetic bacteria, sulfur-oxidizing bacteria, spirochetes and luminescent-bacteria were also studied.

We also investigated strategies that microbes use to compete successfully in nature. Bacterial biofilms, chemotaxis and quorum sensing were studied. A laboratory component on molecular approaches to microbial diversity instructed students to use approaches of molecular phylogeny and comparative genomics. This involved the isolation and amplification of 16S rRNA genes as phylogenetic markers and the use of computer software programs to analyze nucleic acid sequences and to construct phylogenetic trees. We also included a laboratory exercise on fluorescent in-situ hybridization (FISH).

The laboratory component was complemented by an extensive series of lectures describing the physiology, biochemistry, and evolutionary relationships of a variety of bacteria. We also discussed molecular methods to study microbial ecology. Lectures on microbial phylogeny and genomics were also given. The course hosted 21 visiting lecturers, 7 of whom spoke in three minisymposia. For 2003, these minisymposia covered the topics of: "Bacterial Communication", "Microbial Communities", and "Microbial Evolution". In previous years, these minisymposia covered the topics of: "Microbial Communities", "Bacterial Methane Production and Utilization" and "Cyanobacterial Genomics".

Formal laboratory exercises occupy most of the students' research time during the first three weeks and then taper off as they start their own research projects. Attached to this report is a listing of the student projects undertaken during the summers of 2001 – 2003.

The following table reflects the diversity of the applicant pool and the student body. Also included with this report is a listing of the faculty from the years 2001 – 2003.

**Table 1: Diversity of the applicant pool and student body**

Year	APPLICANTS				ADMITTED			
	Female	Male	Minority	Foreign	Female	Male	Minority	Foreign
2003	19	17	1	16	10	9	0	8
2002	23	22	2	22	10	10	1	8
2001	21	19	1	18	8	12	1	8
<b>TOTALS</b>	63	58	4	56	28	31	2	24

For the years 2000 – 2003, admitted students represented the following countries: Argentina, Australia, Belgium, Canada, Colombia, Denmark, Germany, India, Israel, Peru, Russia, Singapore, Switzerland, Taiwan and the UK.

Applications were received from students from the following countries: Argentina, Australia, Belgium, Brazil, Canada, Chile, Columbia, Cyprus, Denmark, Finland, Germany, Ghana, India, Israel, Italy, Kenya, Mexico, Netherlands, Nigeria, Peru, PR China, Romania, Russia, Singapore, Spain, Taiwan and the UK.

### 1) Microbial Diversity Class Lists

#### 2003

Anderson, Christine, Scripps Institution of Oceanography  
 Cadillo-Quiroz, Hinsby, Cornell University  
 Costello, Elizabeth, University of Colorado at Boulder  
 Daprato, Rebecca, Rice University  
 DeAngelis, Kristen, University of California, Berkeley  
 Dubinsky, Eric, University of California  
 Gescher, Johannes, Universität Freiburg  
 Lever, Mark, University of North Carolina, Chapel Hill  
 Martens-Habbena, Willm, University of Oldenburg  
 McCarren, Jay, Scripps Institution of Oceanography  
 Oerther, Daniel, University of Cincinnati  
 Petersen, Dorthe, Goteborg University  
 Poretsky, Rachel, The University of Georgia  
 Sudek, Sebastian, Scripps Institution of Oceanography  
 Teitzel, Gail, Northwestern University  
 Tobler, Nicole, EAWAG/ETH

#### 2002

Boucher, Yan, Dalhousie University  
 Case, Rebecca, University of New South Wales  
 Clement, Barbara, Doane College

Denef, Vincent, Ghent University  
Dethlefsen, Les, Michigan State University  
Dick, Gregory, Scripps Institution of Oceanography  
Erbs, Marianne, EAWAG  
Gentile, Margaret, Stanford University  
Ginder-Vogel, Matthew, Stanford University  
Graco, Michelle, University of Pierre et Marie Curie  
Harrison, Faith, University of Iowa  
Koren, Omry, Tel Aviv University  
Lostroh, Phoebe, University of Iowa College of Medicine  
Maresca, Julie, Pennsylvania State University  
Pinel, Nicolas, University of Washington  
Rajagopal, Soumitra, University of Nebraska  
Remold Susanna, Michigan State University  
Sharp, Katherine, Scripps Institution of Oceanography  
Spain, Jim, United States Air Force  
Walker, Jeffrey, University of Colorado

## **2001**

Baumgartner, Laura, University of Connecticut  
Behrens, Sebastian, Max-Planck-Institute for Marine Microbiology  
Coby, Aaron, Indiana University  
Fleming, Erich, University of Oregon  
Gerlach, Robin, Montana State University  
Giegerich, Jennifer, Pennsylvania State University  
Harris, Jonathan, University of Colorado, Boulder  
Hughes, Jennifer, Brown University  
Kellogg, Laurie, University of Notre Dame  
Kelman, Dovi, Tel Aviv University  
Lim, Grace, Scripps Institution of Oceanography  
Lupp, Claudia, University of Hawaii  
Martiny, Adam, Technical University of Denmark  
Pilcher, Carl, National Aeronautics & Space Administration Headquarters  
Rash, Brian, Louisiana State University  
Reed, Andrew, Rutgers University  
Riemann, Lasse, Scripps Institution of Oceanography  
Robidart, Julie, Scripps Institution of Oceanography  
Schuster, Martin, University of Iowa  
Whitaker, Rachel, University of California, Berkeley

## **2) Microbial Diversity Course Faculty and Staff**

### **2003**

#### **Course Directors**

Harwood, Caroline, University of Iowa  
Schmidt, Tom, Michigan State University  
Spormann, Alfred, Stanford University

#### **Course Faculty & Lecturers**

Bassler, Bonnie, Princeton University  
Behrens, Sebastian, MPI for Marine Microbiology

Chisholm, Penny, Massachusetts Institute of Technology  
Edwards, Katrina, Woods Hole Oceanographic Institute  
Gibson, Jane, Cornell University (Emerita)  
Handelsman, Jo, University of Wisconsin  
Harrison, Faith, University of Iowa  
Kappler, Andreas, California Institute of Technology  
Leadbetter, Jared, California Institute of Technology  
Lory, Stephen, Harvard Medical School  
Lovley, Derek, University of Massachusetts  
Marsh, Terence, Michigan State University  
Martiny, Adam, BioCentrum-DTU  
McCarter, Linda, University of Iowa  
McFall-Ngai, Margaret, University of Hawaii  
Moran, Mary Ann, University of Georgia  
Mueller, Jochen, Stanford University  
OToole, George, Dartmouth Medical School  
Pace, Norm, University of Colorado  
Ruby, Edward, University of Hawaii  
Sockett, Liz, University of Nottingham  
Wade, Brian, Arizona State University  
Waterbury, John B, Woods Hole Oceanographic Institution  
Wolfe, Ralph, University of Illinois (Emeritus)

## 2002

### **Course Directors**

Harwood, Caroline, University of Iowa  
Spormann, Alfred, Stanford University

### **Course Faculty & Lecturers**

Behrens, Sebastian, MPI for Marine Microbiology  
Boetius, Antje, MPI fur Marine Mikrobiologie  
Breznak, John, Michigan State University  
Buckley, Daniel, University of Connecticut  
DeLong, Edward, Monterey Bay Aquarium  
Elhai, Jeff, Virginia Commonwealth Univ.  
Gibson, Jane, Cornell University (emerita)  
Giovannoni, Stephen, Oregon State University  
Gottschalk, Gerhard, Inst. fur Mikrobiologie u Genet  
Handelsman, Jo, University of Wisconsin  
Larimer, Frank, Oak Ridge National Laboratory  
Lory, Stephen, Harvard Medical School  
Loveley, Derek, University of Massachusetts  
Marsh, Terence, Michigan State University  
Martiny, Adam, BioCentrum - DTU  
Meeks, John, University of California  
Metcalf, William, University of Illinois  
Mueller, Jochen, Stanford University  
Rocap, Gabrielle, University of Washington  
Schaefer, Amy, University of Iowa  
Strous, Marc, University of Nymegen  
Thauer, Rudolf, MPI fur Terrestr. Mikro

Wackett, Lawrence, University of Minnesota  
Wolfe, Ralph, University of Illinois

## 2001

### Course Directors

Harwood, Caroline, University of Iowa  
Spormann, Alfred, Stanford University

### Course Faculty & Lecturers

Armitage, Judith, University of Oxford  
Brahamsha, Bianca, University of California, San Diego  
Buckley, Daniel, University of Connecticut  
DeLong, Edward, Monterey Bay Aquarium Research Institute  
Ditty, Jayna, Texas A&M University  
Forney, Larry, University of Idaho  
Gerlt, John A., University of Illinois  
Gibson, Jane, Professor Emeritus  
Golden, Susan, Texas A&M University  
Golden, James W., Texas A&M University  
Larimer, Frank W., Oak Ridge National Laboratory  
LaRossa, Robert, E.I. Du Pont de Nemours and Company  
Lory, Steve, Harvard Medical School  
Lovley, Derek, University of Massachusetts  
Margulis, Lynn, University of Massachusetts  
Mueller, Jochen, Stanford University  
Palenik, Brian, University of California, San Diego  
Pelletier, Dale, Stanford University  
Schaefer, Amy, University of Iowa  
Schmidt, Thomas, Michigan State University  
Weinstock, George, Baylor College of Medicine

## 3) Microbial Diversity Class Projects

### 2003

**Kristen DeAngelis**, University of California

Quorum Scencing or Do bacteria exist that can chemotax towards acyl-homoserine lactones?

**Rebecca C. Daprato**, Rice University

A Tale of Two (Anaerobic Mixed Halorespiring) Cultures: Who's There?

**Eric Dubinsky**, University of California

Isolation of Fe(III)-reducing Aeromonas species from a freshwater marsh in Woods Hole, MA

**Daniel B. Oerther**, University of Cincinnati

Molecular Evidence for a Novel Lineage of Ammonia Oxidizing Beta-subclass Proteobacteria

**Sybille Zitzmann**, MPJMM, Bremen, Germany

Initial Biofilm Formation

**Jay McCarren**, Scripps Inst. Of Oceanography  
Investigating the effect of motility on bacterial predation by a heterotrophic nanoflagellate

**Elizabeth Costello**, University of Colorado  
Stalking the Wild Crenarchaeote: A fluorescence in-situ hybridization (FISH) microscopic search

**Helen K. White**, Woods Hole Oceanographic Inst.  
Investigations into the Persistence of Petroleum Contamination in Marsh Sediments and the Associated Microbial Community

**Gil Zeidner**, Technion, Haifa, Israel  
Dynamics of microbial community in the marine sponge *Holichondria* sp.

**Sebastian Sudek**, Scripps Inst. Of Oceanography  
The Berries - revisited

**Hinsby Cadillo-Quiroz**, Cornell University  
Vertical distribution of aerobic CH<sub>4</sub> consumption in cedar swamp soil: NH<sub>4</sub> implications.

**Johannes Gescher**, Frieburg University  
Comparison of the abundance of the different benzoate degradation pathways and short stories about enrichments on Isopropanol, Mandelonitrile, and Boc-Methionine

**Gail M. Teitzel**, Northwestern University  
Community structure: environmental biofilms and purple non-sulfur bacteria

**Dorthe Groth Petersen**, Nat'l Environmental Research Inst., Denmark  
Competition between two isolates of marine p-hydroxybenzoate degrading bacteria

**Rachel S. Poretsky**, The University of Georgia  
Finding a niche: The habits and habitats of purple non-sulfur bacteria

**Christine Anderson**, Scripps Inst. Of Oceanography  
Isolation, Growth and Investigation of the Bacterial Epibiont of the Heterocysts of an *Anabaena* sp.

**Nicole Tobler**, EAWAG, Switzerland  
Iron Reduction in Freshwater and Saltwater Environments

**Willm Martens-Habbena**, University of Oldenburg  
Novel attempts to cultivate abundant microbes from marine surface water at Buzzards Bay, Woods Hole, MA

**Mark Lever**, University of North Carolina  
Cultivation Experiments with Anaerobic Anoxygenic Phototrophic Iron Oxidizing Bacteria

## 2002

**Yan Boucher**, Dalhousie University

**Rebecca Case**, University of South Wales

**Vincent Denef**, Ghent University  
The quest for Daptobacter

**Barbara Clement**, Doane College  
**Michelle Graco**, University of Pierre et Marie Curie  
**Nick Pinel**, University of Washington  
No bug is an island : the messy business of working with co-cultures

**Les Dethlefsen**, Michigan State University  
Discoveries and observations among the purple nonsulfur bacteria

**Gregory Dick**, Scripps Institution of Oceanography  
Molecular tracking of iron and manganese-reducing enrichments

**Marianne Erbs**, EAWAG  
**Jim Spain**, United States Air Force  
Iron metabolism in natural environments

**Margy Gentile**, Stanford University  
The green berries

**Koty Sharp**, Scripps Institution of Oceanography  
The purple berries

**Matt Grinder-Vogel**, Stanford University  
**Omry Koren**, Tel Aviv University  
Community structure: from the environment to the lab.

**Phoebe Lostroh**, University of Iowa College of Medicine  
DNA eaters

**Faith Harrison**, University of Iowa  
Chemotaxis in Clostridia

**Julie Maresca**, Pennsylvania State University  
**Jeff Walker**, University of Colorado  
Aerobic anoxygenic phototrophs: photon pirates of the sea.

**Sumit Rajagopal**, University of Nebraska  
ClpB as an environmental monitor.

**Susie Remold**, Michigan State University  
Triclosan resistance in environmental isolates.

**2001**

**Laura Baumgartner**, University of Connecticut  
Metabolic interactions between a purple sulfur bacterium and a facultative anaerobe

**Sebastian Behrens**, MPI for Marine Microbiology, Bremen Germany  
Characterization of community structure and composition of microbial biofilms forming a trickling filter bioreactor.

**Aaron Coby**, Indiana University  
Heavy metal tolerant bacteria as bioindicators of metal contamination

**Erich Fleming**, University of Oregon  
The effects of saturating levels of ammonia and nitrate on the recovery of a microbial mat from a common physical disturbance.

**Robin Gerlach**, Montana State University  
Attempted enrichment of Cr(III) oxidizing bacteria

**Jen Giegerich**, Penn State Univ.  
Attempt to gain information on the host-associated spirochete *Cristispira*.

**Kirk Harris**, University of Colorado  
Microscopic analysis of sulfate reducing bacterial consortia.

**Jen Hughes**, Brown University  
Formation of biofilms by purple nonsulfur bacteria

**Laurie Kellogg**, University of Notre Dame  
What not to do: or, how I learned to love microbiology.

**Dovi Kelman**, Tel Aviv University  
Phylogenetic diversity of bacteria and archaea associated with the marine sponge, *Suberites ficus*.

**Grace Lim**, Scripps Institute of Oceanography  
Acyl homoserine lactone degrading marine bacteria: do they exist?

**Claudia Lupp**, University of Hawaii  
Phages from Sippewissett salt marsh.

**Adam Martiny**, Technical University of Denmark  
Metabolic interactions between a purple sulfur bacterium and a facultative anaerobe

**Carl Pilcher**, NASA  
Iron metabolism in bacterial iron formations.

**Brian Rash**, University of Louisiana  
Phylogenetic analysis of spirochetes in the Woods Hole area

**Drew Reed**, Rutgers University  
Survey of  $\alpha$  and  $\beta$  chitin degrading marine bacteria and archaea from selected sites

**Lasse Riemann**, University of Copenhagen  
Cultivability of marine pelagic bacteria under aerobic and anaerobic conditions.

**Julie Robidart**, Scripps Institute of Oceanography  
Sulfate reduction in Sippewissett salt marsh: the oxic vs anoxic zone.

**Martin Schuster**, University of Iowa

Search for unusual chemolithotrophic life styles: oxidation of inorganic sulfur compounds coupled to manganese oxidation *AND Growth cycle and ixotrophy by Saprospira grandis.*

**Rachel Whitaker**, University of California, Berkeley

Formation of biofilms by purple nonsulfur bacteria.

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