**SUMMER INVESTIGATIONS INTO THE METABOLIC
DIVERSITY OF THE MICROBIAL WORLD**

Progress Report
for the period May 5, 1992 through April 30, 1993

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Marine Biological Laboratory
Woods Hole, MA 02543

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MASTER

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1992 COURSE REPORT

MICROBIAL DIVERSITY

Co-Directors: John A. Breznak, Michigan State University.
: Martin Dworkin, University of Minnesota

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I. Objectives of the Course

A. Philosophy

The philosophy of the course is to underscore the essence of microbiology which is diversity: diversity of morphology and cellular development, behavior, and metabolic and physiological functions. Emphasis is on microbes other than those customarily covered in conventional microbiology courses and includes: the archaebacteria, extremophiles, an array of obligate anaerobes, various phototrophs, and those microbes exhibiting complex developmental cycles. Also included are microbes carrying out a variety of transformations of organic and inorganic compounds, as well as those which normally occur in symbiotic association with other microbes or with higher forms of life.

Inasmuch as the course emphasizes nature as a tremendous reservoir of microbial diversity, a special effort is made to exploit the array of terrestrial, freshwater and marine habitats in the vicinity of Woods Hole as the source of microbes to be isolated in the laboratory portion of the course. Additional samples from unusual habitats (eg. deep sea hydrothermal vent areas; deep subsurface cores) are obtained from other investigators. Subsequent to isolation, experiments are designed to examine some of the unique biochemical and physiological properties of the organisms in pure culture and, where appropriate, when placed in defined co-culture with other microbes. To accomplish this, students are taught various techniques for cultivation of microorganisms (including the "Hungate technique" for strict anaerobes), as well as various methods for observing and studying the isolated microbes (phase contrast, fluorescence, and DIC microscopy; gas-liquid and high performance liquid chromatography; spectroscopy; PCR methodology and gel electrophoresis; etc.). Such knowledge is then integrated, during the 2nd half of the course, into the pursuit of independent research projects which are developed by the students in consultation with the instructional staff.

B. History and Tradition

The course was originally developed by Holger Jannasch and Harlyn Halvorson at Woods Hole in the early 1970's. Patterned after the famous van Niel course taught at the Hopkins Marine Station in Pacific Grove, California, the course is an intensive six-and-a-half week offering intended to emphasize and explore the tremendous metabolic, morphologic, and behavioral diversity that exists in the microbial world, but which is often overlooked or underemphasized in conventional microbiology courses. Indeed, it is intended that the concept of the incredible and almost unlimited diversity of microbes emerges as a dominant theme.

Traditionally, students in the course have come from all over the world, and have ranged from graduate students to university professors, as well as researchers in government laboratories and private industry. Undergraduates have also been admitted to the course, but they have been few in number. The students are a highly select group that includes microbiologists and individuals for whom a better understanding of microbial diversity is important, eg. marine biologists, biochemists, geneticists, molecular biologists, biotechnologists, etc. It has also been

a tradition that the position of Course Director (or Co-Director) is one that turns over approximately every 5 years. This provides for both a period of continuity and development, as well as fresh perspective and further evolution every 5 years. As a consequence of the excellent and dedicated instructional staff, as well as of the quality of the students, the course has evolved into one of the finest of its type in the world.

C. Training Goals

The training goals of the course are two-fold. The first is to teach students (via lectures, mini-symposia, etc.) about the diversity of organisms that constitute the microbial world. In so doing, it is hoped to demonstrate that the great strength of microbiology lies in the wealth of microbial types that may be exploited for basic and applied research. The second goal is to train students in the classical, as well as newly developed, strategies for enrichment, isolation, and laboratory investigation of diverse microorganisms from nature, including strict anaerobes and other organisms for which somewhat specialized culture and/or experimental techniques are necessary (eg. obligate syntrophs, symbionts).

II. Course Organization

A. Instructional Staff

The resident instructional staff for 1992 included the course co-directors (Breznak & Dworkin); an invited faculty member (Prof. Howard Gest, Indiana Univ., who participated for 10 days); course coordinator (offsite: Dr. Pamela R. Contag, Stanford Univ.; on-site: Richard Behmlander, Univ. Minn.); 2 postdoctoral teaching assistants (Dr. Joseph Calabrese, West Virginia Univ. & Dr. Jörg Overmann, U. British Columbia); and 2 graduate teaching assistants (Courtney Frasch and Dan Smith; both of Univ. Minnesota).

The responsibility of the course co-directors is to define the scope and format of the course, to participate in lecture and laboratory instruction, to recruit other instructional staff and invited lecturers where necessary and appropriate, and to participate in the acquisition of funding for the course. The course coordinator helps to coordinate the day-to-day activities of the students; supervises teaching assistants and the dishwasher; solves logistical problems associated with field trips; assists in making travel/lodging/meals arrangements for invited speakers; and expedites the acquisition of equipment and supplies. [This year the course-coordinator responsibilities were shared between Dr. Contag (who helped off-site in preparation and material procurement prior to the start of the course) and Mr. Behmlander (who helped with off-site preparations and on-site management)]. Teaching assistants function primarily in laboratory instruction of students and in assuring that necessary materials are prepared, gathered, and/or otherwise made ready for the laboratory portion of the course. The course coordinator(s) and postdoctoral TA's may also present lectures upon invitation by the co-directors. Full names and addresses of the 1992 instructional staff are included in Appendix I.

The non-resident instructional staff includes those individuals who are invited to present one or more guest lectures. These include scientists affiliated with the MBL or WHOI, as well as others who may be available owing to other commitments in the vicinity of Woods Hole. A list of the non-resident instructors and their contribution to the 1992 course is included in the lecture schedule (Appendix II).

B. Instructional Format

The instructional format for the course consists of four principal components: lectures, laboratory experiments, review sessions and mini-symposia.

B.1 Lectures: 52 Lectures were presented as part of the 1992 course. A list of lecture topics and lecturers is presented in Appendix II.

B.2 Laboratory: Laboratory exercises are presented in two phases.

The first phase (lasting approximately 2-3 weeks) consists of formal laboratory experiments and group rotations to familiarize students with the fundamental techniques of enrichment, isolation and cultivation of microorganisms. After isolation of microbes in pure culture, some of the

major biochemical, physiological, and morphological properties of the organisms are examined in experiments in which are also integrated instructions on the use of relevant analytical equipment, eg. gas chromatographs, video microscopes, HPLC, recording spectrophotometer, etc. A list of formal laboratory exercises presented in 1992 is given in **Appendix III**. The purpose of this phase is to provide students with the fundamental knowledge and technical skills that facilitate the execution of their independent research projects.

The second phase (continuing through the remainder of the course) consists of **student independent projects**. In this phase, the initiation, design, and execution of experiments is largely the responsibility of the students, although the instructional staff provides advice on feasibility of experimental design and discusses with the students the interpretation of experimental results. Students are encouraged to initiate two independent projects: one that is relatively easy and has a more-or-less sure chance for success in the time available; and one that is more challenging with perhaps a debatable chance of success. Although some students come to the course with an independent project in mind, the instructional staff also suggests a variety of projects of varying degrees of difficulty from which the students may also select. All students are expected to submit a short report of their results, and these reports are bound and kept on file in the course reading room/library for future reference. A list of student independent projects in 1992 (with summaries of results) is given in **Appendix VI**.

B.3 Review Sessions: Once a week, a review session is held in which the progress of laboratory experiments is discussed and their success is evaluated. A special effort is made to re-emphasize the principles of the laboratory experiments in progress; to discuss, interpret, and compare results; and to troubleshoot any problems. The entire instructional staff is expected to be present at such review sessions, which are moderated by one of the teaching assistants (with responsibility being rotated each week).

B.4 Mini-Symposia: The purpose of the mini-symposia is two-fold. The first is to provide participants in the course with new knowledge - knowledge at the "cutting edge" of a particular research area - by experts in the field. The second purpose is to allow students to have extended, personal contact with some of the most distinguished scientists in the world. Through such contact, students acquire a sense of how research areas are developed and advanced, and how successful investigators attack a research problem.

Four mini-symposia were presented as part of the 1992 course. Themes of the mini-symposia were: **Bacterial Aggregation & Multicellularity; Determination of Cell Shape; Extremophiles; and Bacteria-Plant Interactions**. Usually, mini-symposia are held on Saturday mornings and consist of 3 presentations by distinguished researchers in the field. After lunch with the students, speakers return to the laboratory for informal discussion with the students. This is continued, with refreshments, after dinner in an informal atmosphere. A list of mini-symposia, speakers, and lecture titles is presented in **Appendix IV**.

(cont.)

C. Students (Recruitment, Applicant Review, Admission)

The course is normally limited to 20 total students (primarily, but not exclusively, graduate students, postdoctoral fellows, and independent investigators) and restricted to those who will benefit from this unique experience and who are prepared to undertake a rigorous program. The limitation to 20 students is based on past experience and is considered to be optimal for the number of instructors and facilities and supplies available.

Applicants are reviewed by an admissions committee composed of two or more scientists selected by the MBL who conduct a preliminary evaluation, followed by the course co-directors, who make a final recommendation for admission. The composition of admissions committees must be approved by the Director of the MBL. This year the admissions committee consisted of (aside from the course co-directors): Drs. Holger Jannasch & Paul Dunlap, WHOI; and Prof. Richard P. Blakemore, U. New Hampshire. A working member of the admissions committee must disqualify himself/herself from voting on any application submitted by a student or member of his/her own department, or of any other department of the same institution with which he/she has working relationships during the academic year. Students are admitted to the microbiology course on the basis of their academic records (eg. grade point average and GRE scores for graduate students), demonstrated research ability and originality, recommendations, and stated career goals. For some applicants (eg. college or university faculty members, or Ph.D.-level researchers in industry) a *curriculum vitae* may be submitted in lieu of academic transcripts and GRE scores. Students are advised that the required two letters of recommendation accompanying each application should not come from faculty members of the microbiology course.

The MBL has an active program for recruitment and support of underrepresented minorities in science and these applicants are identified during the application procedure. All applications and advertisements state clearly that "the MBL is an EEO Affirmative Action Institution". Moreover, one fellowship for a woman or other underrepresented minority is made available from the outreach/education program of the NSF-Sponsored Center for Microbial Ecology at Michigan State University, of which one of the course co-directors (Breznak) is a member.

A list of students who participated in the 1992 course is presented in Appendix V.

D. Contact Hours

A typical day consists of 2 x 1h lectures (with time for special announcements and a short break) in the morning followed by laboratory work in the afternoon and into the evening. This is modified on days when mini-symposia are held, and on Sundays when no formal lectures are given. In the second half of the course, lectures begin to taper off as more effort is devoted to independent research projects. As all instructional staff are generally present during lectures and are available during laboratory work, the contact hours for the instructional staff amount to about 60-70 hours per week per staff member.

E. Other Attendees

Since course lecture schedules are posted in the MBL, anyone in the Woods Hole scientific community may attend the lectures. Those individuals who do attend are usually investigators or students affiliated with the MBL or WHOI, although no sign-up sheet is circulated and no record is kept. Nevertheless, casual observations and recollections suggest that perhaps 1-4 individuals not formally affiliated with the course attend lectures.

III. Description of the Course

A. Lectures: As stated above, the intended function of lectures is to educate students in microbial diversity. Accordingly, lectures seek to provide students with the most up-to-date information on the diversity of morphologic, physiologic, metabolic, behavioral and developmental properties of a wide variety of organisms representative of the microbial world. Lectures also underscore the importance of microbes in various ecological habitats and indicate why certain microbial activities (eg. photosynthesis, anaerobic fermentations, inorganic oxidations and reductions, etc.) are absolutely essential for continued life in our biosphere. Notwithstanding our current knowledge of microbial diversity, a particular effort is made to emphasize that perhaps only 10-15% of the microbial world is currently represented in culture and understood, and that Nature holds a vast treasure of organisms from which we still have much to learn. Therefore, an additional function of lectures is to indicate how various, diverse microbes can serve as important models to answer fundamental questions in biology (eg. sensory phenomena; mechanisms of cell differentiation) and to solve practical problems (eg. detoxification of environmental pollutants; conversion of biomass to food, fuels, or chemical feedstocks).

B. Laboratory: The organization and intended function of laboratories is presented above in item II.B. A list of laboratory exercises and independent projects is presented in Appendix III and VI, respectively.

Appendix I. 1992 Resident Instructional Staff

Dr. John A. Breznak, Co-Director	Department of Microbiology Michigan State University East Lansing, Michigan 48824-1101
Dr. Martin Dworkin, Co-Director	} Department of Microbiology Medical School Box 196 UMHC University of Minnesota Minneapolis, MN 55455-0312
Richard Behmlander, Course Coordinator	
S. Courtney Frasch, Graduate TA	
Dan Smith, Graduate TA	
Dr. Joseph Calabrese, Postdoctoral TA	Dept. of Plant Pathology & Environmental Microbiology West Virginia University Morgantown, WV 26506-6057
Dr. Jörg Overmann, Postdoctoral TA	Dept. of Microbiology University of British Columbia Vancouver, V6T 1Z3 B.C.
Dr. Pamela R. Contag, Course Coordinator (off-site)	Dept. of Microbiology & Immunology Stanford University School of Medicine Stanford, California 94305-5402

Appendix II. Lecture Schedule for 1992 MBL Summer Course

MICROBIAL DIVERSITY

[Unless indicated otherwise, lectures were held in Loeb 208 at 8:30 am and 10:00 am, with a break period from 9:30-10:00.]

<u>Lect.</u>	<u>Topic</u>	<u>Lecturer</u>
1	Introduction/Theory of Enrichment Culture	Dworkin
2	Nutrition & Cultivation of Microbes	Breznak
3 (12:15 pm)	Ecology of the Great Sippewissett Salt Marsh	Goehring*
4 (2:00 pm)	Field Trip to the Great Sippewissett Salt Marsh	Goehring*
5&6 (Candle House)	Introduction to Woods Hole & tour of the <i>Atlantis II</i> R/V & DSRV <i>Alvin</i>	Jannasch*
7	Natures Mixed Cultures: Biochemical & Genetic Inter- actions	Dworkin
8	Microbial Motility & Tactic Phenomena	Dworkin
9	Gliding Motility	Leadbetter*
10	Flagellar Motors	Khan*
11	Anaerobic Microbial Food Webs: Fermenters I	Breznak
12	Biogeochemistry of the Great Sippewissett Salt Marsh	Howe*
(Candle House) Mini-Symposium I: Bacterial Aggregation & Multicellularity		Invited Speakers
13	Anaerobic Food Webs: Fermenters II	Breznak
14	Anaerobic Food Webs: Methanogens	Breznak
15 (eve)	: Sulfate & Sulfur-Reducing Bacteria	Breznak
16	: Acetogens & "Obligate" Syntrophs	Breznak
17 (Candle House)	Microbiology of Deep-Sea Hydrothermal Vents	Jannasch*
18-21	Anoxygenic Photosynthesis and Phototrophs	Gest*
22&23	Microbial Evolution & Phylogeny	Woese*
24(pm)	Optical Trapping in Microbiology & Cell Biology	Block*
25	Hyperthermophiles	Stetter*
(Candle House) Mini-Symposium II: Determination of Cell Shape		Invited Speakers
26&27	Ecology of Anoxygenic Phototrophs	Gest*
28&29	Oxygenic Photosynthesis & Phototrophs: Cyanobacteria	Waterbury*

(cont.)

<u>Lect.</u>	<u>Topic</u>	<u>Lecturer</u>
30&31	Thermodynamics & Interspecies H ₂ Transfer	Goodwin*
32-35	Prokaryotic Development (Series includes General Principles; Endospores; <i>Caulobacter</i> ; <i>Anabaena</i> ; Myxobacteria; and the Actinomycetes)	Dworkin
36	Dinitrogen Fixation: <i>Rhizobium</i> & <i>Azotobacter</i>	Dworkin
37	: Biochemistry	Breznak
38&39	Luminescent Bacteria	Dunlap*
40	Ecology of Phototrophic Sulfur Bacteria in Inland Waters	Overmann
41	Halophily & Halophiles	Breznak
42	Phototrophic Bacteria	Madigan*
(Candle House) Mini-Symposium III: Extremophiles		Invited Speakers
43	Cellulose: Biosynthesis	Breznak
44	: Degradation	Breznak
45&46	Origins of Life	Sogin*
47	Spirochetes	Breznak
48	Eukaryotic-Prokaryotic Motility Symbioses	Tamm*
49	Chemoautotrophic Symbionts of Marine Invertebrates	Cavanaugh*
50&51	Construction & Use of Fluorescent Oligonucleotide Probes to Analyze Mixed Microbial Populations	Nierzwicki-Bauer*
52	Energetic Aspects of Methanogenic Syntrophy	Schink*
(Candle House) Mini-Symposium IV: Bacteria-Plant Interactions		Invited Speakers

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*Guest lecture by non-resident instructor, of the following affiliation:

B. Howe, P. Dunlap, D. Goehring, H. Jannasch and J. Waterbury: WHOI
H. Gest: Indiana University
K. Stetter: Univ. of Regensburg, FRG.
S. Nierzwicki-Bauer: Rennselear Polytech.
B. Schink: Univ. Konstanz, FRG
M. Sogin and S. Tamm: MBL
S. Block: Rowland Institute, Worcester, MA.
E. R. Leadbetter: U. Conn
C. Cavanaugh: Harvard Univ.
C. Woese: Univ. of Illinois
S. Goodwin: Univ. Massachusetts
M. Madigan: Southern Illinois University

Appendix III. Laboratory Exercises for the 1991 MBL Summer Course

MICROBIAL DIVERSITY

[Note: Instructor(s) primarily responsible for the exercise is given in parentheses]

<u>Date</u>	<u>Laboratory Exercise</u>
6/15 Noon	Principles & Purposes of the Laboratory Exercises (Dworkin/Breznak)
12:15 pm	Ecology of the Great Sippewissett Salt Marsh (Goehringer)
2:00 pm	Field Trip to the Great Sippewissett Salt Marsh (Goehringer)
7:30 pm	Microscopy Lecture and Lab Rotations on Microscopes (Overmann)
6/16	Tour of the <i>Atlantis II</i> Research Vessel & DSRV <i>Alvin</i> (Jannasch)
	Introduction to Anaerobic Techniques (Breznak)
	Enrichment & Isolation of Lactic Acid Bacteria and Clostridia (Breznak/Smith)
(eve)	The "Volta Experiment" (all)
6/17	Field Trip to School Street Marsh and Oyster Pond (Breznak & TA's)
	Enrichment & Isolation of Methanogens and CO ₂ -Reducing Acetogens (Breznak/Frasch)
	Beer Brewing (Dworkin/Behmlander/Frasch)
6/18	Enrichment & Isolation of Sulfate-Reducers (Breznak/Smith)
6/19	Enrichment & Isolation of Sulfur and Nonsulfur Phototrophs (Dworkin/Overmann)
6/22	Enrichment & Isolation of <i>Beggiatoa</i> and <i>Gallionella</i> (Dworkin/Calabrese)
	Nitrogen-Fixing Bacteria: Isolation of <i>Azotobacter</i> (Dworkin/Frasch)
	Operation of Anaerobic Glove Boxes (Breznak/Calabrese)
6/23	Enrichment & Isolation of <i>Caulobacter</i> and Myxobacteria (Dworkin/Frasch/Smith/Behmlander)
	Introduction to Analytical Techniques (Breznak/Calabrese/Frasch)
6/24	Flex Day - Examine experiments in progress; transfer cultures as necessary; make relevant observations and measurements (all)
6/25	Enrichment & Isolation of Cyanobacteria (Waterbury)
6/26	Isolation of Spirochetes (Breznak/Overmann)
	Video Microscopy (Behmlander)
6/29	Magnetotactic Bacteria (Dworkin/Calabrese)
	Isolation of <i>Bdellovibrio</i> (Dworkin/Calabrese)
(eve)	Discussion of Student Independent Research Projects (all)
6/30	Enrichment/Isolation/Observation of Cyanobacteria (Waterbury/Smith)

(cont.)

<u>Date</u>	<u>Laboratory Exercise</u>
7/1	Examination of Termite Hindgut Microbial Community (Breznak/Calabrese) Spectroscopy Rotation (Overmann) (eve) Students Clarify, Revise, and Initiate Independent Projects (all)
7/2	Flex Day (all) (eve) Students Clarify, Revise, and Initiate Independent Projects (all)
7/3	Isolation of Marine Luminescent Bacteria (Dunlap/Overmann)
7/6-30	Students Finish Formal Laboratory Experiments and Independent Research Projects (all)
7/20	Use of Fluorescent Oligonucleotide Probes for Examining Microbial Communities (Nierzwicki-Bauer/Smith)
7/29-30	Student Presentations of Results of Independent Projects (all)

Appendix IV. Mini-Symposia (topics & speakers)

June 20

I. Bacterial Aggregation & Multicellularity

Potential Role of Multigeneric Coaggregation in the Colonization of Human
Oral Surfaces

Paul E. Kolenbrander - NIH, Bethesda, MD.

Chemical Signals and Cell-Cell Interactions in Pheromone-Induced Conjugation
Gary Dunny - University of Minnesota

James Shapiro - University of Chicago
The Significance of Bacterial colony Patterns

June 27

II. Determination of Cell Shape

Bacterial Shapes and the Forces that Mould Them
Arthur Koch - Indiana University

From Morphogenes to Morphogenesis
Frank M. Harold - Colorado State University

Surface Growth During the Bacterial Division Cycle and the Determination of
the Shape of Rod-Shaped Bacteria
Stephan Cooper - University of Michigan

July 11

III. Extremophiles

Adaptation to Life in Extremely Alkaline Environments
Terry Ann Krulwich - Mt. Sinai School of Medicine

Life Without Liquid Water
Imre Friedman - Florida State University

New Phototrophs from Extreme Environments
Michael Madigan - Southern Illinois University

July 25

IV. Bacteria - Plant Interactions

Biological Interactions in the Symbiotic Association Between the Hornwort
Anthoceros punctatus and Cyanobacteria *Nostoc* spp.
John C. Meeks - University of California at Davis

Beneficial Dinitrogen Fixation Associations with Higher Plants
Frank B. Dazzo - Michigan State University

Appendix V. Students in the 1992 Course: Microbial Diversity

Bernan, Valerie S.	Lederle Labs 205/407 N. Middletown Rd. Pearl River. New York 10965
Byrnes, Jennifer L.	Engineering Sciences Laboratory Harvard University Cambridge, MA. 02138
Canganella, Francesco	Dept. of Agrobiology & Agrochemistry University of Tuscia Viterbo 01100 Italy
Childers, Susan E.	Dept. of Molecular & Cell Biology University of Connecticut Storrs, CT 06269
Ganeva, Maria S.	Department of Biology Sofia University Sofia 1421 Bulgaria
Gibson, John A.	Department of Oceanography Florida State University Tallahassee, FL 32306-3048
Hofmeister, Antje E.	Department of Microbiology Philipps-University-Marburg 3550 Marburg. Germany
Kroken, Scott	Botany Department University of Wisconsin Madison, WI 53706
Kusmaro, Ariel	Dept. of Microbiology & Biotechnology Tel Aviv University Ramat Aviv, Israel
Miambi, Edouard	Lab. of Microbiology & Biotechnology Centre ORSTOM Brazzaville. Republic of Congo
Miroshnichenko, Maragarita L.	Institute of Microbiology Russia Academy of Sciences 117811 Moscow, Russia
Nielsen, Tommy H.	Department of Microbiology Aarhus University 8000 Aarhus C., Denmark
Olendzenski, Lorraine C.	Department of Botany University of Massachusetts Amherst, MA 01003

Polz, Martin F.	The Biological Laboratories Harvard University Cambridge, MA 02138
Renner, Michael J.	Department of Microbiology Michigan State University East Lansing, MI 48824-1101
Rusterholtz, Karl J.	Merck, Sharp & Dohme Research Labs. Rahway, NJ 07065
Sandmeier, Heinrich	Dept. of Preventative Dentistry & Oral Microbiology Dental Institute University of Basel Basel 4051, Switzerland
Schüler, Dirk	Abt. für Membranbiochemie Max-Planck-Institut für Biochemie D-8033 Martinsried, Germany
Seitz, Angelica P.	Dept. of Molecular & Cell Biology University of Connecticut Storrs, CT 06269-2131
Shannon, Robert D.	School of Public & Environmental Affairs Indiana University Bloomington, IN 47405

Appendix VI. Student Independent Projects

(List, followed by abstracts. Complete reports on file in course library/reading room).

Bernan, Valerie S.

- Screening for bioactive compounds from class enrichments.
- Isolation of a marine bacterial consortium involved in the production of a bioactive compound.

Byrnes, Jennifer

- Aerobic methane oxidation.
- Anaerobic methane oxidation.

Canganella, Francesco

- Enrichment and study of *Chlorochromatium* consortia.
- Search for thermophilic CO-utilizing anaerobic bacteria.

Childers, Susan E.

- Enrichment of sulfate-reducing bacteria from termite guts.
- Biological reduction of phosphate to phosphine.

Ganeva, Maria

- Degradation of aromatic compounds coupled to sulfate reduction.

Gibson, John A. E.

- Isolation of moderately halophilic bacteria from oceanic, marsh and lacustrine environments.
- Isolation of bacteria capable of using coenzyme M.

Hofmeister, Antje E. M.

- Enrichment, isolation and study of cAMP-degrading bacteria from the marine environment.

Kroken, Scott

- The proposed existence of temperate climate epiphytic microbes which can metabolize biogenic isoprene as a sole carbon and energy source.

Kusmaro, Ariel

- The bacterial flora of *Aplysia californica* gut.

Miambi, Edouard

- Isolation of pleurocapsalean cyanobacteria from Woods Hole habitats.
- Determination of heterotrophic capacities of cyanobacteria; *Microcoleus*, *Phormidium* and *Prochlorothrix*.

Miroshnichenko, Margarita

- Isolation of thermophilic, acetate-oxidizing eubacteria from mixed culture.

Nielsen, Tommy H.

- Enrichment for acetogenic bacteria from hydrothermal vents.
- Anaerobic parasitic bacteria.

(cont.)

Olendzenski, Lorraine

- (with D. Schüler) Magnetotactic bacteria from School St. marsh and Oyster Pond, Woods Hole, MA.

Polz, Martin

- Search for an anaerobic, marine PHB fermenter.

Renner, Michael J.

- Characterization of spirochetes from the hindgut of *Reticulitermes flavipes*.
- Enrichment procedure for purple non-sulfur bacteria using two-dimensional pH and NaCl gradients with unique carbon sources.

Rusterholtz, Karl J.

- Enrichment for stalked bacteria at the air-water interface.
- Enrichment of *Spirochaeta plicatilis* for microculture study.

Sandmeier, Heinrich

- Attempts to enrich *Cristispira* from mollusk styles.

Schüler, Dirk

- The enrichment and isolation of dissimilatory iron-reducing bacteria from marine and freshwater sediments.
- (with L. Olendzenski) Magnetotactic bacteria from School St. marsh and Oyster Pond, Woods Hole, MA.

Seitz, Angelica

- Purple berries found in Sippewissett Marsh.

Shannon, Robert D.

- The enrichment and isolation of marine bdellovibrios.
- The degradation of syringate via methanethiol and dimethyl sulfide to methane.

Marine Biological Laboratory
Woods Hole, MA

Microbial Diversity
June 14 - July 30, 1992
Faculty

John Breznak, Course Director
Michigan State University

Martin Dworkin, Course Director
University of Minnesota

Howard Gest, Faculty
Indiana University

Richard Behmlander, Course Coordinator
University of Minnesota

Joseph Calabrese, Teaching Assistant
University of West Virginia

Jorg Overmann, Teaching Assistant
University of British Columbia, Canada

Courtney Frasc, Teaching Assistant
University of Minnesota

Daniel Smith, Teaching Assistant
University of Minnesota

Guest Lecturers:

Steve Block, Rowland Institute for Science

Colleen Cavanaugh, Harvard University

Paul Dunlap, Woods Hole Oceanographic Institution

Dale Gehringer, Woods Hole Oceanographic Institution

Steve Goodwin, University of Massachusetts

Brian Howe, Woods Hole Oceanographic Institution

Holger Jannasch, Woods Hole Oceanographic Institution

Shahid Khan, Albert Einstein School of Medicine

Edward Leadbetter, University of Connecticut

Michael Madigan, University of Southern Illinois

Sandra Nierzwicki-Bauer, Rensselaer Polytechnic Institute

Bernhard Schink, University of Konstanz, Germany

Mitchell Sogin, Marine Biological Laboratory

Karl Stetter, University of Regensburg

Sidney Tamm, Marine Biological Laboratory

John Waterbury, Woods Hole Oceanographic Institution

Carl Woese, University of Illinois

Marine Biological Laboratory
Microbial Diversity
June 14 - July 30, 1992
Accepted Students

Student:		Institutional Affiliation:
Bernan, Valerie	Postdoc	Lederle Laboratories
Byrnes, Jennifer L.	Graduate	Harvard University
Canganella, Francesco	Faculty	University of Tuscia, Italy
Childers, Susan E.	Graduate	University of Connecticut
Ganeva, Maria	Post Doctoral	Sofia University, Bulgaria
Gibson, John A.	Graduate	Florida State University
Hofmeister, Antje E.	Graduate	Philipps-University, Marburg, Germany
Kroken, Scott B.	Graduate	University of Wisconsin, Madison
Kusmaro, Ariel	Graduate	Tel Aviv University, ISRAEL
Miambi, Edouard	Post Doctoral	Center ORSTOM/DGRST, Congo
Miroshnichenko, Margarita L.	Post Doctoral	Moscow State University
Nielson, Tommy H.	None listed	Aarhus University, Denmark
Olendzenski, Lorraine C.	Graduate	University of Massachusetts, Amherst
Polz, Martin F.	Graduate	Harvard University
Renner, Michael J.	Graduate	Michigan State University
Rusterholtz, Karl J.		Merck Sharp & Dohme Research Laboratories
Sandmeier, Heninrich	Post Doctoral	University of Basel, Switzerland
Schuler, Dirk	Graduate	Max-Planck-Institut, Germany
Seitz, Angelica P.	Graduate	University of Connecticut, Storrs
Shannon, Robert D.	Graduate	Indiana University

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