One Hundred and Third Report
for the Year 2000
One Hundred and Twelfth Year

Officers of the Corporation

Sheldon J. Segal, Chairman of the Board of Trustees
Frederick Bay, Co-Vice Chair
Mary J. Greer, Co-Vice Chair
John E. Dowling, President of the Corporation
John E. Burris, Director and Chief Executive Officer
William T. Speck, Interim Director and Chief Executive Officer
Mary B. Conrad, Treasurer
Robert E. Mainer, Clerk of the Corporation
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It is with great pleasure that I write this report as the Marine Biological Laboratory’s newest Director and Chief Executive Officer. My relationship with the MBL has grown and expanded in rewarding and exciting ways during the past twenty-five years. I am now pleased to have the opportunity to serve as Director of this esteemed Laboratory. I first came to the MBL as a student and then returned as an investigator for several summers. My role expanded when I was elected to the Laboratory’s Board of Trustees in 1994, and again when I joined the Discovery Campaign Steering Committee. In 1999, I succeeded Mel Cunningham as Chair of the Development Committee. Since being appointed Interim Director upon John Burris’s departure in the summer of 2000, I’ve had a wonderful opportunity to view the inner workings of this remarkable institution.

I think it’s fair to say that the Marine Biological Laboratory is stronger and healthier both financially and programmatically than it has ever been in its history. In this report, I’ll review what has led us to this point, share with you some highlights from the year 2000, and discuss where the Trustees and I see the Laboratory going in the next few years.

**The Discovery Campaign**

The Marine Biological Laboratory concluded its first comprehensive fundraising campaign—Discovery: The Campaign for Science at the Marine Biological Laboratory—in December 2000. Our goal was to raise $25 million for a variety of initiatives at the MBL. When we began planning for the campaign, some felt that this goal was a stretch for the institution. Thanks to the generosity of thousands of Trustees, Corporation Members, Associates, Alumni, Staff Members, Foundations, and Friends of the Laboratory, the MBL far surpassed that goal, raising more than $41 million by the end of the year 2000 in support of research, education, the library and physical plant, and the annual fund.

Funds raised through the Discovery Campaign have already had a major impact on the Laboratory’s educational and research programs. One of the most obvious achievements of the Campaign is the construction of the C. V. Starr Environmental Sciences Building, which will become the new home of The Ecosystems Center in 2001. Thanks to the Campaign we also established the Josephine Bay Paul Center for Comparative Molecular Biology and Evolution and hired two new assistant scientists there (Michael Cummings and Jennifer Wernegreen); added five new summer courses and the Semester in Environmental Sciences Program for undergraduates to our education roster; created more than a dozen endowed scholarships for students and endowed fellowships for young researchers; established a program in scientific aquaculture in the Marine Resources Center; endowed the director’s chair of the Marine Resources Center; and expanded our public outreach efforts through the creation of the Robert W. Pierce Visitors Center.

In addition, we raised funds to support endowed lectureships for the summer courses and an annual lecture in Bioethics starting in the summer of 2001, and to help shore up the Laboratory’s aging physical plant. Moreover, we received gifts to permanently endow the maintenance of the Waterfront Park and the Pierce Visitors Center. Finally, thanks to gifts to the Discovery Campaign, the Library has been air-conditioned and the Crane House on Millfield Street has been refurbished and added to our year-round housing inventory.

**Physical Plant**

We’ve also been able to tackle some other long-overdue maintenance projects on campus. For example, the crumbling section of seawall near the Lillie Building has been reconstructed. By the summer of 2001, the Brick Dormitory will have been renovated and furnished for year-round use. Cottages at Memorial Circle have been updated and de-ledged, and we have begun renovations at Devils Lane. The research laboratories in the Lillie Building are being renovated to accommodate expanding
year-round research programs in the Bay Paul Center, BioCurrents Research Center, and Architectural Dynamics in Living Cells Program. We’ve also added fresh paint and carpeting to the Meigs Room, and have begun painting and replacing lighting and other fixtures throughout the Swope Building.

Our plans also include renovating summer research laboratories in the Whitman Building. We expect to begin modestly renovating the Homestead building, which, once vacated by the staff of The Ecosystems Center, will eventually become home to the administrative offices of Financial Services, Education, Human Resources, and The Biological Bulletin.

The Biological Bulletin

The Marine Biological Laboratory’s journal, The Biological Bulletin, celebrated a major milestone in 2000. Edited by Michael J. Greenberg of the University of Florida’s Whitney Laboratory, the journal has been publishing peer-reviewed articles of general biological interest for more than 100 years. During the summer of 2001 the journal will launch a new initiative by publishing articles electronically with HighWire Press of Stanford University.

Education

During the summer of 2000, the MBL’s Educational Program offered a record 22 summer and special topics courses. Three hundred and thirty-five course directors and faculty members taught 490 advanced graduate and postdoctoral students in the courses last summer. An additional 315 guest lecturers and instructors participated in the courses as well. From all accounts, the quality of our students improves every year.

We offered a symposium on the history of biology and a workshop in microbial diversity designed for middle

and high school teachers. Last summer brought quite a few undergraduates to the MBL as well, through a variety of Research Experience for Undergraduate Programs. One program focused on Marine Models, another was coordinated by the Boston University Marine Program, and others were offered by the Marine Resources and Ecosystems Centers. I’m pleased to report that funding has been allocated for two additional research programs for undergraduates beginning in summer 2001.

The MBL’s own semester-long undergraduate program, The Semester in Environmental Sciences, offered by the staff of The Ecosystems Center, completed its 3rd year in 2000 with 15 students participating. The consortium of colleges whose students come for the fall semester continues to grow, currently numbering more than 40 members.

Research

The summer research program ran at full capacity during the summer of 2000. One hundred and thirty-two investigators used all of our available lab space. In fact, one applicant had to set up his research in a dark room. The majority of the investigators (60%) were professors/chief scientists, followed by associate professors (20%) and postdoctoral fellows (10%). The balance was comprised of assistant scientists and graduate students.

I’m proud to report that for the second year in a row an MBL Summer Scientist—Avraham Hershko of the Technion in Israel—has won the prestigious Lasker Award (Clay Armstrong won this award in 1999). This award is second only to the Nobel Prize in significance in science. Dr. Hershko will deliver a Friday Evening Lecture during the summer of 2001. I’m also pleased to be able to count two of the year 2000’s Nobel Prize winners as members of the MBL family: Paul Greengard of Rockefeller University, an alumnus of the Embryology Course and a former faculty member of the Neurobiology Course, and Eric Kandel of Columbia, a past MBL
investigator and Corporation Member. These awards validate the tremendous significance and impact the MBL’s research and educational programs have on the biology community at large.

The MBL’s research fellowship program hosted 21 investigators during the summer of 2000. The range of the research being undertaken by these scientists was remarkable, and the caliber of their backgrounds scored high by the Fellowship Committee and our external advisors. The Science Writing Fellowship Program also continued to figure prominently among print and broadcast journalists for the outstanding opportunity it affords them to work alongside scientists to learn about the process of doing science.

The Ecosystems Center

Research is and will always be a key mission of the MBL. We have seen a continued growth in our resident research programs. The Ecosystems Center, directed by Jerry Melillo and John Hobbie, now numbers more than 60 staff, and its funding base has more than doubled during the past 5 years. It is now in excess of $7 million. Thirty research projects are underway around the globe, from Siberia to Martha’s Vineyard. In 2000 The Ecosystems Center celebrated its 25th anniversary with a weekend-long celebration. The festivities included an open house, a one-day symposium complete with a visit by Rep. William Delahunt of the Massachusetts 10th District, and a reunion clambake at the Swope Center. More than 50 Ecosystems Center alumni from all over the world traveled to Woods Hole to celebrate the success of the Center’s first 25 years and to discuss the future of ecosystems science.

The Josephine Bay Paul Center

The Bay Paul Center for Comparative Molecular Biology and Evolution, under Mitch Sogin’s direction, currently has 33 scientists and support staff. The Center’s project to sequence the genome of the parasite *Giardia* is nearly complete.

For the first time, the MBL has received a prestigious gift from the Keck Foundation. This $1 million award will establish the W. M. Keck Ecological and Evolutionary Genetics Facility at the Bay Paul Center. Microbial ecologists, molecular evolutionists, and genome scientists from the Bay Paul Center, The Ecosystems Center, and other scientific groups within the Woods Hole community will form a coalition to study how the genes of millions of microbes work together to influence biogeochemical processes within ecosystems.

The BioCurrents Research Center

The NIH BioCurrents Research Center, directed by Peter Smith, has increased in size and now numbers 11 scientists, thanks to the recent addition of Drs. Orian Shirihai and Stefan McDonough to the scientific staff. Among their many research projects, Smith and his colleagues continue to collaborate with Dr. Barbara Corkey of Boston Medical Center on the study of how cells process insulin. They are currently fine tuning instruments that will enable them to monitor the movement and release of glucose, insulin, and calcium within pancreatic beta cells, the goal being to learn more about how diabetes type II works at a cellular level. Another exciting collaboration is underway between the BioCurrents Research Center and the Bay Paul Center to study the evolution, diversity, and physiology of organisms living in extreme environments—like the hot vents of the deep oceans and extremely acidic (battery acid-like) ecosystems.

The Marine Resources Center

Research using DNA fingerprinting to assess paternity and reproductive patterns and population structure in the
local squid fishery—valued at $33 million annually—continues in the Marine Resources Center (MRC), under the direction of Roger Hanlon. Work on how polarized vision is used by the squid to help detect prey is also a focal point. During the Campaign, a landmark gift from Honorary Trustee Ellen Grass established the first endowed Directorship at the MBL. This gift, the grant from the Schooner Foundation to establish the Program in Scientific Aquaculture, and a recent anonymous grant of $500,000 ensures future vitality for the MRC. The MRC is also currently in the process of hiring three faculty-level scientists and a scientific aquaculturist.

I've only touched on a few of the MBL's resident research initiatives. In addition to these research centers, the MBL is home to a score of investigators' research programs that focus on a range of topics including infertility, microscopy, learning and memory, and the effects of lead poisoning on children.

The Trustees will start developing a 5- to 10-year strategic plan—a map charting the direction that the Laboratory will take in both research and education in the coming years. This plan will further strengthen and position the Laboratory to serve science and society.

As we continue to build the year-round research programs, plans have been developed to add a new year-round research program in Global Infectious Diseases and Parasitism. Parasites cause debilitating and often lethal diseases in billions of people around the world. The World Health Organization estimates that one in ten are infected by one or more of the five major parasitic diseases: schistosomiasis, filariasis, malaria, trypanosomiasis, and leishmaniasis. The MBL is already a leader in the field of parasitology and infectious disease, hosting two major international parasitology meetings and offering a world-renowned course in the Biology of Parasitism each summer. This new program will build on the Laboratory's existing strengths in this field and take advantage of the high throughput technologies and scientific expertise available in the Bay Paul Center, creating a one-of-a-kind research environment that fosters interactions between parasitologists and experts in molecular biology, phylogenetics, and environmental microbiology. The Trustees agree that this is a strong and important addition to the MBL's year-round research portfolio.

On the education side, Mitch Sogin and Clare Fraser, one of our newest Trustees, are planning to offer an exciting and novel course in genomics. This course will premiere in Fall 2002. We hope to offer more and more cutting-edge courses throughout the year in the future.

The Library

The MBL/WHOI Library continues to expand both its print and electronic serial collections. More than 2000 full-text electronic journals are now available on our scientists' desktops through the Library's web site. The entire collection has grown to more than 200,000 volumes, occupying all the space the Library has available in Woods Hole. Storage issues are currently being addressed by providing more electronic access to journals and by sending some volumes off campus to the Harvard Depository.

Looking Ahead

It's an exciting time for the Marine Biological Laboratory. Now more than ever, the Trustees are committed to building and strengthening the MBL's year-round research program. Within the next year, the

Trustees

The Trustees elected four new Board members and reappointed one Trustee to the Class of 2005 at their November 4, 2000 meeting. Dr. Porter W. Anderson, who completed his first term on the Board this year, was
appointed to a second term. He is joined by Dr. Claire M. Fraser, President and Director of The Institute for Genomic Research in Maryland; Mr. George Logan, Chairman of the Board and Organizer of the Valley Financial Corporation as well as Principal of the Wood Park Capital Corporation in Roanoke, VA; Robert A. Prendergast, Professor of Ophthalmology and Associate Professor of Pathology at The Wilmer Institute at The Johns Hopkins University School of Medicine, Baltimore, MD; and John W. Rowe, M.D., President and CEO of Aetna Inc. Thomas S. Crane, Co-ordinator of Mintz Levin Cohn Ferris Glovsky and Popeo’s Health Care Fraud and Abuse and Corporate Compliance practice group serving the firm’s Boston and Washington, DC, offices, was elected Clerk of the Corporation.

Sheldon Segal, John Dowling, and Mary B. Conrad were reelected to serve as Chairman of the Board, President of the Corporation, and Treasurer, respectively. Trustee Al Zeien was elected Vice Chair of the Board. The Board also thanked retiring members Fred Bay, Marty Cox, Mary Greer, William Steere, and Gerald Weissmann for their tireless efforts on behalf of the Laboratory.

In Memoriam

As this report was going to press, we were saddened to learn of the tragic deaths of Jim and Alma Ebert, who were killed on May 22, 2001, in a car accident while traveling from Baltimore to Woods Hole for the summer. Jim was President of the MBL Corporation from 1970 to 1978 and again from 1990 to 1998. He was Director of the Laboratory from 1970 to 1978, a Trustee from 1964 to 1968, and was named Director Emeritus in 2000. Alma was active in the MBL Associates, volunteering her time and energy on behalf of the Laboratory, and supporting Jim during his tenure as Director.

For five decades the MBL has benefited from Jim’s considerable knowledge and experience. He was instrumental in bringing significant funding to the Laboratory, and his guidance and insight were key to the MBL’s success. The loss of these dear friends will be deeply felt by the MBL family for many years.

—William T. Speck
Report of the Treasurer

The Marine Biological Laboratory had another impressive operating year in 2000 that was partially offset by weak near-term investment portfolio returns. Auspicious growth in Operating Support and the decline in the Equity Markets were the major contributors to the mixed results.

Three areas of Operating Support showed double-digit increases. The growth in Government Grants accelerated to 14.7% over 1999 results and represented an all-time high of 45.2% of Total Operating Support. Fees for Conferences and Services grew even faster, up 17.1%. Short-term Investment Income also grew by 13.1% as a result of stronger interest rate returns on a larger portfolio of Cash & Cash Equivalents, Short-Term Investments, and the Assets Held by the Bond Trustee. This had a very favorable impact, particularly on the Change in Unrestricted Net Assets from Operations. It increased from only $138 thousand in 1999 to $1.3 million in 2000. This represented a very strong 9.5% Operating Margin.

Reviewing our Non-Operating Activities, we expanded our Investment in Plant to $4.64 million, more than doubling what was done in 1999. Total Contributions, again, exceeded $10 million in the final year of our Discovery Campaign with almost 45% going toward Plant improvements. On the other hand, MBL experienced $2.1 million, or 3.9%, in realized and unrealized investment losses. We also utilized $1.4 million from our standard spending rate draw. This impacted our Long-term Investment portfolio, which fell slightly in value for the first time since 1994.

Even with this, MBL reported a $3.2 million Total Change in Net Assets. This represented the sixth year of positive change, but represented only a 4.3% Return on Average Net Assets.

MBL’s 2000 Balance Sheet experienced some significant changes from 1999. Assets grew by over $11 million due to double-digit growth of 16.4% in Net Plant Assets, increased liquidity, and added Assets held by the Bond Trustee, which was a result of the $10.2 million Variable Rate Revenue Bonds issued March 8, 2000. The Bond refinanced $2.3 million of higher cost debt, with the balance of the proceeds being used to make capital improvements to MBL’s educational, research, and housing facilities. Even with this increased debt, MBL has a sound Leverage Ratio (Unrestricted and Temporarily Restricted Net Assets-to-Debt) of 5.26× at year-end 2000. Also note our strong operational returns resulted in an improved Debt Coverage Ratio of 11.6× over previous years. One last positive sign to note is a $3 million increase in the Laboratory’s Unrestricted Net Assets.

In summary, the Laboratory completed an effective leverage of its financial strength, closed a very successful fundraising campaign, and demonstrated strong operational returns. This more than offset the marginal decline in portfolio performance, and we remain well poised to continue our capital improvement efforts.

—Mary B. Conrad
REPORT OF INDEPENDENT ACCOUNTANTS

To the Board of Trustees of
Marine Biological Laboratory:

In our opinion, the accompanying balance sheet of Marine Biological Laboratory (the “Laboratory”) at December 31, 2000 and the related statements of activities and of cash flows for the year then ended present fairly, in all material respects, the financial position of the Laboratory as of December 31, 2000, and the changes in its net assets and its cash flows for the year then ended in conformity with accounting principles generally accepted in the United States of America. These financial statements are the responsibility of the Laboratory’s management; our responsibility is to express an opinion on these financial statements based on our audit. The prior year summarized comparative information has been derived from the Laboratory’s 1999 financial statements, and in our report dated April 7, 2000, we expressed an unqualified opinion on those financial statements. We conducted our audit in accordance with auditing standards generally accepted in the United States of America. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

Our audit was conducted for the purpose of forming an opinion on the basic financial statements taken as a whole. The supplemental schedule of functional expenses as of December 31, 2000 is presented for the purpose of additional analysis and is not a required part of the basic financial statements. Such information has been subjected to the auditing procedures applied in the audit of the basic financial statements and, in our opinion, is fairly stated, in all material respects, in relation to the basic financial statements taken as a whole.

April 6, 2001
### Balance Sheet

As of December 31, 2000

(With Comparative Totals as of December 31, 1999)

<table>
<thead>
<tr>
<th>ASSETS</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash and cash equivalents</td>
<td>$ 3,583,033</td>
<td>$ 1,942,285</td>
</tr>
<tr>
<td>Short-term investments, at market</td>
<td>3,599,833</td>
<td>3,182,537</td>
</tr>
<tr>
<td>Accounts receivable, net of allowance for</td>
<td>1,109,706</td>
<td>1,158,073</td>
</tr>
<tr>
<td>doubtful accounts of $47,222 in 2000 and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$59,978 in 1999</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current portion of pledges receivable</td>
<td>5,026,750</td>
<td>3,974,385</td>
</tr>
<tr>
<td>Receivables due for costs incurred on</td>
<td>2,036,734</td>
<td>1,380,766</td>
</tr>
<tr>
<td>grants and contracts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other current assets</td>
<td>352,983</td>
<td>306,518</td>
</tr>
<tr>
<td><strong>Total current assets</strong></td>
<td>15,709,039</td>
<td>11,944,564</td>
</tr>
<tr>
<td>Assets held by bond trustee</td>
<td>5,423,615</td>
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<tr>
<td>Long-term investments, at market</td>
<td>44,494,649</td>
<td>45,001,493</td>
</tr>
<tr>
<td>Pledges receivable, net of current portion</td>
<td>2,433,292</td>
<td>3,498,787</td>
</tr>
<tr>
<td>Plant assets, net</td>
<td>23,423,156</td>
<td>20,118,725</td>
</tr>
<tr>
<td>Other assets</td>
<td>206,280</td>
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</tr>
<tr>
<td><strong>Total long-term assets</strong></td>
<td>76,180,922</td>
<td>68,619,005</td>
</tr>
<tr>
<td><strong>Total assets</strong></td>
<td>$ 91,690,031</td>
<td>$ 80,563,569</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LIABILITIES AND NET ASSETS</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current portion of long-term debt</td>
<td>$ —</td>
<td>$ 267,404</td>
</tr>
<tr>
<td>Accounts payable and accrued expenses</td>
<td>2,073,375</td>
<td>1,957,508</td>
</tr>
<tr>
<td>Deferred income and advances on contracts</td>
<td>1,016,060</td>
<td>656,745</td>
</tr>
<tr>
<td><strong>Total current liabilities</strong></td>
<td>3,089,435</td>
<td>2,881,657</td>
</tr>
<tr>
<td>Annuities and unitrusted payable</td>
<td>1,393,735</td>
<td>1,460,948</td>
</tr>
<tr>
<td>Long-term debt, net of current portion</td>
<td>10,200,000</td>
<td>2,056,692</td>
</tr>
<tr>
<td>Advances on contracts</td>
<td>1,230,743</td>
<td>1,574,758</td>
</tr>
<tr>
<td><strong>Total long-term liabilities</strong></td>
<td>12,824,478</td>
<td>5,092,398</td>
</tr>
<tr>
<td><strong>Total liabilities</strong></td>
<td>15,913,913</td>
<td>7,974,055</td>
</tr>
<tr>
<td>Commitments and contingencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Net assets:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unrestricted</td>
<td>22,903,287</td>
<td>19,887,437</td>
</tr>
<tr>
<td>Temporarily restricted</td>
<td>30,752,413</td>
<td>33,349,244</td>
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<tr>
<td>Permanently restricted</td>
<td>22,120,418</td>
<td>19,352,833</td>
</tr>
<tr>
<td><strong>Total net assets</strong></td>
<td>75,776,118</td>
<td>72,589,514</td>
</tr>
<tr>
<td><strong>Total liabilities and net assets</strong></td>
<td>$ 91,690,031</td>
<td>$ 80,563,569</td>
</tr>
</tbody>
</table>

The accompanying notes are an integral part of the financial statements.
MARINE BIOLOGICAL LABORATORY

STATEMENT OF ACTIVITIES

For the Year Ended December 31, 2000

(With Comparative Totals for the Year Ended December 31, 1999)

<table>
<thead>
<tr>
<th>Operating support and revenues:</th>
<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government grants</td>
<td>$14,048,464</td>
<td>$ —</td>
<td>$ —</td>
<td>$14,048,464</td>
<td>$12,248,442</td>
</tr>
<tr>
<td>Private contracts</td>
<td>1,697,062</td>
<td>$ —</td>
<td>$ —</td>
<td>1,697,062</td>
<td>1,819,240</td>
</tr>
<tr>
<td>Laboratory rental income</td>
<td>1,598,373</td>
<td>$ —</td>
<td>$ —</td>
<td>1,598,373</td>
<td>1,548,168</td>
</tr>
<tr>
<td>Tuition, net</td>
<td>543,305</td>
<td>$ —</td>
<td>$ —</td>
<td>543,305</td>
<td>537,835</td>
</tr>
<tr>
<td>Fees for conferences and services</td>
<td>4,407,311</td>
<td>$ —</td>
<td>$ —</td>
<td>4,407,311</td>
<td>3,765,039</td>
</tr>
<tr>
<td>Contributions</td>
<td>1,693,185</td>
<td>2,347,731</td>
<td>1,908,528</td>
<td>5,949,444</td>
<td>8,620,519</td>
</tr>
<tr>
<td>Investment income</td>
<td>1,736,186</td>
<td>594,530</td>
<td>$ —</td>
<td>2,330,716</td>
<td>2,060,478</td>
</tr>
<tr>
<td>Miscellaneous revenue</td>
<td>468,482</td>
<td>$ —</td>
<td>$ —</td>
<td>468,482</td>
<td>466,903</td>
</tr>
<tr>
<td>Present value adjustment to annuities</td>
<td>—</td>
<td>55,176</td>
<td>55,176</td>
<td>(30,533)</td>
<td></td>
</tr>
<tr>
<td>Net assets released from restrictions</td>
<td>4,144,547</td>
<td>(4,249,547)</td>
<td>105,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total operating support and revenues</td>
<td>30,336,915</td>
<td>(1,252,110)</td>
<td>2,013,528</td>
<td>31,098,333</td>
<td>31,036,091</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Expenses:</th>
<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research</td>
<td>17,799,627</td>
<td>$ —</td>
<td>$ —</td>
<td>17,799,627</td>
<td>14,147,645</td>
</tr>
<tr>
<td>Instruction</td>
<td>5,626,223</td>
<td>$ —</td>
<td>$ —</td>
<td>5,626,223</td>
<td>4,742,287</td>
</tr>
<tr>
<td>Conferences and services</td>
<td>1,307,458</td>
<td>$ —</td>
<td>$ —</td>
<td>1,307,458</td>
<td>2,252,842</td>
</tr>
<tr>
<td>Other programs (Note 2)</td>
<td>4,261,327</td>
<td>$ —</td>
<td>$ —</td>
<td>4,261,327</td>
<td>5,297,773</td>
</tr>
<tr>
<td>Total expenses</td>
<td>28,994,635</td>
<td>$ —</td>
<td>$ —</td>
<td>28,994,635</td>
<td>26,440,547</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in net assets before nonoperating activity</th>
<th>Unrestricted</th>
<th>Temporarily Restricted</th>
<th>Permanently Restricted</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1,342,280</td>
<td>(1,252,110)</td>
<td>2,013,528</td>
<td>2,103,698</td>
<td>4,595,544</td>
</tr>
</tbody>
</table>

| Nonoperating revenue:                        | Unrestricted | Temporarily Restricted | Permanently Restricted | 2000     | 1999     |
| Contribution to Plant:                       |              |                        |                        |          |          |
| Private                                        | 404,018      | 4,109,597              | 125,000                | 4,638,615 | 1,757,319 |
| Government                                     | —            | $ —                    | $ —                    | —        | 198,443  |
| Release from restriction                       | 1,615,142    | (1,615,142)            | $ —                    | —        |          |
| Invested in Plant                             | 2,019,160    | 2,494,455              | 125,000                | 4,638,615 | 1,955,762 |
| Total investment income and gains/losses       | (284,514)    | (2,484,381)            | 629,057                | (2,139,838) | 5,938,476 |
| Less: investment earnings used for operations  | (61,076)     | (1,354,795)            | $ —                    | (1,415,871) | (1,262,020) |
| Reinvested (utilized) investment income and gains/losses | (345,590) | (3,839,176)            | 629,057                | (3,555,709) | 4,676,456 |
| Total change in net assets                    | 3,015,850    | (2,596,831)            | 2,767,585              | 3,186,604 | 11,227,762 |
| Net assets, beginning of year                 | 19,887,437   | 33,349,244             | 19,352,833             | 72,589,514 | 61,361,752 |
| Net assets, end of year                       | $22,903,287  | $30,752,413            | $22,120,418            | $75,776,118 | $72,589,514 |

The accompanying notes are an integral part of the financial statements.
# MARINE BIOLOGICAL LABORATORY

## Statement of Cash Flows

For the Year Ended December 31, 2000

(With Comparative Totals for the Year Ended December 31, 1999)

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cash flows from operating activities:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in net assets</td>
<td>$3,186,604</td>
<td>$11,227,762</td>
</tr>
<tr>
<td>Adjustments to reconcile change in net assets to net cash provided by (used in) operating activities:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depreciation and amortization</td>
<td>1,791,975</td>
<td>1,562,487</td>
</tr>
<tr>
<td>Unrealized (appreciation) depreciation on investments</td>
<td>6,700,396</td>
<td>(3,544,380)</td>
</tr>
<tr>
<td>Realized gain on investments</td>
<td>(3,886,669)</td>
<td>(1,639,795)</td>
</tr>
<tr>
<td>Present value adjustment to annuities and unitrusts payable</td>
<td>(55,176)</td>
<td>30,533</td>
</tr>
<tr>
<td>Contributions restricted for long-term investment and unitrusts</td>
<td>(2,033,528)</td>
<td>(2,485,624)</td>
</tr>
<tr>
<td>Provision for bad debt</td>
<td>—</td>
<td>36,968</td>
</tr>
<tr>
<td>Provision for uncollectible pledges</td>
<td>423,982</td>
<td>—</td>
</tr>
<tr>
<td><strong>Change in certain balance sheet accounts:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accounts receivable</td>
<td>48,367</td>
<td>47,489</td>
</tr>
<tr>
<td>Pledges receivable</td>
<td>(410,852)</td>
<td>(3,010,156)</td>
</tr>
<tr>
<td>Grants and contracts receivable</td>
<td>(655,968)</td>
<td>150,317</td>
</tr>
<tr>
<td>Other current assets and other assets</td>
<td>(252,745)</td>
<td>251,390</td>
</tr>
<tr>
<td>Accounts payable and accrued expenses</td>
<td>115,867</td>
<td>(100,233)</td>
</tr>
<tr>
<td>Deferred income</td>
<td>359,315</td>
<td>193,872</td>
</tr>
<tr>
<td>Annuities and unitrusts payable</td>
<td>(73,167)</td>
<td>68,112</td>
</tr>
<tr>
<td>Advances on contracts</td>
<td>(344,015)</td>
<td>302,368</td>
</tr>
<tr>
<td><strong>Net cash provided by operating activities</strong></td>
<td>$4,914,386</td>
<td>$3,091,110</td>
</tr>
</tbody>
</table>

| **Cash flows from investing activities:** |           |           |
| Purchase of property and equipment | (5,096,406) | (2,145,041) |
| Proceeds from sale of investments  | 68,837,634 | 63,104,047 |
| Purchase of investments            | (76,930,252) | (65,485,238) |
| **Net cash used in investing activities** | (13,189,024) | (4,529,232) |

| **Cash flows from financing activities:** |           |           |
| Payments on annuities and unitrusts payable | (96,316)  | (49,897)  |
| Receipt of permanently restricted gifts | 2,033,528  | 2,438,148 |
| Annuity and unitrusts donations received | 102,270   | 47,476    |
| Bond issuance                        | 10,200,000 | —         |
| Payments on long-term debt           | (2,324,096) | (243,274) |
| **Net cash provided by financing activities** | $9,915,386 | $2,192,453 |

| **Net increase in cash and cash equivalents** | 1,640,748 | 754,331 |
| **Cash and cash equivalents at beginning of year** | 1,942,285 | 1,187,954 |
| **Cash and cash equivalents at end of year** | $3,583,033 | $1,942,285 |

The accompanying notes are an integral part of the financial statements.
Marine Biological Laboratory

Notes to Financial Statements

1. Background

The Marine Biological Laboratory (the “Laboratory”) is a private, independent not-for-profit research and educational institution dedicated to establishing and maintaining a laboratory and station for scientific study and investigation, and a school for instruction in biology and natural history. The Laboratory was founded in 1888 and is located in Woods Hole, Massachusetts.

2. Significant Accounting Policies

Basis of Presentation

The accompanying financial statements have been prepared on the accrual basis of accounting and in accordance with the principles outlined in the American Institute of Certified Public Accountants’ Audit Guide, “Not-For-Profit Organizations.” The financial statements include certain prior-year summarized comparative information in total but not by net asset class. Such information does not include sufficient detail to constitute a presentation in conformity with generally accepted accounting principles. Accordingly, such information should be read in conjunction with the Laboratory’s financial statements for the year ended December 31, 1999, from which the summarized information was derived.

The Laboratory classifies net assets, revenues, and realized and unrealized gains and losses based on the existence or absence of donor-imposed restrictions and legal restrictions imposed under Massachusetts State law. Accordingly, net assets and changes therein are classified as follows:

Unrestricted

Unrestricted net assets are not subject to donor-imposed restrictions of a more specific nature than the furtherance of the Laboratory’s mission. Revenues from sources other than contributions are generally reported as increases in unrestricted net assets. Expenses are reported as decreases in unrestricted net assets. Gains and losses on investments and other assets or liabilities are reported as increases or decreases in unrestricted net assets unless their use is restricted by explicit donor stipulations or law. Expirations of temporary restrictions on net assets, that is, the donor-imposed stipulated purpose has been accomplished and/or the stipulated time period has elapsed, are reported as reclassifications between the applicable classes of net assets and titled “Net assets released from restrictions.”

Temporarily Restricted

Temporarily restricted net assets are subject to legal or donor-imposed stipulations that will be satisfied either by the actions of the Laboratory, the passage of time, or both. These assets include contributions for which the specific, donor-imposed restrictions have not been met and pledges, annuities, and endowments for which the ultimate purpose of the proceeds is not permanently restricted. As the restrictions are met, the assets are released to unrestricted net assets. Also, realized/unrealized gains/losses associated with permanently restricted gifts which are not required to be added to principal by the donor are classified as temporarily restricted and maintain the donor requirements for expenditure.

Permanently Restricted

Permanently restricted net assets are subject to donor-imposed stipulations that they be invested to provide a permanent source of income to the Laboratory. These assets include contributions, pledges, and trusts which require that the corpus be invested in perpetuity and only the income be made available for program operations in accordance with donor restrictions.

Performance Indicator

Nonoperating revenues include realized and unrealized gains on investments during the year as well as investment income on the master pooled investments and revenues that are specifically for the acquisition or construction of plant assets. Investment income from short-term investments and investments held in trust by others are included in operating support and revenues. To the extent that nonoperating investment income and gains are used for operations as determined by the Laboratory’s total return utilization policy (see below), they are reclassified from nonoperating as “Investment earnings used for operations” to operating as “Investment income” on the statement of activities. All other activity is classified as operating revenue.

Cash and Cash Equivalents

Cash equivalents consist of resources invested in overnight repurchase agreements and other highly liquid investments with original maturities of three months or less.

Financial instruments which potentially subject the Laboratory to concentrations of risk consist primarily of cash and investments. The Laboratory maintains cash accounts with one banking institution.

Investments

Investments purchased by the Laboratory are carried at market value. Donated investments are recorded at fair market value at the date of the gift. For closely held non-publicly traded investments, management determines the fair value based upon the most recent information available from the limited partnership. For determination of gain or loss upon disposal of investments, cost is determined based on the first-in, first-out method.
Investments with an original maturity of three months to one year, or those that are available for operations within the next fiscal year, are classified as short-term. All other investments are considered long-term. Investments are maintained primarily with three institutions.

In 1924, the Laboratory became the beneficiary of certain investments, included in permanently restricted net assets, which are held in trust by others. The Laboratory has the continuing rights to the income produced by these funds in perpetuity, subject to the contractual restrictions on the use of such funds. Accordingly, the trust has established a process to conduct a review every ten years by an independent committee to ensure the Laboratory continues to perform valuable services in biological research in accordance with the restrictions placed on the funds by the agreement. The committee met in 1994 and determined that the Laboratory has continued to meet the contractual requirements. The market values of such investments are $7,904,545 and $7,275,488 at December 31, 2000 and 1999, respectively. The dividend and interest income on these investments, included in unrestricted support and revenues, totaled $201,407 and $221,882 in 2000 and 1999, respectively.

Investment Income and Distribution

For the master pooled investments, the Laboratory employs a total return utilization policy that establishes the amount of the investment return made available for spending each year. The Finance Committee of the Board of Trustees has approved a spending policy that the withdrawal will be based on a percentage of the 12 quarter average ending market values of the funds. The market value includes the principal plus reinvested income, realized and unrealized gains and losses. Spending rates in excess of 5%, but not exceeding 7%, can be utilized if approved in advance by the Finance Committee of the Board of Trustees. For fiscal 2000 and 1999, the Laboratory obtained approval to expend 6% of the latest 12 quarter average ending market values of the investments.

The net appreciation on permanently and temporarily restricted net assets is reported together with temporarily restricted net assets until such time as all or a portion of the appreciation is distributed for spending in accordance with the total return utilization policy and applicable state law.

Investment income on the pooled investment account is allocated to the participating funds using the market value unit method (Note 4).

Assets Held by Bond Trustee

Assets held by bond trustee relate to assets held by an outside trustee under the March 1, 2000 loan and trust agreement. Per the prospectus, these funds may be used solely for capital projects as determined by the Laboratory’s Board of Directors. At December 31, 2000, these assets were invested in a qualified GIC under a funding agreement with an insurance company.

Plant Assets

Buildings and equipment are recorded at cost. Donated facility assets are recorded at fair market value at the date of the gift. Depreciation is computed using the straight-line method over the asset’s estimated useful life. Estimated useful lives are generally three to five years for equipment and 20 to 40 years for buildings and improvements. Depreciation is not recorded for those assets classified as construction-in-process as they have not yet been placed into service. Depreciation expense for the years ended December 31, 2000 and 1999 amounted to $1,791,975 and $1,562,487, respectively, and has been recorded in the statement of activities in the appropriate functionalized categories. When assets are sold or retired, the cost and accumulated depreciation are removed from the accounts and any resulting gain or loss is included in unrestricted income for the period.

Annuities and Unitrusts Payable

Amounts due to donors in connection with gift annuities and unitrusts are determined based on remainder value calculations, with varied assumptions of rates of return and payout terms.

Deferred Income and Advances on Contracts

Deferred income includes prepayments received on Laboratory publications and advances on contracts to be spent within the next year. Advances on contracts includes funding received for grants and contracts before it is earned. Long-term advances are invested in the master pooled account until they are expended.

Revenue Recognition

Sources of revenue include grant payments from governmental agencies, contracts from private organizations, and income from the rental of laboratories and classrooms for research and educational programs. The Laboratory recognizes revenue associated with grants and contracts at the time the related direct costs are incurred or expended. Recovery of related indirect costs is recorded at predetermined fixed rates negotiated with the government. Revenue related to conferences and services is recognized at the time the service is provided, while tuition revenue is recognized as classes are offered. The tuition income is net of student financial aid of $579,790 and $527,258 in 2000 and 1999, respectively. Fees for conferences and other services include the following activities: housing, dining, library, scientific journals, aquatic resources and research services.

Contributions

Contribution revenue includes gifts and pledges. Gifts are recognized as revenue upon receipt. Pledges are recognized as temporarily or permanently restricted revenue in the year pledged and are recorded at the present value of expected future cash flows, net of allowance for unfulfilled pledges. Gifts and pledges, other than cash, are recorded at fair market value at the date of contribution.

Expenses

Expenses are recognized when incurred and charged to the functions to which they are directly related. Expenses that relate to more than one function are allocated among functions based upon either modified total direct cost or square footage allocations.
Other programs expense consists primarily of fundraising, year-round labs and library room rentals, costs associated with aquatic resource sales and scientific journals. Total fundraising expense for 2000 and 1999 is $1,156,656 and $1,008,920, respectively.

Use of Estimates
The preparation of financial statements in conformity with generally accepted accounting principles requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and disclosure of contingent assets and liabilities at the date of financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Tax-Exempt Status
The Laboratory is exempt from federal income tax under Section 501(c)(3) of the Internal Revenue Code.

Reclassification
Certain prior year balances have been reclassified to conform with the current year presentation.

3. Investments
The following is a summary of the cost and market value of investments at December 31, 2000 and 1999:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificates of deposit</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Money market securities</td>
<td>764,969</td>
<td>1,781,128</td>
<td>764,969</td>
<td>1,781,128</td>
</tr>
<tr>
<td>U.S. Government securities</td>
<td>2,300,738</td>
<td>69,125</td>
<td>2,165,197</td>
<td>69,951</td>
</tr>
<tr>
<td>Corporate fixed income</td>
<td>2,412,548</td>
<td>2,364,068</td>
<td>2,537,913</td>
<td>2,536,808</td>
</tr>
<tr>
<td>Common stocks</td>
<td>16,144,089</td>
<td>15,665,205</td>
<td>16,318,538</td>
<td>10,608,588</td>
</tr>
<tr>
<td>Mutual funds</td>
<td>19,909,549</td>
<td>26,664,204</td>
<td>19,306,250</td>
<td>23,851,004</td>
</tr>
<tr>
<td>Limited partnerships</td>
<td>6,522,589</td>
<td>1,600,300</td>
<td>5,324,442</td>
<td>958,982</td>
</tr>
<tr>
<td><strong>Total investments</strong></td>
<td><strong>$48,094,482</strong></td>
<td><strong>$48,184,030</strong></td>
<td><strong>$46,457,309</strong></td>
<td><strong>$39,846,461</strong></td>
</tr>
</tbody>
</table>

Investment portfolios for the years ended December 31, 2000 and 1999 are as follows:

**Short-Term Investments**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Certificates of deposit</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
<td>$40,000</td>
</tr>
<tr>
<td>Money market</td>
<td>377,654</td>
<td>233,938</td>
<td>377,654</td>
<td>233,938</td>
</tr>
<tr>
<td>Mutual funds</td>
<td>3,102,515</td>
<td>2,875,480</td>
<td>3,085,445</td>
<td>2,965,273</td>
</tr>
<tr>
<td>Common stocks in transit</td>
<td>79,664</td>
<td>33,119</td>
<td>79,664</td>
<td>33,119</td>
</tr>
<tr>
<td><strong>Total short term</strong></td>
<td><strong>$3,599,833</strong></td>
<td><strong>$3,182,537</strong></td>
<td><strong>$3,648,491</strong></td>
<td><strong>$3,272,330</strong></td>
</tr>
</tbody>
</table>

**Long-Term Investments**

Pooled investments:
- Master pooled investments | $34,116,704 | $35,354,938 | $33,153,390 | $27,514,505 |

Separately invested:
- General Chase Trust | 6,204,107  | 5,717,108   | 5,654,623 | 5,335,721  |
- Library Chase Trust | 1,700,438  | 1,558,380   | 1,543,691 | 1,448,569  |
- Annuity and unitrusts investments | 2,473,400 | 2,371,067 | 2,522,842 | 2,275,336 |
| **Total long term** | **$44,494,649** | **$45,001,493** | **$42,874,546** | **$36,574,131** |

**Total investments** | **$48,094,482** | **$48,184,030** | **$46,457,309** | **$39,846,461** |
For the years ended December 31, 2000 and 1999, the Laboratory recorded net realized gains of $3,886,669 and $1,639,795; net unrealized losses (gains) of $6,700,396 and $(3,544,380); and dividend and interest income of $1,588,734 and $1,533,579, respectively.

4. Accounting for Pooled Investments

Certain net assets are pooled for investment purposes. Investment income from the pooled investment account is allocated on the market value unit basis, and each fund subscribes to or disposes of units on the basis of the market value per unit at the beginning of the calendar quarter within which the transaction takes place. The unit participation of the funds at December 31, 2000 and 1999 is as follows:

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrestricted</td>
<td>11,290</td>
<td>8,573</td>
</tr>
<tr>
<td>Temporarily restricted</td>
<td>40,042</td>
<td>42,351</td>
</tr>
<tr>
<td>Permanently restricted</td>
<td>73,724</td>
<td>65,789</td>
</tr>
<tr>
<td>Advances on contracts</td>
<td>5,396</td>
<td>5,557</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>130,502</strong></td>
<td><strong>122,720</strong></td>
</tr>
</tbody>
</table>

Pooled investment activity on a per-unit basis was as follows:

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit value at beginning of year</td>
<td>$283.37</td>
<td>$225.51</td>
</tr>
<tr>
<td>Unit value at end of year</td>
<td>261.53</td>
<td>283.37</td>
</tr>
<tr>
<td><strong>Total return on pooled investments</strong></td>
<td><strong>($21.84)</strong></td>
<td><strong>$57.86</strong></td>
</tr>
</tbody>
</table>

5. Long-Term Debt

Long-term debt consisted of the following at December 31:

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable rate (6.3% at December 31, 1999) Massachusetts Industrial Finance Authority Series 1992A Bonds payable in annual installments through 2012</td>
<td>$ —</td>
<td>$890,000</td>
</tr>
<tr>
<td>6.63% Massachusetts Industrial Finance Authority Series 1992B Bonds, payable in annual installments through 2012</td>
<td>—</td>
<td>1,175,000</td>
</tr>
<tr>
<td>5.8% The University Financing Foundation, Inc. payable in monthly installments through 2000</td>
<td>—</td>
<td>120,929</td>
</tr>
<tr>
<td>5.8% The University Financing Foundation, Inc. payable in monthly installments through 2002</td>
<td>—</td>
<td>138,167</td>
</tr>
<tr>
<td>Variable rate (4.75%) Massachusetts Development Finance Agency Bonds payable in annual installments from 2006 through 2030</td>
<td>10,200,000</td>
<td>—</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10,200,000</strong></td>
<td><strong>$2,324,096</strong></td>
</tr>
</tbody>
</table>

In March 2000, the Massachusetts Development Finance Agency issued on behalf of the Laboratory a series of Variable Rate Revenue Bonds (the "Bonds") in the amount of $10,200,000. The initial interest rate on the issue was 3.65% and is reset weekly. At December 31, 2000, the rate was 4.75%. The bonds are scheduled to mature on February 1, 2030. The Laboratory is required to make interest payments only for the first five years. The first principal payment is due February 1, 2006 with incremental increases through maturity. The proceeds of these bonds were used to finance the capital improvements of the Laboratory's educational, research, and administrative facilities, specifically the construction and equipping of the Environmental Sciences building. A portion of the proceeds was also used to extinguish all of the Laboratory's prior debt obligations.

As collateral for the bonds, the Laboratory has entered into a Letter of Credit Reimbursement Agreement which is set to expire on March 15, 2007. The Letter of Credit is in an amount sufficient to pay the aggregate principal amount of the bonds and up to 46 days' interest.

The agreements related to these bonds subject the Laboratory to certain covenants and restrictions. Under the most restrictive covenant of this debt, the Laboratory is required to maintain a debt service coverage ratio.

In 1992, the Laboratory issued $1,100,000 Massachusetts Industrial Finance Authority (MIFA) Series 1992A Bonds with a variable interest rate and $1,500,000 MIFA Series 1992B with an interest rate of 6.63%. Interest expense totaled $33,201 for the year ended December 31, 2000. The Series 1992 A and B Bonds were scheduled to mature in December 2012, but were retired on March 8, 2000 with the new bond proceeds.

On March 17, 1998, the Laboratory entered into a ten-year interest rate swap contract in connection with the Series 1992A Bonds. This contract was canceled as part of the extinguishment of old debt and new debt issuance on March 8, 2000.
In 1996, the Laboratory borrowed $500,000 with an interest rate of 5.8% per annum from the University Financing Foundation, Inc. The interest expense for the year ended December 31, 2000 was $1,950. The loan was paid off in March 2000 with the new bond proceeds.

In 1997, the MBL borrowed $250,000 with an interest rate of 5.8% per annum from the University Financing Foundation, Inc. The interest expense for the year ended December 31, 2000 was $2,140. This loan was scheduled to mature in 2002 but was paid off in connection with the new debt issued in March of 2000.

The Laboratory has a line of credit agreement with a commercial bank from which it may draw up to $1,000,000. The line of credit has an interest rate of prime plus 1/2 percent. The line expires May 29, 2001. No amounts were outstanding under this agreement at December 31, 2000 and 1999.

6. Plant Assets

Plant assets consist of the following at December 31:

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land</td>
<td>$702,908</td>
<td>$702,908</td>
</tr>
<tr>
<td>Buildings</td>
<td>35,236,087</td>
<td>33,702,485</td>
</tr>
<tr>
<td>Equipment</td>
<td>5,059,022</td>
<td>4,667,026</td>
</tr>
<tr>
<td>Construction in process</td>
<td>4,681,629</td>
<td>1,510,821</td>
</tr>
<tr>
<td>Total</td>
<td>45,679,646</td>
<td>40,583,240</td>
</tr>
<tr>
<td>Less: Accumulated depreciation</td>
<td>(22,256,490)</td>
<td>(20,461,515)</td>
</tr>
<tr>
<td>Plant assets, net</td>
<td>$23,423,156</td>
<td>$20,118,725</td>
</tr>
</tbody>
</table>

7. Retirement Plan

The Laboratory participates in the defined contribution pension plan of TIAA-CREF (the “Plan”). The Plan is available to permanent employees who have completed two years of service. Under the Plan, the Laboratory contributes 10% of total compensation for each participant. Contributions amounted to $862,850 and $785,509 for the years ended December 31, 2000 and 1999, respectively.

8. Pledges

Unconditional promises to give are included in the financial statements as pledges receivable and the related revenue is recorded in the appropriate net asset category. Unconditional promises to give are expected to be realized in the following periods:

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>In one year or less</td>
<td>$5,026,750</td>
<td>$3,974,385</td>
</tr>
<tr>
<td>Between one year and five years</td>
<td>3,021,752</td>
<td>3,632,683</td>
</tr>
<tr>
<td>After five years</td>
<td>—</td>
<td>202,948</td>
</tr>
<tr>
<td>Total</td>
<td>8,048,502</td>
<td>7,810,016</td>
</tr>
<tr>
<td>Less: discount of $168,460 in 2000 and $236,844 in 1999 and allowance of $420,000 in 2000 and $100,000 in 1999</td>
<td>(588,460)</td>
<td>(336,844)</td>
</tr>
<tr>
<td></td>
<td>$7,460,042</td>
<td>$7,473,172</td>
</tr>
</tbody>
</table>

9. Postretirement Benefits

The Laboratory accounts for its postretirement benefits under Statement No. 106, “Employers’ Accounting for Postretirement Benefits Other than Pensions,” which requires employers to accrue, during the years that the employee renders the necessary service, the expected cost of benefits to be provided during retirement. As permitted, the Laboratory has elected to amortize the transition obligation over 20 years commencing on January 1, 1994.

The Laboratory’s policy is that all current retirees and certain eligible employees who retired prior to June 1, 1994 will continue to receive postretirement health benefits. The remaining current employees will receive benefits; however, those benefits will be limited as defined by the Plan. Employees hired on or after January 1, 1995 will not be eligible to participate in the postretirement medical benefit plan.
The following tables set forth the Plan’s funded status as of December 31:

<table>
<thead>
<tr>
<th>Change in benefit obligation</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postretirement benefit obligation at beginning of year</td>
<td>$2,043,659</td>
<td>$2,171,119</td>
</tr>
<tr>
<td>Service cost</td>
<td>23,020</td>
<td>28,231</td>
</tr>
<tr>
<td>Interest cost</td>
<td>149,574</td>
<td>134,533</td>
</tr>
<tr>
<td>Actuarial gain</td>
<td>(87,740)</td>
<td>(174,966)</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(136,844)</td>
<td>(115,258)</td>
</tr>
<tr>
<td>Postretirement benefit obligation at end of year</td>
<td>$1,991,669</td>
<td>$2,043,659</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Change in plan assets</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair value of plan assets at beginning of year</td>
<td>936,149</td>
<td>820,645</td>
</tr>
<tr>
<td>Employer contribution</td>
<td>182,776</td>
<td>192,082</td>
</tr>
<tr>
<td>Actual return on plan assets</td>
<td>56,465</td>
<td>38,680</td>
</tr>
<tr>
<td>Benefits paid</td>
<td>(136,844)</td>
<td>(115,258)</td>
</tr>
<tr>
<td>Fair value of plan assets at end of year</td>
<td>$1,038,546</td>
<td>936,149</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Funded status</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unrecognized actuarial gain</td>
<td>(185,377)</td>
<td>(125,351)</td>
</tr>
<tr>
<td>Unrecognized net obligation at transaction</td>
<td>1,128,691</td>
<td>1,215,513</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accrued postretirement benefit cost</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>(9,809)</td>
<td></td>
<td>(17,348)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Less estimated amount payable within one year and classified as a current liability</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accrued postretirement benefit cost, net of current portion</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(9,809)</td>
<td>(17,348)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Weighted-average assumptions as of December 31</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discount rate</td>
<td>7.50%</td>
<td>8.00%</td>
</tr>
</tbody>
</table>

For purposes of measuring the benefit obligation, an 8.0% annual rate of increase in the per capita cost of covered health benefits was assumed for 2000. The rate was assumed to decrease gradually to 5% in 2005 and remain at that level thereafter.

<table>
<thead>
<tr>
<th>Components of net periodic benefit cost</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service cost</td>
<td>$23,020</td>
<td>$28,231</td>
</tr>
<tr>
<td>Interest cost</td>
<td>149,574</td>
<td>134,533</td>
</tr>
<tr>
<td>Expected return on assets</td>
<td>(69,524)</td>
<td>(61,425)</td>
</tr>
<tr>
<td>Amortization of net obligation at transition</td>
<td>86,822</td>
<td>86,822</td>
</tr>
<tr>
<td>Recognized net actuarial loss</td>
<td>(14,655)</td>
<td>(5,385)</td>
</tr>
<tr>
<td>Net periodic benefit cost</td>
<td>$175,237</td>
<td>$182,776</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact of 1% increase in health care cost trend:</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>on interest cost plus service cost during past year</td>
<td>$14,271</td>
<td>$(71,626)</td>
</tr>
<tr>
<td>on accumulated postretirement benefit obligation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Impact of 1% decrease in health care cost trend:</th>
<th>2000</th>
<th>1999</th>
</tr>
</thead>
<tbody>
<tr>
<td>on interest cost plus service cost during past year</td>
<td>(11,946)</td>
<td>(10,559)</td>
</tr>
<tr>
<td>on accumulated postretirement benefit obligation</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pension plan assets consist of investments in a money market fund.
**MARINE BIOLOGICAL LABORATORY**

**SUPPLEMENTAL SCHEDULE OF FUNCTIONAL EXPENSES**

*For the Year Ended December 31, 2000*

*(With Comparative Totals for the Year Ended December 31, 1999)*

<table>
<thead>
<tr>
<th></th>
<th>Research</th>
<th>Instruction</th>
<th>Conferences</th>
<th>Other</th>
<th>Facilities Maintenance</th>
<th>Administration</th>
<th>Library Services</th>
<th>Research Services</th>
<th>Aquatic Research Services</th>
<th>Total</th>
<th>2000 Total</th>
<th>1999 Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Salaries</strong></td>
<td>$4,404,934</td>
<td>$447,259</td>
<td>$552,998</td>
<td>$626,728</td>
<td>$1,303,126</td>
<td>$1,909,060</td>
<td>$373,101</td>
<td>$382,174</td>
<td>$259,136</td>
<td>$10,258,516</td>
<td>$9,854,375</td>
<td></td>
</tr>
<tr>
<td><strong>Fringe benefits</strong></td>
<td>1,242,196</td>
<td>127,469</td>
<td>157,605</td>
<td>178,618</td>
<td>371,391</td>
<td>759,395</td>
<td>106,334</td>
<td>108,860</td>
<td>73,854</td>
<td>3,125,722</td>
<td>3,046,751</td>
<td></td>
</tr>
<tr>
<td><strong>Professional services</strong></td>
<td>187,605</td>
<td>431,349</td>
<td>80</td>
<td>25,070</td>
<td>14,555</td>
<td>265,047</td>
<td>6,920</td>
<td>10,000</td>
<td>—</td>
<td>940,626</td>
<td>713,843</td>
<td></td>
</tr>
<tr>
<td><strong>Subcontracts</strong></td>
<td>1,946,041</td>
<td>—</td>
<td>1,656,795</td>
<td>—</td>
<td>(289)</td>
<td>(15,578)</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>3,604,836</td>
<td>2,936,708</td>
<td></td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>718,775</td>
<td>53,308</td>
<td>14,673</td>
<td>3,265</td>
<td>(289)</td>
<td>(15,578)</td>
<td>—</td>
<td>14,426</td>
<td>—</td>
<td>788,580</td>
<td>507,695</td>
<td></td>
</tr>
<tr>
<td><strong>Supplies</strong></td>
<td>1,143,432</td>
<td>445,593</td>
<td>100,547</td>
<td>142,629</td>
<td>330,665</td>
<td>150,680</td>
<td>26,674</td>
<td>370,430</td>
<td>57,562</td>
<td>2,767,852</td>
<td>2,471,122</td>
<td></td>
</tr>
<tr>
<td><strong>Travel</strong></td>
<td>522,561</td>
<td>363,399</td>
<td>6,737</td>
<td>60,260</td>
<td>2,013</td>
<td>50,903</td>
<td>8,662</td>
<td>7,124</td>
<td>—</td>
<td>1,021,661</td>
<td>871,625</td>
<td></td>
</tr>
<tr>
<td><strong>Sera</strong></td>
<td>2,454</td>
<td>8,789</td>
<td>—</td>
<td>4,518</td>
<td>3,305</td>
<td>2,506</td>
<td>638,040</td>
<td>80</td>
<td>—</td>
<td>659,692</td>
<td>528,925</td>
<td></td>
</tr>
<tr>
<td><strong>Utilities</strong></td>
<td>4,170</td>
<td>1,079</td>
<td>220,849</td>
<td>1,853</td>
<td>672,381</td>
<td>124,140</td>
<td>10</td>
<td>548</td>
<td>1,863</td>
<td>1,026,893</td>
<td>993,310</td>
<td></td>
</tr>
<tr>
<td><strong>Depreciation</strong></td>
<td>—</td>
<td>—</td>
<td>2,809</td>
<td>—</td>
<td>1,789,166</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>1,791,975</td>
<td>1,562,487</td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>305,964</td>
<td>390,302</td>
<td>296,346</td>
<td>178,230</td>
<td>911,716</td>
<td>415,290</td>
<td>176,580</td>
<td>259,092</td>
<td>74,762</td>
<td>3,008,282</td>
<td>2,953,706</td>
<td></td>
</tr>
<tr>
<td><strong>Internal direct charges, net</strong></td>
<td>$1,478,052</td>
<td>$1,332,532</td>
<td>(1,979,367)</td>
<td>(6,841)</td>
<td>(258,542)</td>
<td>(44,351)</td>
<td>328,556</td>
<td>(747,050)</td>
<td>(102,989)</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11,958,184</td>
<td>3,601,079</td>
<td>1,030,072</td>
<td>1,213,970</td>
<td>5,139,489</td>
<td>3,617,092</td>
<td>1,664,877</td>
<td>405,684</td>
<td>364,188</td>
<td>28,994,635</td>
<td>26,440,547</td>
<td></td>
</tr>
<tr>
<td><strong>Overhead expense allocations</strong></td>
<td>5,841,443</td>
<td>2,025,144</td>
<td>277,386</td>
<td>3,047,357</td>
<td>(5,139,489)</td>
<td>(3,617,092)</td>
<td>(1,664,877)</td>
<td>(405,684)</td>
<td>(364,188)</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td><strong>Total expenses</strong></td>
<td>$17,799,627</td>
<td>$5,626,223</td>
<td>$1,307,458</td>
<td>$4,261,327</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>$ —</td>
<td>$ —</td>
<td>$28,994,635</td>
<td>$26,440,547</td>
<td></td>
</tr>
</tbody>
</table>

*Internal direct charges are net expenses from one functional area to another based upon the actual use of goods and services.

**Overhead expense allocations include the costs allocated from the Laboratory’s functional areas to the final cost objectives.

The accompanying notes are an integral part of the financial statements.
Report of the Library Director

During the past several years a major paradigm shift has clearly taken place in the MBL/WHOI Library. We now have more than 2000 full-text electronic journals available on the network. The library web site is the starting point for content rich information that is being delivered to the much heralded “scientists’ desktop.”

The simple act of checking in a journal and placing it on the shelf or requesting an Interlibrary Loan now requires the use of various pieces of software like Prospero, CLIO, OCLC Microenhancer, OCLC Passport, Ariel, Microsoft Office, EDI, ABLE, URSA, and various modules of Mariner, as well as online delivery service software for statewide courier services: FedEx, UPS, CISTI, NTIS, and ISI. The inauguration of information delivery via our web site also employs the use of SQUID, Geobrowser, LUCID, MySQL, Ultra Edit, Adobe GoLive, Adobe Premiere, Adobe Acrobat, Omni Page, Web Star, Fetch, Quid Pro Quo, Microsoft Office, Portfolio, Graphics Converter, Home Page, SSH, FileMaker, BB Edit, Illustrator, Photoshop, PageMaker, and Apache, and languages such as PHP3, Perl, and SQL. Obviously, “instant” delivery of information requires many hours of staff time implementing major software and hardware infrastructure installations to support this effort.

This instant information drive is powerful, but intellectual ownership and archival requirements are elusive in the world of ePublishers and libraries. Print subscriptions still arrive daily, and electronic journals seem to disappear from a web site at whim. We are making choices in an age of disruptive technologies and value-changing economies. Still, much was accomplished in 2000 in the library. The emphasis this year was on expanding the serial collection, both print and electronic. The collection has grown to more than 200,000 volumes—occupying all the physical space we have available in Woods Hole.

Space and Renovations

Providing space for library resources is a constant concern for library patrons and staff. Some of the storage problems have been addressed by providing more electronic access to journals and sending some volumes off campus to the Harvard Depository. A Feasibility Study performed by Jay Lucker, Library Consultant, and Stephen Hale, Architect, presented several design ideas to the Trustees. Along with the major recommendation for additional space, the study resulted in a redesign of the equipment and furniture in the catalog room, which allowed more computer terminals for patrons, and the installation of a “window” to the reference desk for easy access to “live” reference information. In addition, the WHOI Archives finished a compact shelving project that encompasses 2130 square feet and resulted in 11,200 linear feet; it will allow for more aggressive record management and 15 years’ added growth in archival space projections.

The major improvement to the current library space in the Lillie building was the installation of a new HVAC system that supplies heat in the winter and cooling in the summer to the stack area, the library office, and the reading rooms. This joint venture, financially supported
by both MBL and WHOI, is preventing the wild temperature swings that can be so damaging to the collections. This is a key improvement and the basis for any conservation and preservation program.

**Special Collection and Rare Books**

Dr. Garland Allen and Carol Winn identified nearly 2500 volumes in the open stacks, dating from the early 19th century, that require preservation and increased security to protect their plates and illustrations. Our Rare Books Room is filled to capacity, so we must find additional space for these materials in the coming years.

The Mary Sears collection, which included individual pieces of the *Challenger* and *Siboga* expeditions, was cataloged and indexed this year. Dr. Arthur Humes' collection was also processed; it included a collection of exotic shells. Also acquired and added to the Florence Gould Collection in the Rare Books was Guillaume Rondelet’s *Libri de Piscibus Marinis* (1554). This volume is now the oldest book in the collection and one of the first books to describe marine organisms and fishes.

**Electronic Access**

As access to information becomes more interactive and information retrieval moves at breakneck speed, the importance of web design and accessibility heightens. The library’s web page will continue to be in “re-design” mode with the addition of new resources and services. A new staff member, Amy Stout, Digital Systems and Services Coordinator, is in charge of posting and monitoring the use of this integral part of the library’s services. Major upgrades to the library’s software took place this year, which resulted in a new look and feel to the web interface, allowing more flexibility in customizing displays for patrons.

Electronic access to the *Oxford English Dictionary* and web versions of *Zoo Record* and *PsyclINFO* were new additions to the library holdings this year. The library joined JSTOR, a project that provides digital archives of classic serials in the general sciences, ecology, and botany. JSTOR gives us access, for example, to the entire run of *The Philosophical Transactions of the Royal Society of London* from Volume 1, Number 1 in 1665.

**Cooperating Libraries**

The Boston Library Consortium (BLC) received grant funding from the Massachusetts Board of Library Commissioners for the implementation of a virtual catalog and interlibrary loan (ILL) direct distance borrowing project (VirCat). This grant has made it possible for a growing number of libraries in the consortium to allow patron initiated borrowing from each other’s collections without going through the ILL librarians. A group of BLC libraries, including MBL/WHOI, purchased ScienceDirect from Elsevier. This increased our full-text electronic coverage of Elsevier titles from 111 to 850, which represents the combined holdings of Elsevier titles by the BLC members along with an additional 400 Springer-Verlag full-text eJournals.

**Volunteers and Staff**

Judy Ashmore, the Assistant Director for MBL Library Operations, Marguerite (Peg) Costa, Cataloger, and Margot Garritt, WHOI Archivist, together representing more than 50 years of experience in the Library, retired this year. Their work has been greatly appreciated by the entire Woods Hole scientific community.

Eleanor Uhlinger, former Director of the Pell Marine Science Library, joined the library as Assistant Director in January 2001. Sha Li (Lisa), Director of Information Services Center and Library for the South China Sea Institute of Oceanology, Chinese Academy of Sciences in Guangzhou, China, spent two months in the library on a study visit learning new technology.

The volunteers in the Rare Books Room and Archives in the Main library, as well as the volunteers in the Data library, have provided invaluable assistance in helping to organize and make these collections available for future scientists. The oral history project at WHOI has been a great success and will be of inestimable value as the 75th anniversary of that institution approaches. Peg Costa joined the ranks of volunteers and helps Carol Winn with the original cataloging project in the rare books.

It is with extreme sorrow that I report that Dr. Robert Huettner died in March 2001. He will be remembered as someone who had a very real element of the spirit of discovery and learning, a teacher who exuded enthusiasm as well as knowledge. Bob and his wife, Millie, have been volunteers in the Rare Books room for more than 10 years.

The MBL/WHOI Library hosted the Information Futures Institute at the Jonsson Center in May and welcomed leaders in the field of library science. Participation in these meetings is important not only for the national recognition it affords, but for the leadership these groups exercise in shaping the future of research libraries.

The library has embraced the era of informatics. Funded by the Jewett Foundation, extensive research is underway creating an electronic Key system in taxonomy and a taxonomic name server that will serve the academic enterprise over the web. The library committee has finished its strategic plan, which continues to support the library's mission, and looks forward to a future providing a collaborative and collegial environment, with access to information essential to scientific research, preservation of materials for future generations, and teaching in the Woods Hole scientific institutions.

—Catherine Norton
Educational Programs

Summer Courses

Biology of Parasitism: Modern Approaches
(June 8–August 11, 2000)

Directors
Pearce, Edward, Cornell University
Tschudi, Christian, Yale University School of Medicine

Faculty
Phillips, Meg, University of Texas Southwestern Medical Center
Russell, David, Washington University School of Medicine
Scott, Phillip, University of Pennsylvania
Selkirk, Murray, Imperial College of Science, Technology & Medicine, United Kingdom
Sibbey, David, Washington University School of Medicine
Ullu, Elisabetta, Yale University School of Medicine
Waters, Andrew P., Leiden University Medical Centre

Lecturers
Allen, Judith, University of Edinburgh
Arts, David, University of Pennsylvania
Bangs, Jay, University of Wisconsin-Madison
Beckers, Cornelis, University of Alabama, Birmingham
Beverley, Stephen, Washington University School of Medicine
Borst, Piet, Netherlands Cancer Institute
Burleigh, Barbara, Harvard School of Public Health
Cully, Doris, Merck & Co.
Dunne, David, Cambridge University
Fidock, David, Albert Einstein College of Medicine
Goldberg, Daniel, Washington University School of Medicine
Grencis, Richard, University of Manchester, United Kingdom
Guiliano, David
Gull, Keith, University of Manchester, United Kingdom
Hajduk, Steve, University of Alabama, Birmingham
Hoffman, Steve
Hunter, Christopher, University of Pennsylvania
Komuniecki, Richard, University of Toledo
Kopf, Manfred, Basel Institute for Immunology, Switzerland
Landèe, Scott, Oregon Health Sciences University
Langhorne, Jean, Medical Research Council
McKerrow, James
Mottram, Jeremy, University of Glasgow
O’Neill, Scott, Yale University School of Medicine
Parsons, Marilyn, Seattle Biomedical Research Institute
Preiser, Peter, Medical Research Council
Rathod, Pradip, Catholic University of America
Sacks, David, National Institutes of Health
Scher, Artur, Institut Pasteur, France
Sher, Alan, National Institutes of Health
Sinnis, Photini, New York University School of Medicine
Tarleton, Rick, University of Georgia
Turco, Sam, University of Kentucky Medical Center
Wang, Ching Chung, University of California, San Francisco
Wirth, Dyann, Harvard School of Public Health

Teaching Assistants
Beatty, Wandy, Washington University School of Medicine
Dijkeng, Appolaine, Yale University School of Medicine
Hussein, Ayman, Imperial College of Science, Technology & Medicine, United Kingdom
Jackson, Laurie, University of Texas Southwestern
Kissinger, Jessica, University of Pennsylvania
Lovett, Jennie, Washington University School of Medicine
MacDonald, Andrew, Cornell University
Morrissette, Naomi, Washington University School of Medicine
Reiner, Steven
van der Wel, Annemarie, Biomedical Primate Research Centre, The Netherlands

Course Assistants
Chipperfield, Caitlin Nadine, Cornell University
Johnson, Ben, Cornell University

Students
Andersson, John, Karolinska Institut
D’Angelo, Maximiliano, University of Buenos Aires
Dolezal, Pavel, Charles University, Prague
Ferreira, Ludmila, Universidade Federal de Minais Gerais
Figueiredo, Luana, Institut Pasteur
Gilk, Stacey, University of Vermont
Lamb, Tracey, University of Edinburgh
Lowell, Joanna, Rockefeller University
Martins, Gislâne, University of São Paulo
Murti, Sivane, Centro de Pesquisas “Rene Rachou,” Brazil
O’Donnell, Rebecca, University of Melbourne
Ralph, Stuart, University of Melbourne
Selgai, Alifica, Tata Institute of Fundamental Research, India
Tangleby, Laura, U.S. News & World Report, Science Writer
Triggs, Veronica, University of Wisconsin, Madison
Ulbert, Sebastian, Netherlands Cancer Institute
Villarino, Alejandro, University of Pennsylvania

Embryology: Concepts and Techniques in Modern Developmental Biology
(June 18–July 29, 2000)

Directors
Bronner-Fraser, Marianne, California Institute of Technology
Fraser, Scott, California Institute of Technology
Faculty
Adoutte, Andre, University of Paris-Sud, France
Blair, Seth S., University of Wisconsin, Madison
Carroll, Sean, University of Wisconsin, Madison
Collazo, Andrés, House Ear Institute
Ettenson, Charles, Carnegie Mellon University
Harland, Richard, University of California, Berkeley
Henry, Jonathan, University of Illinois, Urbana
Krumlauf, Robb, National Institute for Medical Research
Levine, Michael, University of California, Berkeley
Martindale, Mark, Kewalo Marine Laboratory
Niswander, Lee, Memorial Sloan-Kettering Cancer Center
Rothman, Joel, University of California, Santa Barbara
Saunders, John, Jr., Marine Biological Laboratory
Schapbach, Trudi, Princeton University
Shankland, Martin, University of Texas, Austin
Soriano, Philippe, Fred Hutchinson Cancer Research Center
Wieschaus, Eric, Princeton University
Wray, Gregory, Duke University
Zeller, Robert, University of California, San Diego

Lecturers
Davidson, Eric, California Institute of Technology
Holland, Linda, University of California, San Diego
Hopkins, Nancy, Massachusetts Institute of Technology
Joyner, Alexandra, New York University School of Medicine
Rosenthal, Nadia, Massachusetts General Hospital, East
Smith, William, University of California, Santa Barbara
Stern, Claudio, Columbia University

Teaching Assistants
Allison, Toby, Howard Hughes Medical Institute
Atit, Radhika, Memorial Sloan-Kettering Cancer Center
Baker, Clare, California Institute of Technology
Garcia-Castro, Martin, California Institute of Technology
Gendreau, Steve, Exelixis, Inc.
Kuhlman, Julie, University of Oregon
Lane, Mary Ellen, University of Massachusetts Medical Center
Lartillot, Nicolas, University of Paris-Sud, France
Liu, Karen, University of California, Berkeley
Maduro, Morris, University of California, Santa Barbara
Mariani, Francesca, University of California, Berkeley
Michelli, Craig, University of Wisconsin, Madison
Ober, Elke, University of California, San Francisco
Seaver, Elaine, University of Hawaii
Tabin, Clifford, Harvard Medical School
Tobey, Allison, Memorial Sloan-Kettering Cancer Center
Tranor, Paul, Medical Research Council, United Kingdom
Wallingford, John, University of California, Berkeley
Walsh, Emily, University of California, San Francisco
Williams, Terri A., Yale University
Wilson, Valerie, University of Edinburgh

Course Assistants
Harwitz, Mark, Marine Biological Laboratory
Stringer, Kristen, Marine Biological Laboratory
Wylie, Matthew, Marine Biological Laboratory

Students
Aspock, Gadrun, University of Basel
Ballard, Victoria, University of Surrey, United Kingdom
Bates, Damien, Murdoch Childrens Research Institute

Beckhelling, Clare, Marine Biology Station, France
Bellipanni, Gianfranco, University of Pennsylvania
Cheeks, Rebecca, University of North Carolina, Chapel Hill
Diehnman, Darwin, Hagedorn Research Institute
Dorman, Jennie, University of Washington
Ellertsdottir, Elin, University of Freiburg
Espinoza, Nora, Louisiana State University
Ezin, Max, University of Virginia
Field, Holly, University of California, San Francisco
Gong, Ying, California Institute of Technology
Gross, Jeffrey, Duke University
Huber, Jennifer, University of Hawaii
Imai, Kazushi, Columbia University
Javaherian, Ashkan, Cold Spring Harbor Lab
Jiang, Di, National Institutes of Health
Khokha, Mustafa, University of California, Berkeley
Kyrkjebo, Vibeke, Sars Centre
Lee, Vivian, Oregon Health Sciences University
Mansfield, Jennifer, Columbia University
Marx, Vivien, Freelance Science Journalist
Nasevic, Aidas, University of Minnesota
Prud’homme, Benjamin, CNRS
Skrum, Isaac, Princeton University
Warkman, Andrew, University of Western Ontario

Microbial Diversity (June 11–July 27, 2000)

Directors
Harwood, Carol, University of Iowa
Spormann, Alfred, Stanford University

Faculty
Overmann, Jorg, University of Oldenburg
Schmidt, Thomas, Michigan State University

Lecturers
Delong, Edward, Monterey Bay Aquarium Research Institute
Gaasterland, Terry, Rockefeller University
Greenberg, E. Peter, University of Iowa
Groisman, Eduardo A., Washington University School of Medicine
McFall-Ngai, Margaret, University of Hawaii
Ornston, Nicholas, Yale University
Parsch, Matthew, Northwestern University
Ramey, Paul, Oxford University
Schoolnik, Gary, NIH/NIAID
Stemmer, Pim, Maxygen, Inc.
Visscher, Pieter, University of Connecticut
Walker, Graham, Massachusetts Institute of Technology
Weinstock, George, University of Texas, Houston

Teaching Assistants
Johnson, Hope, Stanford University
Leadbetter, Jared, University of Iowa
Lepp, Paul, Stanford University
Schaefer, Amy, University of Iowa

Course Coordinator
Hawkins, Andrew, University of Iowa

Course Assistant
Ament, Nell, Marine Biological Laboratory

Students
Barak, Yoram, Hebrew University
Begos, Kevin, Winston-Salem Journal, Science Writer
Blake, Ruth, Yale University
Buckley, Daniel, Michigan State University
Callaghan, Amy, Rutgers University
Goldman, Robert, University of Houston
Hansel, Colleen, Stanford University
Kadavy, Dana, University of Nebraska, Lincoln
Kimisips, Mary Jo, University of Illinois, Urbana-Champaign
Lester, Kristin, Stanford University
Lin, Li-hung, Princeton University
MacRae, Jean, University of Maine
McCance, James, Leicester University, England
McMullin, Erin, Penn State University
Neretin, Lev, Shirshov Institute of Oceanography
Powell, Sabrina, University of North Carolina, Chapel Hill
Scott, Bari, SoundVision Productions Science Writer
Simpson, Joyce, University of Illinois, Urbana
Singh, Brajesh, Imperial College
Stevenson, Bradley, Michigan State University
Ward, Dawn, University of Delaware
Zaar, Annette, Universitat Freiberg

Neural Systems and Behavior
(June 11–August 4, 2000)

Directors
Carr, Catherine, University of Maryland
Levine, Richard, University of Arizona, Tucson

Faculty
Brodteufner, Peter, Bryn Mawr College
Dudchenko, Paul, University of Stirling
Ferrari, Michael, University of Arkansas
French, Kathleen, University of California, San Diego
Glanzman, David, University of California, Los Angeles
Kelley, Darcy, Columbia University
Knierim, James, University of Texas Medical School
Kristan, William, University of California, San Diego
Nadam, Farzan, Rutgers University
Nusbaum, Michael, University of Pennsylvania School of Medicine
Prusky, Glen, The University of Lethbridge, Canada
Roberts, William, University of Oregon
Szzupak, Lidia, Universidad de Buenos Aires
Weeks, Janis, University of Oregon
Wood, Emma, University of Edinburgh
Zakon, Harold, University of Texas, Austin

Lecturers
Augustine, George, Duke University
Korn, Henri, Pasteur Institute
Maler, Leonard, University of Ottawa
Pflueger, Hans-Joachim, Freie Universitat Berlin
Ribera, Angela, University of Colorado Health Science Center
Schwartz, Andrew, The Neuroscience Institute
Walters, Edgar T., University of Texas Medical School

Teaching Assistants
Armstrong, Cecilia, University of Washington
Beenhakker, Mark, University of Pennsylvania
Blitz, Dawn Marie, University of Chicago
Bower, Mark, University of Arizona, Tucson
Chen, Shaping, House Ear Institute
Chitwood, Raymon, Baylor College of Medicine
Coleman, Melissa, St. Joseph's Hospital
Duch, Carsten, University of Arizona, Tucson
Gamkrelidze, Georgi, Lucent Technology
Gerrard, Jason, University of Arizona, Tucson
Goodman, Miriam B., Columbia University
Hill, Andrew, Emory University
Masino, Mark, Emory University
McAulay, Lynne, University of Texas, Austin
Otis, Thomas, University of California, Los Angeles
Parameshwaran, Suchitra, University of Maryland
Philpot, Benjamin, Brown University
Scoates, Daphne, University of Maryland
Steff, Brandon, University of California, Los Angeles
Villarcal, Greg, University of California, Los Angeles
Yong, Rocio, University of California, Los Angeles
Zee, M. Jade, University of Oregon

Course Assistants
Almers, Lucy, Marine Biological Laboratory
Psujek, Sean, Marine Biological Laboratory

Students
Akay, Turgay, University of Cologne
Archie, Kevin, University of Southern California
Billimoria, Cyrus, Brandeis University
Black, Michael, Arizona State University
Boyden, Edward, Stanford University
Bradford, Yvonne, University of Oregon
Cardin, Jessica, University of Pennsylvania
Dasika, Vasant, Boston University
Ding, Long, University of Pennsylvania
Froemke, Robert, University of California, Berkeley
Grammer, Michael, University of Southern California
Hubbard, Aida, University of Texas, San Antonio
Hurti, Barbekka, University of Colorado, Boulder
Karmarkar, Uma, University of California, Los Angeles
Konur, Sila, Columbia University
Oestreich, Joerg, University of Texas, Austin
Rela, Lorena, University of Buenos Aires
Singh, Shiva, University of Maryland
Siuda, Edward, Michigan State University
Tobin, Anne-Elise, Emory University
Neurobiology (June 11–August 12, 2000)

Directors
Faber, Donald, Albert Einstein College of Medicine
Lichtman, Jeff W., Washington University School of Medicine

Section Director
Greenberg, Michael, Children’s Hospital

Faculty
Denk, Winfried, Max-Planck Institute for Medical Research
Gan, Wenbiao, New York University School of Medicine
Griffith, Leslie, Brandeis University
Harris, Kristen, Boston University
Hart, Anne, Massachusetts General Hospital
Heuser, John E., Washington University School of Medicine
Howell, Brian, National Institutes of Health
Khdakkhah, Kamran, University of Colorado School of Medicine
Lambert, Nevin, Medical College of Georgia
Lin, Jen-Wei, Boston University
Nedivi, Elly, Massachusetts Institute of Technology
Nowak, Linda, Cornell University
Reese, Thomas, National Institutes of Health
Sanes, Joshua, Washington University Medical School
Schweizer, Felix, University of California, Los Angeles
Shamah, Steven, Children’s Hospital
Smith, Carolyn, National Institutes of Health
Terasaki, Mark, University of Connecticut Health Center
Thompson, Wesley J., University of Texas
Van Vactor, David, Harvard Medical School
Wong, Rachel, Washington University School of Medicine

Lecturers
Barres, Ben A., Stanford University School of Medicine
Bean, Bruce, Harvard University
Conchello, Jose-Angel, Washington University
Ghosh, Anirvan, Johns Hopkins University School of Medicine
Linden, David, Johns Hopkins University
McCleskey, Edwin, Oregon Health Sciences University
McMahan, Uel, Stanford University School of Medicine
Müller, Chris, Brandeis University
Sigworth, Fred, Yale University
Smith, Stephen, Stanford University School of Medicine
Tsien, Roger, University of California, San Diego
Turrigiano, Gina

Teaching Assistants
Pereda, Alberto, Albert Einstein College of Medicine
Petersen, Jennifer, National Institutes of Health
Turney, Stephen, Washington University
Walsh, Mark, Washington University School of Medicine

Course Assistants
Chiu, Delia, Marine Biological Laboratory
Nover, Harris, Marine Biological Laboratory

Students
Ang, Eugenius, Yale University
Kettunen, Petronella, Karolinska Institutet
Khabbaz, Anton, Princeton University/Lucent Technologies
Livet, Jean, IBDM, Marseille
Long, Michael, Brown University
McKellar, Claire, Harvard University
Misgeld, Thomas, Max-Planck-Institute of Neurobiology, Martinsried, Germany
Nelson, Laura, National Institute for Medical Research, United Kingdom
Ruta, Vanessa, The Rockefeller University
Weissman, Tamily, Columbia University
Yasuda, Ryohei, Teikyo University Biotech Research Center
Zhong, Haining, Johns Hopkins University

Physiology: The Biochemical and Molecular Basis of Cell Signaling (June 11–July 22, 2000)

Directors
Garbers, David, University of Texas Southwestern Medical Center
Reed, Randall, Johns Hopkins University School of Medicine

Faculty
Furlow, John, University of California, Davis
Lockless, Steve, University of Texas Southwestern Medical Center
Noel, Joseph, Salk Institute
Prasad, Brinda, Johns Hopkins School of Medicine
Quill, Timothy, University of Texas Southwestern Medical Center
Ranganathan, Rama, University of Texas Southwestern Medical Center
Verdecia, Mark, Salk Institute
Wedel, Barbara, University of Texas Southwestern Medical Center
Zhao, Haiqing, Johns Hopkins School of Medicine
Zielinski, Raymond, University of Illinois, Urbana

Isenberg Lecturer
Hudspeth, A. J., James, Rockefeller University

Lecturers
Armstrong, Clay, University of Pennsylvania
Buck, Linda, Harvard Medical School
Chapman, David, Harvard Medical School
Deeves, Peter, Johns Hopkins University School of Medicine
Dixon, Jack, University of Michigan Medical School
Ehrlich, Barbara, Yale University
Fraser, Scott, California Institute of Technology
Freedman, Leonard, Memorial Sloan-Kettering Cancer Center
Hilgenmann, Donald W., University of Texas Southwestern Medical Center
Huganir, Richard, Johns Hopkins University School of Medicine
Jaffe, Lione, Marine Biological Laboratory
MacKinnon, Rodner, Rockefeller University
Machesky, David, University of Texas Southwestern Medical Center
Opran, Daniel, Brandeis University
Stampfer, Jonathan S., Duke University Medical Center
Willke, Thomas, University of Texas Southwestern Medical Center

Course Coordinator
Lemme, Scott, University of Texas Southwestern Medical Center
Rossi, Kristen, University of Texas Southwestern Medical Center

Students
Brehdez, Timat, University of Miami School of Medicine
Carroll, Michael, University of Newcastle upon Tyne, United Kingdom
Colón-Ramos, Daniel, Duke University
Cordiero, Maria, Instituto Gulbenkian de Ciência, Portugal
Costa, Patricia, University of Rio de Janeiro
Cotrina, Tiziana, Scuola Normale Superiore
Crespo-Barreto, Juan, University of Puerto Rico
Cruz, Georgina, University of South Florida
Dacek, Mark, University of California, San Francisco
Feigal, Melissa, University of Florida
Fleischer, Jörg, University of Hohenheim
Glater, Elizabeth, Brown University
Jhaveri, Dhanisha, Tata Institute of Fundamental Research
Johansson, Viktoria, Göteborg University
Mah, Silvia, Scripps Institution of Oceanography
Marrari, Yannick, Villefranche Sur Mer
Meister, Jean-Jacques, Swiss Federal Institute of Technology
Menna, Elisabetta, Institute of Neurophysiology, Pisa
Nguyen, Anh, University of Kansas
Petrie, Ryan, University of Calgary
Rankin, Kathleen, Oberlin College
Rodeheffer, Carey, Emory University
Rodgers, Erin, University of Alabama, Birmingham
Seipel, Susan, Rutgers University
Sen, Subhajit, Tata Institute of Fundamental Research
Shatkin-Margolis, Seth, Duke University
Shilkrut, Mark, Technion-Israel Institute of Technology
Takai, Erica, Columbia University
Zeidner, Gil, Weizmann Institute of Science

Special Topics Courses
Analytical and Quantitative Light Microscopy
(May 4–May 12, 2000)

Directors
Studer, Greenfield, University of Massachusetts Medical School
Wolf, David, BioHybrid Technologies Inc.

Faculty
Amos, William B., Medical Research Council, United Kingdom
Cardullo, Richard, University of California, Riverside
Gelles, Jeff, Brandeis University
Inoue, Shinya, Marine Biological Laboratory
Oldenbourg, Rudolf, Marine Biological Laboratory
Salmon, Edward, University of North Carolina, Chapel Hill
Silver, Randi, Cornell University Medical College
Spring, Kenneth, National Institutes of Health
Straight, Aaron, Harvard Medical School
Swedlow, Jason, University of Dundee

Lecturer
McCrone, Walter, McCrone Research Institute

Teaching Assistants
Grego, Sonia, University of North Carolina, Chapel Hill
Hinchcliffe, Edward, University of Massachusetts Medical School
Pollard, Angela, BioHybrid Technologies

Course Coordinator
Miller, Rick, University of Massachusetts Medical School

Students
Abraham, Clara, University of Chicago
Alvarez, Xavier, N.E. Regional Primate Research Center, Harvard Medical School
Andrews, Paul, University of Dundee
Bonnet, Gregoire, Rockefeller University
Bravo-Zanoguera, Miguel, University of California, San Diego
Cohen, David, Cornell University Medical College
Connait, Marie, Westvaco Forest Sciences Lab
Crittenden, Sarah, University of Wisconsin, Madison
Directors
Hunt, Joan, University of Kansas Medical Center
Mayo, Kelly, Northwestern University
Schatten, Gerald, Oregon Health Sciences University

Faculty
Ascoli, Mario, University of Iowa College of Medicine
Campbell, Keith, PPL Therapeutics
Camper, Sally, University of Michigan Medical School
Chan, Anthony, Oregon Health Sciences University
Croy, Barbara Anne, University of Guelph, Canada
Dominko, Tanja, Oregon Regional Primate Research Center
Gibori, Guelu, University of Illinois
Hunt, Patricia A., Case Western Reserve University
Jaffe, Laurinda, University of Connecticut Health Center
Moore, Karen, University of Florida
Morris, Patricia, The Rockefeller University
Mukherjee, Abir, Northwestern University
Nilson, John, Case Western Reserve Medical School
Page, Ray, PPL Therapeutics Inc.
Pedersen, Roger, University of California, San Francisco
Shipman, Margaret, University of Virginia Medical Center
Smith, Lawrence, University of Montreal
Terasaki, Mark, University of Connecticut Health Center
Wakayama, Teruhiko, Rockefeller University
Weigel, Nancy, Baylor College of Medicine

Lecturers
Bakzon, Ronald, University of South Alabama
Behringer, Richard, University of Virginia
Charo, Alta, University of Wisconsin, Madison
Compton, Duane, Dartmouth Medical School
Crowley, William, Massachusetts General Hospital
De Sousa, Paul, Alexandre Roslin Institute
Fazleabas, Asgerally, University of Illinois

Hennighausen, Lothar, National Institutes of Health, NIDDK
Mitchison, Timothy, Harvard Medical School
Myles, Diana, University of California
Ober, Carole, University of Chicago
Orth, Joanne, Temple University School of Medicine
Palazzo, Robert, University of Kansas
Pedraza, Jorge, Texas A&M University
Reijo Pera, Renee, University of California
Richards, Jo-Anne, Baylor College of Medicine
Ruderman, Joan, Harvard Medical School
Shoket, Andrew, Children's Memorial Hospital, CMIER
Shuder, Greenfield, University of Massachusetts Medical School
Stearns, Tim
Straus, Jerome, University of Pennsylvania Medical Center
Tilly, Jonathan L., Massachusetts General Hospital
Wall, Robert, U.S. Department of Agriculture
Wessel, Gary, Brown University
Woodruff, Teresa, Northwestern University

Teaching Assistants
Berard, Mark, University of Michigan
Carroll, David, Florida Institute of Technology
Giusti, Andrew, University of Connecticut Health Center
Gray, Heather, University of Chicago
Greenwood, Janice, University of Guelph
Hinkle, Beth, University of Connecticut Health Center
Hodges, Craig, Case Western Reserve University
Jaquette, Julie, University of Iowa
Mallik, Nusrat, Baylor College of Medicine
Miller, Michelle, Oregon Health Sciences University
Payne, Christopher, Oregon Regional Primate Research Center
Ranft, Linda, University of Connecticut Health Center
Saunders, Thomas, University of Michigan
Takahashi, Diana, Oregon Regional Primate Research Center
Voronina, Ekaterina, Brown University
Weck, Jennifer, Northwestern University

Course Coordinators
Burnett, Tim, University of Kansas Medical Center
Marin Bivens, Carrie, University of Massachusetts
McMullen, Michelle, Northwestern University
Petrie, Maggie, University of Kansas Medical Center
Simerly, Calvin, Oregon Regional Primate Research Center

Students
Alberio, Ramiro, Ludwig-Maximilian University, Germany
Allegriaci, Cinzia, Perugia University, Italy
Ashkar, Ali, University of Guelph
Berkowitz, Karen, University of Pennsylvania
Chong, Kowit-Yu, Oregon Regional Primate Research Center
Diaz, Lorenzo, INNSZ
Graham, Kathryn, Oregon Health Sciences University
Greenlee, Anne, Marshfield Medical Research Foundation
Heifetz, Yael, Cornell University
Keller, Dominique, Texas A&M University
Lavoie, Holly, University of South Carolina
Majumdar, Suheer, National Institute of Immunology
Powell, Jacqueline, Morehouse School of Medicine
Richard, Craig, Magee-Women's Research Institute
Sahgal, Namita, Kansas University Medical Center
Zhang, Gungui, University of Virginia

Frontiers in Reproduction: Molecular and Cellular Concepts and Applications
(May 21–July 1, 2000)
Fundamental Issues in Vision Research
(August 13–25, 2000)

Directors
Masur, Sandra K., Mount Sinai School of Medicine
Papermaster, David, University of Connecticut Health Center

Faculty
Barlow, Robert, Syracuse University
Barres, Ben A., Stanford University School of Medicine
Beebe, David C., Washington University School of Medicine
Berson, Elliot L., Harvard Medical School
Bok, Dean, University of California, Los Angeles
Dickersin, Kay, Brown University
Dowling, John E., Harvard University
Fisher, Richard, National Institutes of Health
Gordon, Marion, Rutgers College of Pharmacy
Hamm, Heidi E., Northwestern University Medical School
Horton, Jonathan, University of California
Horwitz, Joseph, University of California, Los Angeles
Lang, Richard A., New York University School of Medicine
LaVail, Jennifer, University of California, San Francisco
Lavker, Robert, University of Pennsylvania
Lehrer, Robert, University of California, Los Angeles
Leske, M. Cristina, State University of New York, Stony Brook
Liberman, Ellen, National Institutes of Health
Malchow, Robert, University of Illinois, Chicago

Mashland, Richard, Massachusetts General Hospital
Nathans, Jeremy, Johns Hopkins University School of Medicine
Niderkorn, Jerry Y., University of Texas Southwestern Medical Center
Overbeck, Paul A., Baylor College of Medicine
Piatigorsky, Joram, National Institutes of Health
Raviola, Elio, Harvard Medical School
Shatz, Carla, Harvard Medical School
Stambolian, Dwight, University of Pennsylvania
Sugrue, Stephen P., University of Florida College of Medicine
Wasson, Paul, Harvard Medical School

Lecturers
Assad, John, Harvard Medical School
Hernandez, M. Rosario, Washington University School of Medicine
Moses, Marsha, Children's Hospital, Boston
Russell, Paul, National Institutes of Health

Students
At-Khatib, Khaldun, University of Illinois, Chicago
Bernstein, Audrey, Mount Sinai Medical School
Brinbaum, Andrea, University of Illinois, Chicago
Camelo, Serge, Institut Pasteur
Cronin, Carolyn, University of Virginia
Gaudio, Paul, Yale University
Goh, Meilan Stephanie, University of Illinois, Chicago
Hartford, April, University of Louisville
Jessami, Nadim, Scripps Research Institute
Jiang, Shunai, Emory University
Kenyon, Kristy, Massachusetts Eye and Ear Infirmary
Libby, Richard, Medical Research Council, United Kingdom
Liu, Xiaorong, University of Virginia
Mahajan, Vinit, University of California, Irvine
Pennesi, Mark, Baylor College of Medicine
Pittman, Kristi, North Carolina State University
Rose, Linda, University of Maryland
Ruttan, Gregory, University of Miami, Florida
Sagdullaev, Botir, University of Louisville
Shestopalov, Valery, Washington University

Medical Informatics (May 28–June 3, 2000)

Director
Masys, Daniel, University of California, San Diego

Faculty
Canese, Kathi, National Library of Medicine
Cimino, James, Columbia University
Friedman, Charles, University of Pittsburgh
Giuse, Nunzia, Vanderbilt University Medical Center
Hightower, Allen, Centers for Disease Control and Prevention
Kingsland, Lawrence, National Library of Medicine
Lindberg, Donald, National Library of Medicine
McDonald, Clement, Regenstrief Institute
Miller, Randolph, Vanderbilt University Medical Center
Nahin, Annette, National Library of Medicine
Ozbolt, Judy, Vanderbilt University Medical Center
Stead, William, Vanderbilt University Medical Center
Wheeler, David, National Library of Medicine

Students
Athreya, Balu, DuPont Hospital for Children
Barney, Judith, Ingham Regional Medical Center
Bettis, Eugene, Medical College of Georgia
Blatt, Jody, Health Care Financing Administration
Brill, Peter, Trover Foundation
Brown, James, University of Southern California
Clintworth, William, University of Southern California
Cohn, Wendy, University of Virginia
Cowper, Diane, Hines VA Hospital
Cooper, Natasha, Penn State College of Medicine
Desai, Sundeeb, Northwestern Medical Faculty Foundation
Ebeling, Kelly, University of Wisconsin, Madison
Fukla, Pauline, Louisiana State University
Halsted, Deborah, Houston Academy of Medicine
Harris, Anthony, University of Maryland
Levine, Alan, University of Texas, Houston
Jenson, James, University of New Mexico
Klingens, Donald, Riverside Regional Medical Center
Kubal, Joseph, VA Information Resource Center
McKnight, Michelynn, Norman Regional Hospital
Obijiofor, Chioma, Bioresources Development and Conservation Program
Schwartz, Marilyn, Naval Medical Center, San Diego
Smith, John, University of Alabama, Birmingham
Sooho, Alan, Battle Creek Veterans Administration
Stocking, John, University of Louisville
Strachan, Dina, King/Drew Medical Center
Thibodeau, Patricia, Duke University
Vaidya, Vinay, University of Maryland
Weeltje, Keith, Medical College of Georgia
Yamamoto, David, University of California, Los Angeles
Zick, Laura, Clarion Health

Medical Informatics (October 1-7, 2000)

Director
Cimino, James, Columbia University

Faculty
Bakken, Suzanne, Columbia University
Cimino, Chris, Albert Einstein College of Medicine
Friedman, Charles, University of Pittsburgh
Jenders, Robert, Columbia University
Kingsland, Lawrence, National Library of Medicine
Lindberg, Donald, National Library of Medicine
Mays, Daniel, University of California, San Diego
McCray, Alexa, National Library of Medicine
Nahin, Annette, National Library of Medicine
Perednia, Douglas, Association of Telehealth Providers
Starren, Justin, Columbia University
Wheeler, David, National Library of Medicine

Students
Amend, Clifford, Care First Blue Cross Blue Shield
Abu, Ajit, St. Louis VA Medical Center
Baer, Michael, Lebanon Veterans Admin. Medical Center
Barclay, Allan, Indiana University School of Medicine
Barke, Cynthia, Hampton University
Byrd, Vetriv, University of Alabama, Birmingham
Dain, Steven, University of Western Ontario
Davis, Wayne, University of Michigan Medical School
DiPro, Joseph, University of Georgia
Fernandes, John, Chicago College Osteopathic Medicine
Frank, Christine, Rush-Presbyterian-St. Luke's Medical Center

Gallardo, Gladys, Universidad Central del Caribe
Gamble, James, Manilas Health Center
Gill, Jagjit, Mayo Clinic and Foundation
Goodwin, Cheryl, Swedish Medical Center
Guarcello, Catherine, St. Elizabeth’s Medical Center
Jones, Dixie, LSU Health Science Center
Kelly, Catherine, Massachusetts General Hospital
Mackowiak, Leslie, Duke University Health System
McKoy, Karen, Lahey Clinic
Moser, Stephen, University of Alabama, Birmingham
Murray, Kathleen, University of Alaska Anchorage
Peppar, David, University Medical Center
Riesenberg, Lee, Ann Guthrie Healthcare System
Sathe, Nila, Vanderbilt University Medical Center
Sullivan, Eileen, University of New Mexico
Taylor, Vera, Morehouse School of Medicine
Weilks, Kay, Mayo Clinic Scottsdale
Wiedermann, Bernhard, Children's National Medical Center, Washington

Methods in Computational Neuroscience (July 30-August 26, 2000)

Directors
Bialek, William, NEC Research Institute
de Ruiter, Rob, NEC Research Institute

Faculty
Abbott, Lawrence, Brandeis University
Colby, Carol, University of Pittsburgh
Collett, Thomas, University of Sussex
Dan, Yang, University of California, Berkeley
Delaney, Kerry, Simon Fraser University, Canada
Doupe, Allison, University of California, San Francisco
Ermontout, Bard, University of Pittsburgh
Festerv, David, Northwestern University
Gelperin, Alan, Bell Laboratories
Hopfield, John, Princeton University
Johnston, Daniel, Baylor College of Medicine
Kelley, Darcy, Columbia University
Kleinfield, David, University of California, San Diego
Kopell, Nancy, Boston University
Marder, Eve, Brandeis University
Markram, H., University of California
Miller, K. D., University of California, San Francisco
Microinjection Techniques in Cell Biology
(May 16–23, 2000)

Director
Silver, Robert, Marine Biological Laboratory

Faculty
Klaessig, Suzanne, Cornell University
Kline, Douglas, Kent State University
Shelden, Eric, University of Michigan
Wilson, Susan, Cornell University

Teaching Assistant
Miller, Roy Andrew, Kent State University

Students
Cabot, Ryan, University of Missouri
Caswell, Wayne, Lahey Clinic
Combelles, Catherine, Tufts University
Davies, Daryl, University of Southern California
Dong, Lily, UT Health Science Center, San Antonio
Geraci, Fabiana, University of Palermo
Gilbert, Joanna, Harvard Medical School
Gundersen-Rindal, Dawn, U.S. Department of Agriculture
Harwood, Claire, University of Pennsylvania
Hawash, Ibrahim, Purdue University
Howe, Charles, Stanford University
Kay, EunDuck, Doheny Eye Institute
Kline-Smith, Susan, Indiana University
Macdonald, Jennifer, Medical University of South Carolina
Nguyen, Hong-Ngan, University of Louisiana of Lafayette
Okusa, Akiko, Harvard University
von Dassow, Peter, Scripps Institute of Oceanography
Webb, Bradley, Queen’s University
Widehitz, Randall, University of Southern California
Yang, Jia, Duke University, HHMI

Modeling of Biological Systems
(March 25–May 4, 2000)

Director
Silver, Robert, Marine Biological Laboratory

Faculty
Boston, Raymond C., University of Pennsylvania
Cheatham, Thomas E., University of Utah
Hertzfeld, Judith, Brandeis University
Hummel, John, Argonne National Laboratory
Kollman, Peter, University of California, San Francisco
Morse, Peter, University of Pennsylvania
Pearson, John, Los Alamos National Laboratory
Petsko, Greg A., Brandeis University
Ponce Dawson, Silvina, Ciudad Universitaria, Argentina

Students
Genick, Ulrich, The Salk Institute
Ginsberg, Tara, University of Texas, Houston
Hershberg, Uri, Hebrew University
Immerstrand, Charlotte, Linkoping University, Sweden
Jiang, Yi, Los Alamos National Laboratory
Molecular Biology of Aging (August 12–18, 2000)

Directors
Guarente, Leonard P., Massachusetts Institute of Technology
Wallace, Douglas, Emory University School of Medicine

Faculty
Austad, Steven, University of Idaho
Beal, M. Flint, Cornell University
Bohr, Vilhelrn A., National Institutes of Health
Campisi, Judith, Lawrence Berkeley National Laboratory
Culotta, Valeria L., Johns Hopkins University
de Lange, Titia, The Rockefeller University
Hanawalt, Philip, Stanford University
Johnson, Thomas, University of Colorado
Jones, Dean P., Emory University
Kenyon, Cynthia, University of California, San Francisco
Kim, Stuart, Stanford, University School of Medicine
Lithgow, Gordon J., University of Manchester
Martin, George, University of Washington School of Medicine
McChesney, Patricia, University of Texas Southwestern Medical Center
Price, Donald L., Johns Hopkins University School of Medicine
Richardson, Arlan, University of Texas Health Science Center, San Antonio
Ruvkun, Gary, Massachusetts General Hospital
Tanzi, Rudolph E., Harvard Medical School
Tower, John, University of Southern California
Van Voorhis, Wayne, University of Arizona, Tucson
Wright, Woodring E., University of Texas Southwestern Medical Center

Lecturers
Finch, Celeb, University of Southern California
Hekimi, Siegfried, McGill University
Weindruch, Richard H., Veterans Administration Hospital

Teaching Assistants
Coskan, Elif Pinar, Emory University School of Medicine
Ford, Ethan, Massachusetts Institute of Technology
Kerstann, Keith, Emory University School of Medicine
Kokoszka, Jason, Emory University
Levy, Shawn, Vanderbilt-Ingram Cancer Center
Marciniak, Robert, Massachusetts Institute of Technology
McVey, Mitch, Massachusetts Institute of Technology
Murdock, Deborah, Emory University

Course Coordinator
Burke, Rhonda E., Emory University School of Medicine

Course Assistant
Ament, Nell, Marine Biological Laboratory

Students
Bailey, Adina, University of California, Berkeley
Baur, Joe, UT Southwestern Medical Center, Dallas

Molecular Mycology: Current Approaches to Fungal Pathogenesis (August 7–25, 2000)

Directors
Edwards, John, Jr., Harbor-UCLA Medical Center
Magee, Paul T., University of Minnesota
Mitchell, Aaron P., Columbia University

Faculty
Filler, Scott, Harbor-UCLA Medical Center
Heitman, Joseph, Duke University Medical Center
Rhodes, Judith, University of Cincinnati Medical Center
White, Theodore, Seattle Biomedical Research Institute

Lecturers
Cushion, Melanie, University of Cincinnati
Doering, Tamara, Washington University School of Medicine
Fink, Gerald, Whitehead Institute
Kozel, Thomas, University of Nevada School of Medicine
Kwon-Chung, June, National Institutes of Health
Levitz, Stuart, Boston University
Magee, Beatrice, University of Minnesota
Paziss, John, Proteome, Inc.
Quinn, Cheryl, Pharmacia & Upjohn
Scherer, Stewart, Rosetta Inpharmatics

Teaching Assistants
Flemmken, Michelle, Montana State University
Johnston, Douglas, Harbor-UCLA Medical Center
Lengeler, Klaus B., Duke University Medical Center

Course Assistant
Martin, Sam, Marine Biological Laboratory

Students
Askew, David, University of Cincinnati
Austin, W. Lena, Howard University
Blankenship, Jill, Duke University
Burr, Ian, Pfizer Central Research
Francis, Susan, University of Washington
Hochstenbach, Frans, University of Amsterdam
Ibrahim, Ashraf, Harbor-UCLA Medical Center
Lo, Hsiu-Jung, National Health Research Institutes
Mol, Pietermella, University of Amsterdam
Munro, Carol, University of Aberdeen
Pereia, Sofia, University of Texas
Spellberg, Brad, Harbor-UCLA Medical Center
Spreghini, Elisabetta, Yale University
Toenjes, Kurt, University of Vermont
Wasylinka, Julie, Simon Fraser University

**Neural Development and Genetics of Zebrafish**
(August 13–26, 2000)

**Directors**
Dowling, John E., Harvard University
Hopkins, Nancy, Massachusetts Institute of Technology

**Faculty**
Chien, Chi-Bin, University of Utah Medical Center
Collazo, Andres, House Ear Institute
Eisen, Judith S., University of Oregon
Fecho, Joseph, State University of New York, Stony Brook
Harlow, Roger, Marine Biological Laboratory
Houart, Corrine, University College London, United Kingdom
Kimmel, Charles, University of Oregon
Lin, Shao, Medical College of Georgia
Neuhauess, Stephan, Max-Planck-Institut für Entwicklungsbiologie, Germany
Talbot, William S., Stanford University School of Medicine
Wilson, Stephen, University College London, United Kingdom

**Lecturers**
Astrofsky, Keith, Massachusetts Institute of Technology
Fraser, Scott, California Institute of Technology

**Teaching Assistants**
Amacher, Sharon, University of California, Berkeley
Clarke, Jon, University College London, United Kingdom
Fadool, James, Florida State University
Granato, Michael, University of Pennsylvania
Lyons, David, University College London
Mazanec, April, University of Oregon
Mullins, Mary, University of Pennsylvania
Perkins, Brian, Harvard University
Pomrehn, Andrea, Stanford University
Wagner, Daniel, University of Pennsylvania Medical School
Walker-Durcanck, Charline, University of Oregon
Waterbury, Julie, University of Pennsylvania

**Course Coordinator**
Schmitt, Ellen, Harvard University

**Facility Technician**
Linnon, Beth, Marine Biological Laboratory

**Course Assistant**
Bradley, Margaret, Marine Biological Laboratory

**Students**
Challa, Anil Kumar, Ohio State University
Croall, Dorothy, University of Maine
Darimont, Beatrice, University of Oregon
Kaneko, Maki, University of Houston
Leung, Fung Ping, Hong Kong University
Levkowitz, Gil, Weizmann Institute of Science
Lupo, Giuseppe, University of Pisa
Maldonado, Ernesto, Massachusetts Institute of Technology
Mangoli, Maryam, University College London, United Kingdom
Meyer, Martin, Stanford University
Naco, Grace, Johns Hopkins School of Medicine
Nelson, Ralph, National Institutes of Health
Niel, Cristopher, Stanford University
Schneider, Valerie, Harvard Medical School
Starr, Catherine, The Rockefeller University
Yvon, Anne-Marie, University of Massachusetts, Amherst

**Neurobiology & Development of the Leech**
(August 13–September 1, 2000)

**Directors**
Calabrese, Ronald L., Emory University
Salley, Christine, Purdue University
Shankland, Martin, University of Texas, Austin

**Faculty**
Ali, Declan, Hospital for Sick Children
Baader, Andreas, Universität Bern, Switzerland
Bissen, Shirley, University of Missouri
Blackshaw, Susanna, University of Oxford, United Kingdom
Brodie, Peter, Bryn Mawr College
Carbonetto, Salvatore, Montreal General Hospital, Canada
Drapeau, Pierre, McGill University, Canada
Fernandez de Miguel, Francisco, Universidad Nacional Autonoma de Mexico
Massino, Mark, Emory University
Modney, Barbara, Cleveland State University
Muller, Kenneth, University of Miami School of Medicine
Nicholls, John, SISSA, Italy
Weisblat, David, University of California, Berkeley

**Lecturer**
Macagno, Eduardo, Columbia University

**Course Assistant**
Johnson, Ben, Marine Biological Laboratory
Optical Microscopy and Imaging in the Biomedical Sciences (October 11-19, 2000)

Director
Izzard, Colin, State University of New York, Albany

Faculty
DePasquale, Joseph, New York State Department of Health
Hard, Robert, State University of New York, Buffalo
Imoue, Shinya, Marine Biological Laboratory
Maxfield, Frederick, Cornell University Medical College
Murray, John, University of Pennsylvania School of Medicine
Piston, David M., Vanderbilt University
Spring, Kenneth, National Institutes of Health
Swedlow, Jason, University of Dundee, UK

Lecturers
Hinsch, Jan, Leica, Inc.
Keller, H. Ernst, Zeiss Optical Systems
Oldenbourg, Rudolf, Marine Biological Laboratory

Teaching Assistant
Sigurdson, Wade, State University of New York, Buffalo

Course Associate
Snyder, Kenneth, State University of New York, Buffalo

Course Assistant
Pierini, Lynda, Weill Medical College of Cornell University

Students
Arudchandran, Ramachandran, National Institutes of Health
Christensen, Trace, Mayo Clinic
Diez, Stefan, Max-Planck-Institute
Dobrunz, Lynn, University of Alabama, Birmingham
Flett, Alexander, University of Dundee
Fure, Bruce, Harvard Medical School
Garcia-Mata, Rafael, University of Alabama, Birmingham
Gaspar, Claudia, Montreal General Hospital
Goldworthy, Michael, Memorial University of Newfoundland
Gross, Peter, Beth Israel Deaconess Medical Center
Hagting, Anja, Wellcome/CRC Institute
Holton, Gary, Pacific Northwest National Laboratory
Hu, Ke, University of Pennsylvania
Islam, Mohammad, University of Pennsylvania
Karlsson, Christina, Karolinska Institute
Linser, Paul, Whitney Lab, University of Florida
Martinez, Angie, Harvard Medical School
Martins, Gabriel, State University of New York, Buffalo
North, Alison, Rockefeller University
Ono, Yasuko, University of Arizona
Praetorius, Jeppe, National Institutes of Health
Quao, Jing, Massachusetts General Hospital
Rice, Marian, Mount Holyoke College
Schmidle, David, University of Oklahoma

Rapid Electrochemical Measurements (May 11-15, 2000)

Director
Gerhardt, Greg, University of Kentucky

Faculty
Cass, Wayne, University of Kentucky
Currier, Theresa, University of Kentucky
Gratton, Alain, McGill University
Hoffman, Alex, National Institutes of Health
Huettel, Peter, University of Kentucky
Palmer, Michael, University of Colorado Health Science Center
Porterfield, David, University of Missouri-Rolla
Purdum, Matt, University of Kentucky
Stanford, John, University of Kentucky
Sulzer, David, Columbia University
Surgener, Stewart, University of Kentucky

Teaching Assistants
Burmester, Jason, University of Kentucky
Pomerleau, Francois, McGill University

Course Coordinator
Lindsay, Robin, University of Kentucky

Students
Ahmad, Laura, Eli Lilly & Company
Bruno, John, The Ohio State University
Byrd, Kenneth, Indiana University School of Medicine
Cho, Sunyoung, Kyunghee University, Korea
Espey, Michael, National Institutes of Health
Fadel, Jim, Vanderbilt University
Grinevich, Vladimir, University of Kentucky
Hall, Elaine, State University of New York, Buffalo
Jackson, Mark, Yale University
Jow, Brian, Wyeth-Ayerst Research
Judy, Jack, University of California, Los Angeles
Kasano, Kiyoshi, National Institutes of Health
Lan, Esther, University of California, Los Angeles
Lee, Irwin, Harvard Medical School
Maidment, Nigel, University of California, Los Angeles
Montañez, Sylvia, University of Texas Health Science Center
Olabal, Daniel, Rutgers University
Perry, Kenneth, Lilly Research Labs
Phillips, Janice, University of St. Andrews
Reid, Stephen, University of Saskatchewan
Salvatore, Michael, Louisiana State University Health Sciences Center
Sipas, Athanasios, Massachusetts Institute of Technology
Walker, Eric, University of California, Los Angeles
Wilbrecht, Linda, Rockefeller University
Workshop on Molecular Evolution
July 30–August 11, 2000

Director
Cummings, Michael, Marine Biological Laboratory

Faculty
Beerli, Peter, University of Washington
Edwards, Scott, University of Washington
Felsenstein, Joseph, University of Washington
Fraser, Claire M., Institute for Genomic Research
Huelsenbeck, John P., University of Rochester
Kuhner, Mary, University of Washington
Lewis, Paul O., University of Connecticut
Maddison, Wayne P., University of Arizona
Meyer, Axel, University of Konstanz, Germany
Patel, Nipam, University of Chicago
Pearson, William, University of Virginia Health Sciences Center
Rand, David, Brown University
Rice, Ken, Bioinformatics
Riley, Margaret A., Yale University
Swofford, David, Smithsonian Institution
Thompson, Steven, Bionfo 4U
Voytas, Daniel F., Iowa State University
Yokoyama, Shozo, Syracuse University

Lecturer
Yoder, Anne D., Northwestern University Medical School

Teaching Assistants
Amaral-Zettler, Linda, Marine Biological Laboratory
Babin, Josephine, Louisiana State University
Church, Sherr A., University of Virginia
Frantz/Dale, Ben
McArthur, Andrew, Marine Biological Laboratory
Medina, Monica, Marine Biological Laboratory
Myers, Daniel, Marine Biological Laboratory
Pritham, Ellen, University of Massachusetts
Reed, David, Louisiana State University
Waring, Molly E., Marine Biological Laboratory

Students
Allender, Charlotte, Southampton University
Ardell, David, Uppsala University
Barbour, Jason, University of California, San Francisco
Baric, Sanja, University of Innsbruck
Bedard, Donna, Remselaar Polytechnic Institute
Brungiu, Josephine, Yale School of Medicine
Borenstein, Seth, Knight Ridder Newspapers
Boykin, Laura, University of New Mexico
Calcagnotto, Daniela, America Museum of Natural History
Ciampi, Frank, San Francisco State University
Drozdowicz, Yolanda, University of Pennsylvania
Eick, Brititte, University of Cape Town
Erpenbeck, Dirk, University of Amsterdam
Ester, Philip, Tennessee State University
Garcia-Saez, Alberto, Alfred Wegener Institute
Garcia, Martin, UNAM
Gurgel, Carlos, University of Louisiana, Lafayette
Handley, Scott, Centers for Disease Control and Prevention
Hanel, Reinhold, University of Innsbruck
Held, Christoph, Universität Bielefeld
Holland, Brenden, University of Hawaii
Johns, Susan, University of California, San Francisco
Joseph, Leo, Academy of Natural Sciences
Katia, Awadh, Yale University
Kim, Hyung, Smithsonian Institution
Kalathinal, Rob, McMaster University
Liu, J., University of Georgia
Lonecker, Krista, Oregon State University
Lundholm, Nina, University of Copenhagen
Mark Welch, David, Harvard University
McLaughlin, Ian, PE Biosystems
McMahon, Katherine, University of California, Berkeley
Moncayo, Abexardo, University of Texas
Munroe, Stephen, Marquette University
Nepokroeff, Molly, Smithsonian Institution
Newman, Lucy, University of Maryland
O’Connor, Daniel, University of California, Santa Barbara
Online, Julie, Harbor Branch Oceanographic Institution
Pannaccuilli, Federico, University of Genou
Pellegrino, Katia, Brigham Young University
Perez, Ernesto, Université Libre de Bruxelles
Perez-losada, Marcos, Brigham Young University
Philips, Louise, University of Melbourne
Regnery, Rassell, Centers for Disease Control & Prevention
Rhoads, Allen, Howard University
Richardson, Paul, Joint Genome Institute
Rokas, Antonis, University of Edinburgh
Salzburger, Walter, University of Innsbruck
Sankale, Jean-Louis, Harvard School of Public Health
Stone, Karen, University of Alaska, Fairbanks
Tifini, Peter, University of California, Irvine
Utiger, Urs, Zoologisches Museum Zürich
Vasidi, Vasili, University of Colorado Health Sciences Center
Vincent, Martin, Centers for Disease Control and Prevention
Watson, Linda, Miami University
Westmeat, Mark, Field Museum of Natural History
Wilgenbuesch, James, Smithsonian Institution
Wilmotte, Annick, University of Liege
Won, Yong-Jin, Rutgers University
Xie, Gang (Gary), Los Alamos National Laboratory

Other Programs

Marine Models in Biological Research
Undergraduate Program
(June 13–August 11, 2001)

Directors
Browne, Carole L., Wake Forest University
Tytell, Michael, Wake Forest University School of Medicine

Faculty
Allen, Nina S., North Carolina State University
Browne, Carole, Wake Forest University
Furie, Barbara, Harvard School of Medicine
Furie, Bruce, Harvard School of Medicine
Gould, Robert, New York State Institute for Basic Research
Hanlon, Roger, Marine Biological Laboratory
Sanchez, Lloret y Sánchez, National Autonomous University of Mexico
Mikuki, Jill A., Portland State University
O’Donnell, Vicki, National University of Ireland, Maynooth
Richards, Thomas, Southampton University

Sponsors
Arrhenius, Gustaf, Scripps Institution of Oceanography
Cady, Sherry, Portland State University
Des Marais, David, NASA Ames Research Center
Gogarten, Peter, University of Connecticut
Hinkle, C. Ross, Kennedy Space Center
Nierzwicki-Bauer, Sandra, RPI
Pohorille, Andrew, NASA Ames Research Center
Priscu, John, Montana State University
Roberts, Michael S., Kennedy Space Center
Rothschild, Lynn, NASA Ames Research Center

Semester in Environmental Science
(September 4–December 15, 2000)

Administration
Hobbie, John E., Director
Foreman, Kenneth H., Associate Director
Moniz, Polly C., Administrative Assistant

Faculty
Deegan, Linda A.
Foreman, Kenneth H
Giblin, Anne E.
Hobbie, John E.
Hopkinson, Charles S., Jr.
Hughes, Jeffrey
Melillo, Jerry M.
Nadelhoffer, Knute J.
Neill, Christopher
Peterson, Bruce J.
Rastetter, Edward B.
Shaver, Gains R.
Vallino, Joseph J.
Williams, Mathew

Research and Teaching Assistants
Eldridge, Cynthia
Gay, Marcus
Kwiatkowski, Bonnie
Micks, Patricia
Morrisseau, Sarah
Tholke, Kris

SES Students
Angeloni, Catherine A., Wheaton College
Bandstra, Leah M., Beloit College
Businski, Tara N., Bates College
Charelli, Robyn N., Brandeis University
Creswell, Joel E., Macalester College
Dalsimer, Heather S., Dickinson College
Hayes, Alison B., Lawrence University
Johnson, Rebecca T., Oberlin College
Karasack, Rebecca D., Dickinson College
Krumholz, Jason S., Lawrence University

NASA Planetary Biology Internship
(June–September 2000)

Directors
Dolan, Michael F., University of Massachusetts
Margulis, Lynn, University of Massachusetts

Interns
Ampoasah-Manager, Kwabena, University of Ghana
Clarkson, William, Oxford University
Delaire, Luis, National Autonomous University of Mexico
Fiorello, John, University of New Hampshire
Lamb, David, University of North Dakota
Lawson, Jennifer, University of Illinois, Chicago

Malchow, R. Paul, University of Illinois, Chicago
Mensing, Allen, University of Minnesota, Duluth
Palazzo, Robert, University of Kansas
Rome, Lawrence, University of Pennsylvania
Tytell, Michael, Wake Forest University School of Medicine
Wainwright, Norman, Marine Biological Laboratory

Seminar Speakers
Augustine, George, Duke University Medical Center
Ehrlich, Barbara, Yale University School of Medicine
Gallant, Paul, National Institutes of Health
Hill, Susan, Michigan State University
Oldenbourg, Rudolf, Marine Biological Laboratory
Sloboda, Roger, Dartmouth College

Students
Fornwalt, Brandon, University of South Carolina
Gilles, Nicole, University of Minnesota
Gupton, Stephanie, North Carolina State University
Hembree, Chad, Wake Forest University
Kingston, Margaret, Wake Forest University
Lee, Tony, Duke University
Levin, Tracy, Smith College
Mangiameli, Lisa, Colgate University
Rosenkranz, Naomi, Yeshiva University
Szucsik, Amanda, Rutgers University
Zerbe, Jamie, University of Kansas
Lecturers
Lawrence, Corey R., Clarkson University
Schwartz, Jessica C., Connecticut College
Shayler, Hannah A., Connecticut College
Taylor, Catherine A., Brandeis University
Teeters, Kelsa E., Brandeis University

SPINES—Summer Program in Neuroscience, Ethics and Survival (June 10–July 8, 2000)

Directors
Martinez, Jose, University of Texas, San Antonio
Townsel, James G., Meharry Medical College

Faculty
Augustine, George, Duke University
Berger-Sweeney, Joanne E., Wellesley College
Escalona de Motta, Gladys, University of Puerto Rico
Eigen, Anne, Albert Einstein College of Medicine
Fox, Thomas O., Harvard University Medical School
Gonzalez-Lima, Francisco, University of Texas
Maynard, Kenneth L., Massachusetts General Hospital
Zukin, R. Suzanne, Albert Einstein College

Lecturers
Kravitz, Edward, Harvard Medical School
Wyche, James, Brown University

Teaching Assistant
Hohmann, Christine, Morgan State University

Course Coordinator
Garcia, Elizabeth, University of Texas, San Antonio

Students
Boomer, Akilah, Johns Hopkins University
Colon, Wanda, University of Puerto Rico
Davis, Kamisha, University of Utah
Kamendi, Harriet, Howard University
Lorge, Greta, University of Michigan
Mercado, Eduardo, Rutgers University
Reyes, Rosario, University of Oregon
Rodriguez, Gustavo, Purdue University
Vidal, Luis, University of Puerto Rico

Villereal, Greg, University of California, Los Angeles
Whittle, Chris, University of Alaska, Fairbanks

Teachers’ Workshop: Living in the Microbial World (August 13–19, 2000)

Directors
Dugas, Jeff, University of Connecticut, Storrs
Olendzenski, Lorraine, University of Connecticut, Storrs

Faculty
Dorritie, Barbara, Cambridge Rindge and Latin School, Cambridge, MA
Wier, Andrew, University of Massachusetts, Amherst

Presenters
Amils, Ricardo, Autonomous University of Madrid, Spain
Edgcomb, Virginia, Marine Biological Laboratory
Margulis, Lynn, University of Massachusetts, Amherst
Stolz, John, Duquesne University
Wainwright, Norm, Marine Biological Laboratory

Teacher Participants
Barker, Jean, Pleasant Lea Junior High School, Lee’s Summit, MO
Brothers, Chris, Falmouth High School, MA
Campbell, LeeAnne, Mashpee High School, MA
Demetriou, Christina, Astor School, Dover, United Kingdom
Dugan, Maureen, Nashoba Regional High School, Bolton, MA
Estabrooks, Jordan, Somers School, MA
Fenske, Sue, Bernard J. Campbell Junior High School, Lee’s Summit, MO
Jaye, Robert, Solomon Schecter Day School, MA
Johnson, Linda, Nauset Regional Middle School, Orleans, MA
Kamborian, Kimberly, Fenway High School, Boston, MA
Kuvin, Gale, Amherst Regional High School, MA
Panico, Suzanne, Fenway High School, Boston, MA
Soracco, Marlene, Bourne High School, MA
Supplees, Eileen, Sir Roger Manwood School, Kent, United Kingdom
Trask, Janet, Mashpee High School, MA
Trimarchi, Ruth, Amherst Regional High School, MA
Tute, Deb, Nauset Regional Middle School, Orleans, MA
Virchick, Garret, Fenway High School, Boston, MA
Watts, Ngaire, Sir Roger Manwood School, Kent, United Kingdom
Summer Research Programs

Principal Investigators

Antic, Srdjan, Yale University School of Medicine
Armstrong, Clay, University of Pennsylvania
Armstrong, Peter B., University of California, Davis
Augustine, George J., Duke University Medical Center
Baker, Robert, New York University Medical Center
Barlow, Robert B., Jr., State University of New York Health Science Center
Beaugé, Luis, Instituto de Investigacion Medica "Mercedes y Martin Ferreyra," Argentina
Belluscio, Leonardo, Duke University Medical Center
Ben-Jonathan, Nira, University of Cincinnati
Bennett, Michael V. L., Albert Einstein College of Medicine
Bodnick, David, Wesleyan University
Borou, Walter, Yale University Medical School
Boyer, Barbara, Union College
Boyle, Richard, Oregon Health Sciences University
Brady, Scott T., The University of Texas Southwestern Medical Center, Dallas
Brown, Joel, Albert Einstein College of Medicine
Browne, Carole, Wake Forest University School of Medicine
Brazzono, Roberto, Institut Pasteur, France
Burger, Max M., Friedrich Miescher Institut, Switzerland
Burgess, David, Boston College
Burgos, Mario, Universidad Nacional de Cuyo, Argentina
Changeux, Jean-Pierre, Institut Pasteur, France
Chappell, Richard L., Hunter College, City University of New York
Chiao, Chuan-Chin, University of Maryland
Clay, John, National Institutes of Health
Cohen, Lawrence B., Yale University School of Medicine
Cohen, William D., Hunter College, City University of New York
De Weer, Paul, University of Pennsylvania School of Medicine
Devlin, C. Leah, Penn State University
DiPolo, Reinaldo, Instituto Venezolano Investigaciones Cientificas, Venezuela
Dodge, Frederick, State University of New York Upstate Medical University
Edds-Walton, Peggy, University of California, Riverside
Ehrlich, Barbara, Yale University School of Medicine
Fadool, Debra Ann, Florida State University
Fay, Richard, Loyola University of Chicago
Field, Christine, Harvard University Medical School
Fishman, Harvey M., University of Texas Medical Branch, Galveston
Gadsby, David, Rockefeller University
Garcia-Blanco, Mariano, Duke University Medical Center
Gerhart, John, University of California, Berkeley
Giuditta, Antonio, University of Naples, Italy
Goldman, Robert D., Northwestern University Medical School
Gould, Robert, New York State Institute for Basic Research
Groden, Joanna, University of Cincinnati
Haimo, Leah, University of California, Riverside
Hale, Melina, State University of New York, Stony Brook
Haydon, Philip, Iowa State University
Heck, Diane, Rutgers University
Herskovic, Avram, Technion-Israel Institute of Technology, Israel
Highstein, Steven M., Washington University School of Medicine
Hill, Susan Douglas, Michigan State University
Hines, Michael, Yale University School of Medicine
Hofmann, Johann, Stanford University
Holmgren, Miguel, Harvard University Medical School
Holz, George, New York University School of Medicine
Johnston, Daniel, Baylor College of Medicine
Jones, Teresa, National Institutes of Health
Kaczmarek, Leonard, Yale University School of Medicine
Kamin, Benjamin, Boston University School of Medicine
Kaplan, Barry, National Institutes of Mental Health
Kaplan, Ilene E., Union College
Kaupp, U.B., Institut für Biologische Informationsverarbeitung, Germany
Khan, Shahid, Albert Einstein College of Medicine
Kier, William, University of North Carolina, Chapel Hill
Kirschner, Marc, Harvard University Medical School
Koulen, Peter, Yale University School of Medicine
Kuhns, William, The Hospital for Sick Children, Canada
Kuner, Thomas, Duke University Medical Center
Lafer, Eileen M., University of Texas Health Science Center
Landowne, David, University of Miami School of Medicine
Langford, George, Dartmouth College
Laskin, Jeffrey, University of Medicine and Dentistry of New Jersey
Lafer, Hans, University of Connecticut
LaVail, Jennifer, University of California, San Francisco
LeBaron, Richard, University of Texas, San Antonio
Lenzi, David, University of Virginia School of Medicine
Levitan, Irwin, University of Pennsylvania Medical Center
Link, Brian, Harvard University
R36 Annual Report

Lipicky, Raymond J., Food and Drug Administration
Llinás, Rodolfo R., New York University Medical Center

Magee, Jeff, Louisiana State University Medical Center
Malchow, Robert Paul, University of Illinois, Chicago
Malgaroli, Antonio, University of Milan, Italy
Martinez, Joe, University of Texas, San Antonio
McFarlane, Matthew, New York University Medical Center
McNeil, Paul, Medical College of Georgia
Mensinger, Allen, University of Minnesota, Duluth
Messerli, Mark, Purdue University
Mitchison, Timothy, Harvard University Medical School
Moore, John W., Duke University Medical Center
Moosiker, Mark, Yale University

Nasi, Enrico, Boston University School of Medicine
Ogden, David, National Institute for Medical Research
Ogunsenat, Oladele A., University of California, Irvine

Palazzo, Robert, University of Kansas
Pant, Harish, National Institutes of Health
Parysek, Linda, University of Cincinnati
Paydarifar, David, University of Massachusetts Medical School

Rakowski, Robert F., Finch University of Health Sciences/The Chicago Medical School
Ratner, Nancy, University of Cincinnati
Reese, Thomas S., National Institutes of Health
Rieder, Conly, Wadsworth Center
Ripps, Harris, University of Illinois College of Medicine
Rome, Larry, University of Pennsylvania
Rosenbaum, Joel, Yale University
Russell, John M., Syracuse University

Saggau, Peter, Baylor College of Medicine
Sahmon, Edward, University of North Carolina, Chapel Hill
Schmolesky, Matthew, University of Utah
Sloboda, Roger D., Dartmouth College
Spiegel, Evelyn, Dartmouth College
Spiegel, Melvin, Dartmouth College
Srinivas, Madhur, Albert Einstein College of Medicine
Steinacker, Antonette, University of Puerto Rico
Sugimori, Mitsuyuki, New York University Medical Center

Telzer, Bruce, Pomona College
Tilney, Lewis, University of Pennsylvania
Trinkaus, John P., Yale University
Tytell, Michael, Wake Forest University School of Medicine

Udvadia, Ava, Duke University Medical Center

Wadsworth, Pat, University of Massachusetts
Wang, Jing, Lucent Technologies
Weidner, Earl, Louisiana State University
Whate, Thomas, Harvard University Medical School
Whittaker, J. Richard, University of New Brunswick, Canada
Wills, Zachary, Harvard University Medical School

Yanoah, Ebenezer, University of California, Davis
Zemath, Young, Imam University of Pennsylvania

Zecovic, Dejan P., Yale University School of Medicine
Zimmerberg, Joshua, National Institutes of Health

Zottoli, Steven, Williams College
Zakin, R. Suzanne, Albert Einstein College of Medicine

Other Research Personnel

Absar, Ternuo, Niigata University Brain Research Institute, Japan
Ahmed, Tanweer, University of Leeds, United Kingdom
Allen, Nina, North Carolina State University
Aldetine, Anibal, Instituto de Investigacion Medica "Mercedes y Martin Ferreyra," Argentina
Angarita, Benjamin, Williams College
Artigas, Pablo, Rockefeller University
Assokan, Rengasamy, University of California, Davis
Atherton, Jill, Allegheny College

Bastani, Gorka, National Institutes of Health
Bauer, Sharon, Hunter College
Benderkisb, Michael, Duke University Medical Center
Berberian, Graciel, Instituto de Investigacion Medica "Mercedes y Martin Ferreyra," Argentina
Bergamaschi, Andrea, University S. Raffaele, Italy
Bertetto, Lisa, Wesleyan University
Bingham, Eula, University of Cincinnati Medical School
Bonacci, Lisa, Hunter College
Bornstein, Gil, Technion-Israel Institute of Technology, Israel
Boudko, Dmitri, University of Florida
Boyle, Richard, Oregon Health Sciences University
Bringwieser, Gerda, Johns Hopkins University School of Medicine
Bucior, Iwona, Friedrich Miescher Institute, Switzerland

Callender, Delon, Hunter College
Chou, Ying-Hao, Northwestern University
Clarkson, Melissa, University of Kansas
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Oldenburg, Rudolf, Associate Scientist
Shribak, Michael, Staff Scientist

Staff
Knudson, Robert, Instrumental Development Engineer
Baraby, Diane, Laboratory Assistant
MacNeil, June, Executive Assistant

Visiting Investigators
Desai, Arshad, EMBL, Heidelberg, Germany
Fukai, Yoshio, Northwestern University Medical School
Goda, Makoto, Kyoto University, Japan
Keefe, David, Rhode Island Women and Infants Hospital
Liu, Lin, Rhode Island Women and Infants Hospital
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Tran, Phong, Columbia University

The Josephine Bay Paul Center for Comparative Molecular Biology and Evolution

This Center employs the latest advances in phylogenetic theory, computational biology, and high-throughput genome sciences to study evolutionary processes that trace back to the first life forms on earth. Through the application of high-powered statistical techniques, scientists in the Josephine Bay Paul Center investigate how the evolution of genes and genomes has driven phenotypic change at all levels of biological organization. This holistic approach provides tools to quantify and assess biodiversity and to identify genes and genetic mechanisms of biomedical and environmental importance. We study all kinds of microbes, their evolutionary history, their interactions with each other and macroscopic forms of life, and how members of diverse microbial communities contribute and respond to environmental change. Examples of current research include: 1) a project supported by the National Science Foundation to study the co-evolution of genomes for symbiotic bacteria and their hosts; 2) investigations supported by the National Institutes of Health to study expression and the complete genome sequence of Giardia lamblia, a water-borne human pathogen that attacks the intestinal tract and exacts a terrible toll on public health worldwide; 3) a computational biology program funded by the NIH, NASA, and private corporations to integrate evolutionary theory with the functional annotation of protein coding regions in bacterial genomes; and 4) an interdisciplinary study supported by NASA and NSF to study life in extreme environments on the planet earth in search of general principles that can guide the quest for living forms elsewhere in the universe. The Center encourages studies of genotypic diversity across all phyla and promotes the use of modern molecular genetics and phylogeny to gain insights into the evolution of molecular structure and function.

Our research activities are complemented by an active education program. In addition to training postdoctoral fellows, the Josephine Bay Paul Center offers the internationally recognized Workshop in Molecular Evolution at the Marine Biological Laboratory, a workshop for secondary educators titled Living in the Molecular World, and several comprehensive web sites: 1) a description of research and education associated with our membership in the Astrobiology Institute at the Marine Biological Laboratory; 2) the interactive EcoCyc Project (an interactive program that describes the metabolism of E. coli as well as the identity and location of functional genes in the E. coli genome); 3) the Giardia lamblia genome page (which provides annotated analyses and current progress summaries from the MBL’s Giardia lamblia genome project); and 4) the Workshop in Molecular Evolution site (which offers descriptions, information, and advice about sophisticated software packages for phylogenetic inferences and analyses of population biology data).

A generous gift from the Bay Paul Foundation and continuing annual support from the G. Unger Vetlesen Foundation provided initial funding in 1997 to form The Josephine Bay Paul Center for Comparative Molecular Biology and Evolution. The Center has excellent resources for studies of molecular biology and evolution, including well-equipped research laboratories and a powerful computational facility. With a grant from the W.M. Keck Foundation in 2000, the center established a technology-rich Ecological and Evolutionary Genetics Facility. This advanced laboratory provides a full range of high-throughput, DNA-sequencing equipment, a DNA microarray facility and high-performance computers. Several adjunct appointments and collaborative projects strengthen research activities in the center. These activities include interdisciplinary investigations of microbial diversity with scientists at the Woods Hole Oceanographic Institution, molecular ecology studies at the MBL Ecosystem Center’s Plum Island LTER site, physiology...
studies of acidophilic protists with the MBL BioCurrents Research Center, and collaborative efforts to study mechanisms and patterns of evolution with faculty of Harvard University, the Harvard School of Public Health, and the University of Sydney, Australia. Future expansion in the Josephine Bay Paul Center will focus upon molecular evolution of global infectious disease and genome sciences.

Resident Core Investigators

Sogin, Mitchell, Director and Senior Scientist
Cornell, Neal, Senior Scientist
Cummings, Michael, Assistant Scientist
McArthur, Andrew, Staff Scientist II
Morrison, Hilary, Staff Scientist II
Riley, Monica, Senior Scientist
Wernegreen, Jennifer, Assistant Scientist

Adjunct Scientists

Halanych, Ken, Woods Hole Oceanographic Institution
Meselson, Matthew, Harvard University
Patterson, David, University of Sydney
Teske, Andreas, Woods Hole Oceanographic Institution

Laboratory of Neal Cornell

Dr. Neal Cornell, a senior scientist at the Marine Biological Laboratory, played a key role in designing and attracting new faculty to the Josephine Bay Paul Center for Comparative Molecular Biology and Evolution. Dr. Cornell passed away in 2000, but all of us who knew him cherish fond memories and harbor a deep gratitude for his contributions to science and the MBL community. Research in Dr. Cornell’s laboratory, which continued to pursue his research goals through the end of 2000, was concerned with the comparative molecular biology of genes that encode the enzymes for heme biosynthesis. These efforts placed particular emphasis on 5-aminolevulinate synthase, the first enzyme in the pathway. Because the ability to produce heme from common metabolic materials is a near universal requirement for living organisms, these genes provide useful indicators of molecular aspects of evolution. For example, 5-aminolevulinate synthase in vertebrate animals and simple eukaryotes such as yeast and Plasmodium falciparum have high sequence similarity to the enzyme from the alpha-purple subgroup of eubacteria. This supports the suggestion that alpha-purple bacteria are the closest contemporary relatives of the ancestor of eukaryotic mitochondria. The analysis also raised the possibility that plant and animal mitochondria had different origins. Aminolevulinate synthase genes in mitochondria-containing protists are currently being analyzed to obtain additional insight into endosymbiotic events. Also, genes of primitive choanates are being sequenced to gain information about the large-scale gene duplication that played a very important role in the evolution of higher vertebrates. Other studies in the laboratory have been concerned with the effects of environmental pollutants on heme biosynthesis in marine fish, and it has been shown that polychlorinated biphenyls (PCBs) enhance the expression of the gene for aminolevulinate synthase.

Laboratory of Michael P. Cummings

Our research is in the area of molecular evolution and genetics and includes examination of patterns and processes of sequence evolution. We use methods from molecular biology, population genetics, systematics, statistics, and computer science. The basis for much of the research is comparative; it includes several levels of biological organization, and involves both computer-based and empirical studies. A major research focus is analysis genotype-phenotype relationships using tree-based statistical models (decision trees) and extension of this methodology. Current investigations in this area examine how gene sequence data can be used to understand and predict drug resistance in tuberculosis, variation in color vision, and basic immune system functions at the molecular level. For example, using drug resistance in Mycobacterium tuberculosis as a model system, we are investigating how well phenotype (level of drug resistance) can be predicted with genotype information (DNA sequence data). Understanding evolution of drug resistance, and developing accurate methods for its prediction using DNA sequence data, can help in assessing potential resistance in a more timely fashion and circumvent the need for culturing bacteria. More generally, the relationship of genotype to phenotype is a fundamental problem in genetics, and through these investigations we hope to gain insight. The primary empirical work in the laboratory involves examination of opsins, proteins involved in color vision, from local species of Odonata (dragonflies and damselflies). Other projects include a review of genetic diversity in plants using coalescence-based analyses and the genetic consequences of reserve designs in conservation.

Staff

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Clegg, Janet, University of California, Riverside
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Undergraduates
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Waring, Molly E., Harvey Mudd College

Laboratory of Monica Riley
The genome of the bacterium Escherichia coli contains all of the information required for a free-living chemosynthetic organism to live, adapt, and multiply. The information content of the genome can be dissected from the point of view of understanding the role of each gene and the gene product in achieving these ends. The many functions of E. coli have been organized in a hierarchical system representing the complex physiology and structure of the cell. In collaboration with Dr. Peter Karp of SRI International, an electronic encyclopedia of information has been constructed on the genes, enzymes, metabolism, transport processes, regulation, and cell structure of E. coli. The interactive EcoCyc program has graphical hypertext displays, including literature citations, on nearly all of E. coli metabolism, all genes and their locations, a hierarchical system of cell functions and some regulation and transport processes.

In addition, the E. coli genome contains valuable information on molecular evolution. We are analyzing the sequences of proteins of E. coli in terms of their evolutionary origins. By grouping like sequences and tracing back to their common ancestors, we learn not only about the paths of evolution for all contemporary E. coli proteins, but we extend even further back before E. coli, traversing millennia to the earliest evolutionary times when a relatively few ancestral proteins served as ancestors to all contemporary proteins of all living organisms. The complete genome sequence of E. coli and sophisticated sequence analysis programs permit us to identify evolutionarily related protein families, determining ultimately what kinds of unique ancestral sequences generated all of present-day proteins. The data developed in the work has proven to be valuable to the community of scientists sequencing other genomes. E. coli data serve as needed reference points.

Staff
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McCormack, Tom, Postdoctoral Scientist
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Pelegrini-Toole, Alida, Research Assistant II
Serres, Margerethe, Postdoctoral Scientist

Laboratory of Mitchell L. Sogin
This laboratory employs comparative phylogenetic studies of genes and genomes to define patterns of evolution that gave rise to contemporary biodiversity on the planet earth. The laboratory is especially interested in discerning how the eukaryotic cell was invented as well as the identity of microbial groups that were ancestral to animals, plants, and fungi. The laboratory takes advantage of the extraordinary conservation of ribosomal RNAs to define phylogenetic relationships that span the largest of evolutionary distances. These studies have overhauled traditional eukaryotic microbial classifications systems. The laboratory has discovered new evolutionary assemblages that are as genetically diverse and complex as plants, fungi, and animals. The nearly simultaneous separation of these eukaryotic groups (described as the eukaryotic "Crown") occurred approximately one billion years ago and was preceded by a succession of earlier diverging protist lineages, some as ancient as the separation of the prokaryotic domains. Many of these early branching life forms are represented by parasitic protists including Giardia lamblia, which is a significant human parasite. Because of its medical importance and relevance to understanding the evolutionary history of eukaryotes, we have initiated a project to determine the entire genome sequence of Giardia lamblia. In addition to identifying other genes that will be of value for unraveling sudden evolutionary radiations that cannot be resolved by rRNA comparisons, this project will provide insights into the presence or absence of important biochemical properties in the earliest ancestors common to all eukaryotic species. Finally, this project has revealed important features of genome architecture that require a reconsideration of available mechanisms for controlling gene expression in eukaryotes.

A second research theme is the study of microbial life in extreme environments and molecular-based investigations of diversity and gene expression in microbial communities. Using the ribosomal RNA database and nucleic acid-based probe technology, it is possible to detect and monitor microorganisms, including those that cannot be cultivated in the laboratory. This strategy has uncovered new habitats and major revelations about geographical distribution of microorganisms. We are particularly interested in protists that thrive in acid mine drainages and the characterization of physiological mechanisms that allow their growth at extraordinarily low (<2.0) pH levels. Our investigations of gene expression in microbial communities is based upon the premise that microorganisms are the primary engines of our biosphere. They orchestrate all key processes in geochemical cycling, biodegradation, and in the protection of entire ecosystems from environmental insults. They are responsible for most of the primary production in the oceans. Microbial creatures of untold diversity have complex chemistries, physiologies, developmental cycles, and behaviors. With the powerful tools of high-throughput DNA sequencing and DNA microarrays for massive parallel expression studies, we can directly measure how microbial gene expression patterns in an entire ecosystem respond to changing chemical and physical parameters. We will employ an experimental paradigm that links biogeochemical processes with ever-changing temporal and spatial distributions of microbial populations and their metabolic properties. The concurrent measurement of biogeochemical parameters, community-wide gene expression patterns, and spatial descirptions of microbial populations offers a means to understand the structure and function of biogeochemical machinery at different levels of biological organization. We seek to discover the links between biological diversity and the resilience and stability of biogeochemical transformations.

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Kim, Ulandt, Research Assistant
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G + C (guanine + cytosine) contents, small genome sizes, and elevated rates of DNA sequence evolution. Our research explores the molecular and evolutionary mechanisms that shape these characteristics of endosymbiont genomes, with a focus on mutualistic endosymbionts of insects and obligate pathogens of animals.

One aim of this lab is to differentiate the effects of genetic drift, directional mutation pressure, and natural selection on molecular evolution of symbiotic and free-living bacteria. Our primary approach has been to compare patterns of DNA sequence divergence at homologous loci across symbiotic and related free-living bacterial species. These comparisons have revealed a strong effect of genetic drift and directional mutational pressure on sequence evolution in Buchnera aphidicola, the vertically transmitted endosymbiont of aphids, compared to its close free-living relative, Escherichia coli. Recently, our molecular phylogenetic analyses have shown that Buchnera lacks horizontal gene transfer that is typical of many free-living bacterial groups. Ongoing and future work will explore the molecular evolution of other insect endosymbionts in the gamma-3 Proteobacteria, including the obligate bacterial associates of carpenter ants (Camponotus). We also employ full genome comparisons to identify genes that have been lost in small endosymbiont genomes, and to compare patterns of genome reduction in mutualistic and pathogenic lineages. Of particular interest is the substantial loss of proof-reading and DNA repair loci from several symbiont genomes, which may elevate mutational rates and biases in these species.

Staff
Wernegreen, Jennifer, Assistant Scientist

BioCurrents Research Center

The BioCurrents Research Center (BRC) is a national resource of the National Institutes of Health, part of the Biomedical Technology Resource Program of the NCRR. As with all such resources it has two main goals: 1) to research and develop new biomedical technologies, and 2) to make specialized technologies available to visiting biomedical investigators. The emphasis of the BRC is on the physiology of cellular transport mechanisms, particularly as they influence the boundary conditions in the media adjacent to the plasma membrane. To this end we develop new microsensor technologies that operate in a self-referencing mode. We offer access to ion-selective, electrochemical, and biosensor devices, coupled to advanced imaging techniques and electrophysiological approaches—combinations unique to the BRC.

The BRC has seen a marked expansion in year 2000 after a successful competitive renewal in December of 1999. This resulted in an increase in staff, which included the appointment of two Assistant Scientists: Stefan McDonough and Orian Shirihai. Two new postdoctoral researchers also joined the group in 2000: Sung-Kwon Jung and Andreas Hengstenberg, as did Laurel Moore and Robert Lewis in support roles. Towards the end of 2000 we added Mark Messerli, who works with both the BRC and Bay Paul Center.

The current structure of the resource comprises the core support facility and three independent laboratories, as well as a number of affiliate endeavors where the members of the Center work closely with colleagues in the MBL and the regional medical schools. In particular, we have strong links with the MBL program in Architectural Dynamics in Living Cells, the Laboratory for Reproductive Medicine, and the Bay Paul Center. Our involvement with regional hospitals includes Boston Medical Center (diabetes), Massachusetts General Hospital (protein trafficking), and Women and Infants (reproductive biology). In summary, the core in-house research emphasis is on biophysics of calcium transport and regulation (S. McDonough), the molecular biology

Laboratory of Jennifer Wernegreen

The work in this lab focuses on the evolution of bacteria that complete their life cycles within or closely related with eukaryotic host cells. These symbiotic prokaryotes include well-known parasites as well as obligately mutualistic bacteria that provide nutritional or other benefits to their hosts. By virtue of their host associations, endosymbionts may have smaller population sizes and experience different selective forces than their free-living bacterial relatives. These changes in population size and selection may each contribute to the features shared by many endosymbiont genomes, such as low genomic

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Bahr, Michele, The Ecosystems Center
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Crump, Byron, The Ecosystems Center

Laboratory of Jennifer Wernegreen

The work in this lab focuses on the evolution of bacteria that complete their life cycles within or closely related with eukaryotic host cells. These symbiotic prokaryotes include well-known parasites as well as obligately mutualistic bacteria that provide nutritional or other benefits to their hosts. By virtue of their host associations, endosymbionts may have smaller population sizes and experience different selective forces than their free-living bacterial relatives. These changes in population size and selection may each contribute to the features shared by many endosymbiont genomes, such as low genomic
of transport processes (O. Shirihai), and sensor development and the biology of transport mechanisms (P.J.S. Smith).

In addition, the BRC is developing an online database of pharmacological compounds. The database has made considerable progress over the past year and should be openly available by the summer of 2001. It will be accessible through our web page at (www.mbl.edu/BioCurrents).

The Center supports an extensive outreach program to regional and national universities, medical schools, and hospitals, and publishes extensively in the field of cellular transport. Over the past year we have continued to host a diverse group of visiting investigators whose studies have ranged from ion transport and metabolic studies at the single cell level to mapping ion flux associated with the olfactory sensilla of the intact blue crab. Overall our emphasis remains on biomedical studies using the specialized microsensors available, particularly those designed to measure flux of calcium, potassium, hydrogen, oxygen, nitric oxide, and ascorbate. Under development are the newer biosensors and electro-optical probes.

The Center also maintains other core support facilities, such as a fully equipped cell culture facility, electrode manufacture, and microinjection systems which, as available, we also open to the general scientific community.

Staff

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Laboratory of Stefan McDonough

Calcium ions trigger many cellular functions including neurotransmission, muscle contraction, regulation of cell membrane excitability, and the activation of enzymatic cascades. A major route of calcium entry into a cell is through voltage-gated calcium ion channels. Proteins found in the plasma membrane of every excitable cell and many nonexcitable cells. These proteins form channels that open to allow a selective influx of calcium ions into the cell when the cell fires an electrical spike. Calcium channels are current or potential targets for clinical drugs treating cardiac arrhythmia, epilepsy, hypertension, pain, diabetes, and brain damage after stroke.

Research in this laboratory focuses on the channels that conduct calcium entry, the mechanisms controlling calcium levels within the cell, and the tools to distinguish among different types of calcium channels. Experiments are carried out using patch-clamp electrophysiology on mammalian neurons, mammalian cardiac myocytes, or cloned calcium channels expressed in nonexcitable cells. One effort, in collaboration with the laboratories of Bruce and Barbara Furie and of Alan Rigby, is to identify and characterize conotoxins that target voltage-gated ion channels. Other experiments use the self-referencing ion-selective and oxygen sensors of the BioCurrents Center, in collaboration with the Laboratory of Peter Smith. Current areas of research include the effects of zinc ions on calcium channels, a possible cause of ischemic neuronal damage; calcium channel biophysics during the cardiac ventricular action potential; the metabolic cost to the heart of maintaining calcium homeostasis during resting and excited states; and the mechanisms of activation of alternatively spliced forms of neuronal N-type calcium channels.

Laboratory of Orian Shirihai

Erythroid differentiation involves expression of a set of unique transport and enzymatic systems to support a robust induction of hemoglobin synthesis. Active communication between the mitochondrial matrix and cytosol is essential for heme biosynthesis. The first step, production of aminolevulinic acid (ALA), occurs in the inner matrix. ALA is transported to the cytosol and eventually converted to coproporphyrinogen III, which recycles the mitochondrion and, upon further modifications, is joined with iron to form heme. This product is then transported out of the inner matrix for assembly of cytochromes or hemoglobin. Thus, at least four mitochondrial transport steps are required. Although the enzymatic steps in heme synthesis are well characterized, little is known about how biosynthetic intermediates are shuttled across mitochondrial membranes. While malfunctioning of these transporters most probably underlie hematologic and neurologic diseases, their substrates are phototoxic molecules used in photo-dynamic therapy for cancer; the mechanism of transport into the target organelle is of major interest.

A novel mitochondrial transporter, discovered by Dr. Shirihai, has been the focus of research in the lab. This protein, named ABC-me (for ATP-binding cassette-mitochondrial erythroid), localizes to the mitochondrial inner membrane and is expressed at particularly high levels in erythroid tissues of embryos and adults. ABC-me is induced during erythroid maturation in cell lines and primary hematopoietic cells, and its over-expression enhances hemoglobin synthesis in erythroleukemia cells. Members of the ABC transporter superfamily have been implicated in numerous human diseases, including cystic fibrosis (CFTR), adrenoleukodystrophy (ALDP), Zellweger's syndrome...
(PM70), progressive familial intrahepatic cholestasis (SPGP), and Stargardt macular dystrophy (ABCR). To explore the functional role of this transporter, the lab is generating a knockout mouse and cell line, which would serve as a tool to study the biophysics and biochemistry of this transporter as well as the phenotype appearing in the absence of this gene. ABC-me represents a novel member of the ABC superfamily with a potentially important role in erythroid development. In collaboration with Dr. Weiss from the University of Pennsylvania and Dr. Orkin from Harvard, we have recently cloned and sequenced the human homologue of ABC-me and started screening multiple samples from candidate patients send to us by physicians from the United States, Italy, and England.

**Laboratory of Peter J.S. Smith**

The activities of this laboratory center on instrument development, providing new insights into cellular transport mechanisms, and applying these devices to biomedical problems. Much of the biological work is done in collaboration with visiting investigators to the BRC. Over the past year an increasing body of work has been undertaken using the new amperometric microsensors capable of measuring single cell movement of gases such as oxygen and nitric oxide. We continue to investigate the metabolic cost of ion regulation in single cultured neurons.

In collaboration with Mitch Sogin of the Bay Paul Center, a new research area was launched, investigating the transport physiology of extracellular organisms. The emphasis is to understand how membrane- borne transport proteins continue to regulate a near neutral cytosol while being exposed to acidic conditions of pH 1 or 2. This project is funded through the NSF LEXEN program, attracting Mark Messerli to the group, first as an MBL summer fellow but now on a full-time basis funded by a NASA Fellowship.

In sensor design, we have made great progress with the new generation of amperometric sensors, incorporating an immobilized enzyme. Our attempts have focused on glucose and, thanks to the efforts of Sung-Kwon Jung, our first single cell glucose flux measurements have been achieved. Hybrid, light-optical sensors have also been a focus over the past year, where, working with visiting fellow Andreas Hengstenberg, we have successfully built a micro-oxygen sensor on the surface of a single mode fiber optic capable of stimulating a preloaded cellular reporter molecule. In collaboration with Stefan McDonough, this technology has been successful in imaging calcium activity while recording oxygen uptake from a single cardiac myocyte.

**Boston University Marine Program**

**Faculty**

Atena, Jelle, Professor of Biology, Director
Dionne, Vincent, Professor of Biology
Golubic, Stjepko, Professor of Biology
Kaufman, Les, Associate Professor of Biology
Lobel, Phillip, Associate Professor of Biology
Voigt, Rainer, Research Associate Professor
Ward, Nathalie, Lecturer

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McCafferty, Michelle, Administrative Assistant
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Kaatz, Ingrid, Lobel Laboratory
Trott, Thomas, Atema Laboratory

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Hecker, Barbara, Hecker Consulting
Moore, Michael, Woods Hole Oceanographic Institution
Simmons, Bill, Sandia National Laboratory
Wainwright, Norman, Marine Biological Laboratory

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**PhD Students**

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Dooley, Brad
Hauxwell, Jennifer
Herrold, Ruth
Kroeger, Kevin
Ma, Diana
Miller, Carolyn
Oliver, Steven
Steve, Erica
Tomasky, Gabrielle
York, Joanna
Zettler, Erik

New
Frenz, Christopher
Skomal, Gregory

**Masters Students**

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Atkinson, Abby
Bentis, Christopher
Bowen, Jennifer
Casper, Brandon
Cavanaugh, Joseph
Chichester, Heather
D’Ambrosio, Alison
Errigo, Michael
Evgenidou, Angeliki
Fredland, Inga
Frenz, Christopher
Grable, Melissa
Gremer, Dawn
Kollaros, Maria
Konkle, Anne
Lamb, Amy
Lawrence, David
Lever, Mark
Levine, Michael
Mailey, Vanessa
Martel, David
Neviackas, Justin
Oweke, Opwong William
Perez, Edmundo
Pugh, Tracy
Laboratory of Jelle Atema

Many organisms and cellular processes use chemical signals as their main channel of information about the environment. All environments are noisy and require some form of filtering to detect important signals. Chemical signals are transported by turbulent currents, viscous flow, and molecular diffusion. Receptor cells extract chemical signals from the environment through various filtering processes. In our laboratory, fish, marine snails, and crustacea have been investigated for their ability to use chemical signals under water. Currently, we use the lobster and its exquisite senses of smell and taste as our major model to study the signal-filtering capabilities of the whole animal and its narrowly tuned chemoreceptor cells.

Research in our laboratory focuses on amino acids, which represent important food signals for the lobster, and on the function and chemistry of pheromones used in lobster courtship. We examine animal behavior in the sea and in the lab. This includes social interactions and chemotaxis. To understand the role of chemical signals in the sea we use real lobsters and untethered small robots. Our research includes measuring and computer modeling odor plumes and the water currents lobsters generate to send and receive chemical signals. Other research interests include neurophysiology of receptor cells and anatomical studies of receptor organs and pheromone glands.

Laboratory of Vincent Dionne

Odors are powerful stimuli. They can focus the attention, elicit behaviors (or misbehaviors), and even resurrect forgotten memories. These actions are directed by the central nervous system, but they depend upon the initial transduction of chemical signals by olfactory receptor neurons in the nasal passages. More than just a single process appears to underlie odor transduction, and the intracellular pathways that are used are far more diverse than once thought. Hundreds of putative odor receptor molecules have been identified that work through several different second messengers to modulate the activity of various types of membrane ion channels.

Our studies are being conducted with aquatic salamanders using amino acids and other soluble chemical stimuli that these animals perceive as odors. Using electrophysiological and molecular approaches, the research examines how these cellular components produce odor detection, and how odors are identified and discriminated.
Laboratory of Les Kaufman

Current research projects in the laboratory deal with speciation and extinction dynamics of haplochromine fishes in Lake Victoria. We are studying the systematics, evolution, and conservation genetics of a species flock encompassing approximately 700 very recently evolved taxa in the dynamic and heavily impacted landscape of northern East Africa. In the lab we are studying evolutionary morphology, behavior, and systematics of these small, brightly colored cichlid fishes.

Another area of study is developmental and skeletal plasticity in fishes. We are studying the diversity of bone tissue types in fishes, differential response to mineral and mechanical challenge, and matrophic versus environmental effects in the development of coral reef fishes.

We also study the biological basis for marine reserves in the New England fisheries. We are involved in collaborative research with NURC, NMFS, and others studying the relative impact on groundfish stocks of juvenile habitat destruction versus fishing pressure.

Laboratory of Phillip Lobel

Fishes are the most diverse vertebrate group and provide opportunities to study many aspects of behavior, ecology, and evolution. We primarily study 1) how fish are adapted to different habitats, and 2) behavioral ecology of species interactions. Current research focuses on fish acoustic communications.

We are also conducting a long-term study of the marine biology of Johnston Atoll, Central Pacific Ocean. Johnston Atoll has been occupied continuously by the military since the 1930s, and has proven to be a unique opportunity for assessing the biological impacts of island industrialization and its effects on reefs. Johnston Atoll is the site of the U.S. Army’s chemical weapons demilitarization facility, JACADS.

Laboratory of Ivan Valiela

A focus of our work is the link between land use on watersheds and consequences in the receiving estuarine ecosystems. The work examines how landscape use and urbanization increase nutrient loading to groundwater and streams. Nutrients in groundwater are transported to the sea, and, after biogeochemical transformation, enter coastal waters. There, increased nutrients bring about a series of changes in the ecological components. To understand the coupling of land use and consequences to receiving waters, we study the processes involved, assess ecological consequences, and define opportunities for coastal management.

A second long-term research topic is the structure and function of salt marsh ecosystems, including the processes of predation, herbivory, decomposition, and nutrient cycles.

Center for Advanced Studies in the Space Life Sciences

In 1995, the NASA Life Sciences Division and the Marine Biological Laboratory established a cooperative agreement with the formation of the Center for Advanced Studies in the Space Life Sciences (CASSLS at MBL). The Center’s overall goals are to increase awareness of the NASA Life Sciences Program within the basic science community and to examine and discuss potential uses of microgravity and other aspects of spaceflight as probes to provide new insights to fundamental processes important to basic biology and medicine.

Through symposia, workshops and seminars, CASSLS advises NASA and the biological science community on a wide variety of topics.

Through fellowships, CASSLS supports summer research for investigators in areas pertinent to the aims of NASA life sciences.

Since the Center began its operations in July 1995, more than 400 people have attended eight CASSLS workshops. Typically these workshops last for two to four days and feature an international array of scientists and NASA/International space agency staff. In many cases, workshop chairs have a long-time association with the MBL. Workshop schedules incorporate many opportunities for interaction and discussion. A major outcome for workshops is the publication of proceedings in a peer-reviewed journal. Moreover, our meetings introduce outstanding biologists to research questions and prominent scientists involved in gravitational biology and the NASA Life Sciences Program.

The Center sponsored one workshop in 2000: “Invertebrate Sensory Information Processing: Implications for Biologically Inspired Autonomous Systems,” chaired by Dr. Frank Grasso. The Center sponsored one Fellow during the summer of 2000: Dr. Mark Messerli, Biology Department, Purdue University. He conducted research in regulation of cytoplasmic pH in eucaryotic acidophiles in collaboration with Dr. Peter J.S. Smith and Dr. Mitchell Sogin of the Marine Biological Laboratory. In addition, two scholars-in-residence worked with the Center in 2000: Dr. Richard Wassersug of Dalhousie University and Dr. Lawrence Schwartz of the University of Massachusetts, Amherst. Finally, the Center worked with colleagues in Astrobiology and the Josephine Bay Paul Center to offer a stimulating lecture series.

Staff

Blazis, Diana E.J., Director
Oldham, Pamela A., Administrative Assistant

Scholars-in-residence

Schwartz, Lawrence
Wassersug, Richard

The Ecosystems Center

The Ecosystems Center carries out research and education in ecosystem ecology. Terrestrial and aquatic scientists work in a wide variety of ecosystems ranging from the streams, lakes and tundra of the Alaskan Arctic (limits on plant primary production) to sediments of Massachusetts Bay (controls of nitrogen cycling), to forests in New England (effects of soil warming on carbon and nitrogen cycling), and South America (effects of greenhouse gas fluxes of conversion of rain forest to pasture) and to large estuaries in the Gulf of Maine (effects on plankton and benthos of nutrients and organic matter in stream runoff). Many projects, such as those dealing with carbon and nitrogen cycling in forests, streams, and estuaries, use the stable isotopes $^{13}C$ and $^{15}N$ to investigate natural processes. A mass spectrometer facility is available. Data from field and laboratory research are used to construct mathematical models of whole-system responses to change. Some of these models are combined with geographically referenced data to produce estimates of how environmental changes affect key ecosystem indexes, such as net primary productivity and carbon storage, throughout the world’s terrestrial biosphere.

The results of the Center’s research are applied, wherever possible, to the questions of the successful management of the natural resources of the earth. In addition, the ecological expertise of the staff is made available to public affairs groups and governmental agencies who deal with problems such as acid rain, coastal eutrophication, and possible carbon dioxide-caused climate change.

The Semester in Environmental Science was offered again in Fall...
2000. Fifteen students from seven colleges participated in the program. The center also offers opportunities for postdoctoral fellows.

**Administrative Staff**

Hobbie, John E., Co-Director  
McIlhno, Jerry M., Co-Director  
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Donovan, Suzanne J., Executive Assistant  
Moniz, Priscilla C., Administrative Assistant, Semester in Environmental Studies  
Nunez, Guillermo, Research Administrator  
Scanlon, Deborah G., Executive Assistant  
Seifert, Mary Ann, Administrative Assistant

**Scientific Staff**

Hobbie, John E., Senior Scientist  
McIlhno, Jerry M., Senior Scientist  
Deegan, Linda A., Associate Scientist  
Giblin, Anne E., Associate Scientist  
Herbert, Darrell A., Staff Scientist  
Holmes, Robert M., Staff Scientist  
Hopkinson, Charles S., Senior Scientist  
Hughes, Jeffrey E., Staff Scientist  
Nadelhoffer, Knute J., Senior Scientist  
Neill, Christopher, Assistant Scientist  
Petersen, Bruce J., Senior Scientist  
Rastetter, Edward B., Associate Scientist  
Shaver, Gaus R., Senior Scientist  
Stendler, Paul A., Senior Research Specialist  
Tran, Hanqin, Staff Scientist  
Vallino, Joseph J., Assistant Scientist  
Williams, Mathew, Assistant Scientist

**Educational Staff Appointments**

Buzby, Karen, Postdoctoral Scientist  
Cieri, Matthew D., Postdoctoral Scientist  
Crump, Byron, Postdoctoral Scientist  
Garcia-Montiel, Diana C., Postdoctoral Scientist  
LeDizé-Maurel, Séverine, Postdoctoral Scientist  
Kapell-Schmidt, Inger, Postdoctoral Scientist  
Nordin, Annika, Postdoctoral Scientist  
Raymond, Peter, Postdoctoral Scientist  
Sommerkorn, Martin, Postdoctoral Scientist  
Tobias, Craig R., Postdoctoral Scientist  
Williams, Michael R., Postdoctoral Scientist

**Technical Staff**

Ahrens, Toby, Research Assistant  
Bahr, Michele P., Research Assistant  
Bettez, Nei D., Research Assistant  
Burnette, Donald W., Research Assistant  
Claessens, Lodoucide H.J.M., Research Assistant  
Colman, Benjamin P., Research Assistant  
Eldridge, Cynthia, Research Assistant  
Fox, MaryKay, Research Assistant  
Garratt, Robert H., Senior Research Assistant  
Gay, Marcus O., Research Assistant  
Goldstein, Joshua H., Research Assistant  
Jablonski, Sarah A., Research Assistant  
Jillson, Tracy A., Research Assistant  
Kelsey, Samuel, Research Assistant  
Kicklighter, David W., Senior Research Assistant  
Kwiatkowski, Bonnie L., Research Assistant  
Laundre, James A., Senior Research Assistant  
Lezberg, Ann, Research Assistant  
Lux, Heidi, Research Assistant  
Merson, Rebekah, Research Assistant  
Micks, Patricia, Research Assistant  
Morriseau, Sara, Research Assistant  
Nolin, Amy L., Research Assistant  
Nowicki, Genevieve, Research Assistant  
O'Brien, Katherine A., Research Assistant  
Otter, Marshall L., Research Assistant  
Pan, Shufen, Research Assistant  
Petersen, G. Gregory, Research Assistant  
Regan, Kathleen M., Research Assistant  
Ricca, Andrea, Research Assistant  
Schwamb, Carol, Laboratory Assistant  
Slavik, Karie A., Research Assistant  
Thieler, Kama K., Research Assistant  
Tholke, Kristin S., Research Assistant  
Thomas, Suzanne M., Research Assistant  
Tucker, Jane, Senior Research Assistant  
Vasiliou, David S., Research Assistant  
Weston, Nathaniel B., Research Assistant  
Wright, Amos, Research Assistant  
Wyda, Jason C., Research Assistant

**Consultants**

Bowles, Francis P., Research Systems Consultant  
Bowles, Margaret C., Administrative Consultant

**Visiting Scientists and Scholars**

DeStasio, Bart, SES Faculty Fellow, Lawrence College  
Koba, Keisuke, Graduate School of Informatics, Kyoto University, Japan

**Laboratory of Aquatic Biomedicine**

Our laboratory has developed the *Spisula solidissima* embryo model to study mechanisms of neurotoxicology. We have shown that polychlorinated biphenyls (PCBs) selectively target the nervous system during development. We are now linking up and down regulation of the p53 family of genes with neuronal cell development using new probes developed by this laboratory.

In the second line of research, we are using the clam leukemia model to investigate how environmental chemicals influence the progression of leukemia. Further, we are studying whether mutations in p53 alter the pathogenesis of leukemia in populations of *Mya arenaria*. Fieldwork to Nova Scotia showed that leukemia in *Mya* was also detected in Sydney, N.S., which is heavily polluted with a variety of industrial chemicals.

**Staff**

Reinsch, Carol L., Senior Scientist  
Cox, Rachel, Postdoctoral Scientist  
Jessen-Elfer, Kathryn, Postdoctoral Scientist  
Kreiling, Jill, Postdoctoral Scientist  
Stephens, Ray, Adjunct Scientist
Visiting Scientists

Shohet, Stephen, University of California, San Francisco
Walker, Charles, University of New Hampshire

Student

Miller, Jessica, Boston University

**Laboratory of Cell Communication**

Established in 1994, this laboratory is devoted to the study of intercellular communication. The research focuses on the cell-to-cell channel, a membrane channel built into the junctions between cells. This channel provides one of the most basic forms of intercellular communication in organs and tissues. The work is aimed at the molecular physiology of this channel, in particular, at the mechanisms that regulate the communication. The channel is the conduit of growth-regulating signals. It is instrumental in a basic feedback loop whereby cells in organs and tissues control their number; in a variety of cancer forms it is crippled.

This laboratory has shown that transformed cells lacking communication channels lost the characteristics of cancer cells, such as unregulated growth and tumorigenicity, when their communication was restored by insertion of a gene that codes for the channel protein. Work is now in progress to track the channel protein within the cells from its point of synthesis, the endoplasmic reticulum, to its functional destination in the plasma membrane, the cell-to-cell junction, by expressing a fluorescent variant of the channel protein in the cells. Knowledge about the cellular regulation of this process will aid our understanding of what goes awry when a cell loses the ability to form cell-to-cell channels and thus to communicate with its neighbors, thereby taking the path towards becoming cancerous.

Another line of work is taking the first steps at applying information theory to the biology of cell communication. Here, the intercellular information spoor is tracked to its source: the macromolecular intracellular information core. The outlines of a coherent information network inside and between the cells are beginning to emerge.

**Staff**

Loewenstein, Werner, Senior Scientist
Rose, Birgit, Senior Scientist
Jilson, Tracy, Research Assistant

**Laboratory of Paul Colinvaux**

We have shown that accumulated pollen data now leave little doubt that the Amazon lowlands remained forested without fragmentation throughout glacial cycles. Changes in relative abundance of trees within the highly diverse forests can be seen in the pollen record, however, particularly in response to changing temperature. The pollen vocabulary for the Amazon on which this conclusion is based has been codified in our *Amazon Pollen Manual and Atlas* with text in Portuguese as well as English for the benefit of Brazilian researchers. We show that the Amazon ecosystems yield two kinds of pollen signals: what might be called the "classical" signal by wind-blown pollen, which allows separation of biomes and many edaphically constrained fauces of Amazon forests such as *varea or igapó*, and a species-rich signal from animal-pollinated trees washed from the immediate watershed or catchment of the sedimentary basin.

With our collaborators in Brazil and the University of Florida we completed pollen and stratigraphic analyses, now being prepared for publication, of the first transglacial lake core from a forested site (Maicuru inselberg) in the eastern Amazon lowlands. Our collaborators at the Florida Institute of Technology and the University of Cincinnati identified chemical changes in the early sedimentary history of Lake Pata in the western Amazon lowlands that show a strong synchrony with insolation changes associated with the precessional component of astronomical climate forcing back to marine oxygen isotope stage 7, this being the first such signal from the equatorial lowlands. In 2000 we also concluded a paleoenvironmental reconnaissance of the Lake Nicaragua region and are developing plans for raising a long core from the lake.

**Staff**

Colinvaux, Paul, Adjunct Scientist

**Laboratory of Alyse Dosemecci**

The laboratory investigates molecular processes that underlie synaptic modification. The main project is to classify how the frequency of activation at a synapse can determine whether the synapse will be potentiated (strengthened) or depressed (weakened) through the participation of an enzyme called CaM kinase II. This enzyme is regulated by autophosphorylation on distinct sites in the presence and absence of calcium. Biochemical studies with isolated postsynaptic density fractions are conducted to clarify functional consequences of CaMKII autophosphorylation in response to sequental exposure to calcium-containing and calcium-free media at different temporal patterns.

In a related project, a new affinity-based method is being developed for the preparation of postsynaptic density fractions of high purity. In collaboration with Dr. Lucas Pozzo-Miller (University of Alabama, Birmingham), we are studying changes in the activity of CaMKII in hippocampal slices following high-frequency and low-frequency electrical stimulation to generate long-term potentiation and long-term depression, respectively. Related projects in collaboration with Dr. Thomas Reese (NIH, NINDS) include studies on the redistribution of CaMKII and structural changes in the post-synaptic density in response to excitatory stimuli.

**Staff**

Dosemecci, Alyse, Adjunct Scientist

**Visiting Investigator**

Pozzo-Miller, Lucas, University of Alabama

**Laboratory of Barbara Furie and Bruce Furie**

γ-carboxyglutamic acid is a calcium-binding amino acid that is found in the conopeptides of the predatory marine cone snail, *Conus*. This laboratory has been investigating the biosynthesis of this amino acid in *Conus* and the structural role of γ-carboxyglutamic acid in the conopeptides. This satellite laboratory relates closely to the main laboratory, the Center for Hemostasis and Thrombosis Research, on the Harvard Medical School campus in Boston; the main focus of the primary laboratory is the synthesis and function of γ-carboxyglutamic acid in blood-clotting proteins and the role of vitamin K.

Cone snails are obtained from the South Pacific and maintained in the Marine Resources Center. Until recently, the marine cone snail had been the sole invertebrate known to synthesize γ-carboxyglutamic acid (Gla).
The venomous cone snail produces neurotoxic conopeptides, some rich in GlA, which it injects into its prey to immobilize it. To examine the biosynthetic pathway for GlA, we have studied the Conus carboxylase which converts glutamic acid to γ-carboxyglutamic acid. This activity has an absolute requirement for vitamin K. The Conus carboxylase substrates contain a carboxylation recognition site on the conotoxin precursor. Given the functional similarity of mammalian vitamin K-dependent carboxylases and the vitamin K-dependent carboxylase from Conus textile, we hypothesized that structurally conserved regions would identify sequences critical to this common functionality.

Furthermore, we examined the diversity of animal species that maintain vitamin K-dependent carboxylation to generate γ-carboxyglutamic acid. We have cloned full-length carboxylase homologs from the beluga whale (Delphinapterus leucas) and toadfish (Opsanus tau). In addition, we have partially cloned the carboxylase gene from chicken (Gallus gallus), hagfish (Myxine glutinosa), horseshoe crab (Limulus polyphemus), and cone snail (Conus textile) in order to compare these structures to the known bovine, human, rat, and mouse cDNA sequences. Comparison of the predicted amino acid sequences identified a highly conserved 32-amino acid residue region in all of these putative carboxylases. In addition, this amino acid motif is also present in the Drosophila genome and identified a Drosophila homolog of the γ-carboxylase. Assay of hagfish liver and Drosophila demonstrated carboxylase activity in these non-vertebrates. More recently, we have cloned the entire vitamin K-dependent carboxylase gene from the cone snail, Conus textile. The predicted amino acid sequence shows most regions are similar to the mammalian sequence, and that there is about 40% sequence identity overall. These results demonstrate the broad distribution of the vitamin K-dependent carboxylase gene, including a highly conserved motif that is likely critical for enzyme function. The vitamin K-dependent biosynthesis of γ-carboxyglutamic acid appears to be a highly conserved function in the animal kingdom.

Novel γ-carboxyglutamic acid-containing conopeptides have been isolated from the venom of Conus textile. The amino acid sequence, amino acid composition, and molecular weights of these peptides have been determined. For several peptides, the cDNA encoding the precursor conotoxin has been cloned. The three-dimensional structure of some of these GlA-containing conopeptides are being determined by 2D NMR spectroscopy. Complete resonance assignments of conotoxin P14.1 were made from 2D 1H NMR spectra via identification of intraresidue spin systems using 1H-1H through-bond connectivities. NOESY spectra provided δυ, δυυ, and δυυυ NOE connectivities and vicinal spin-spin coupling constants 2J, were used to calculate φ torsion angles. Structure determination is nearing completion. The goal of this project is to determine the structural role of γ-carboxyglutamic acid in the GlA-containing conotoxins and other γ-carboxyglutamic acid-containing proteins.

Staff
Fune, Barbara C., Adjunct Scientist
Fune, Bruce, Adjunct Scientist
Begley, Gail, Scientist I
Czerwiec, Eva, Postdoctoral Fellow
Rigby, Alan, Adjunct Scientist
Stenflo, Johan, Visiting Scientist

Laboratory of Shinya Inoué

Scientists in this laboratory study the molecular mechanism and control of mitosis, cell division, cell motility, and cell morphogenesis, with emphasis on biophysical studies made directly on single living cells, especially developing eggs in marine invertebrates. Development of biophysical instrumentation and methodology, such as the centrifuge polarizing microscope, high-extinction polarization optical and video microscopy, digital image processing techniques including dynamic stereoscopic imaging, and exploration of their underlying optical theory are an integral part of the laboratory’s efforts.

Staff
Inoué, Shinya, Distinguished Scientist
Burgos, Mario, Visiting Scientist
Goda, Makoto, Visiting Scientist
Baraby, Diane, Laboratory Assistant
Knudson, Robert, Instrument Development Engineer
MacNeil, Jane, Executive Assistant

Laboratory of Rudolf Oldenbourg

The laboratory investigates the molecular architecture of living cells and of biological model systems using optical methods for imaging and manipulating these structures. For imaging cell architecture non-invasively and non-destructively, dynamically and at high resolution, we have developed a new polarized light microscope (Pol-Scope). The Pol-Scope combines microscope optics with new electro-optical components, video, and digital image processing for fast analysis of specimen birefringence over the entire viewing field. Examples of biological systems currently investigated with the Pol-Scope are microtubule-based structures (asters, mitotic spindles, single microtubules); actin-based structures (acrosomal process, stress fibers, nerve growth cones); zona pellucida of vertebrate oocytes; and biopolymer liquid crystals.

Staff
Oldenbourg, Rudolf, Associate Scientist
Shribak, Michael, Staff Scientist
Knudson, Robert, Instrument Development Engineer
Baraby, Diane, Laboratory Assistant

Laboratory of Michael Rabinowitz

This laboratory investigates environmental geochemistry and epidemiology. Areas of recent activity include modeling lead bioavailability, writing a history of lead biokinetic models, performing a case control survey of tea drinking and oral cancer in Taiwan, quantifying the transport and fate of various sources of residential lead exposure, and serving on several advisory boards of Superfund research projects in Boston and New York.

Current activity focuses on characterizing lead paints and pigments. Hundreds of lead poisoning lawsuits are filed every year against landlords, but no compensation has ever been paid by the half dozen companies that made lead pigments, because it has not been possible to identify the specific manufacturer. This research has been funded by the Eagle Picher Trust. Other activity, sponsored by HUD, involves using stable isotopes of lead to determine the relative importance of various household surfaces (doors, floors, windows, walls) as sources of indoor dust lead levels. Dust lead is the major predictor of childhood lead exposure and poisoning. This would allow for more focused deleading.

Another effort has been using historical fire insurance maps to locate and identify unrecognized hazardous waste sites.

Staff
Rabinowitz, Michael, Associate Scientist
Laboratory for Reproductive Medicine, Brown University and Women and Infants Hospital, Providence

Work in this laboratory centers on investigating cellular mechanisms underlying female infertility. Particular emphasis is placed on the physiology of the oocyte and early embryo, with the aim of assessing developmental potential and mitochondria dysfunction arising from mtDNA deletions. The studies taking place at the MBL branch of the Brown Laboratory use some of the unique instrumentation available through the resident programs directed by Rudolf Oldenbourg and Peter J.S. Smith. Most particularly, non-invasive methods for oocyte and embryo study are being sought. Of several specific aims, one is to use the Pol- Scope to analyze the dynamic birefringence of meiotic spindles. An additional aim is to study transmembrane ion transport using non-invasive electro-physiological techniques available at the BioCurrents Research Center. The newly developed oxygen probe offers the possibility of looking directly at abnormalities in the mitochondria arising from accumulated mtDNA damage. Our laboratory has also focused on studying the mechanism underlying age-associated infertility in terms of oocyte quality and has attempted to rescue developmentally compromised oocytes or embryos through nuclear-cytoplasmic transfer technology. We have characterized oxidative stress-induced mitochondrial dysfunctions, developmental arrest, and cell death in early embryos using animal models. Ultimately, this laboratory aims to produce clinical methods for assessing preimplantation embryo viability, an advance that will significantly contribute to the health of women and children.

Staff
Keefe, David, Director
Liu, Lin, Adjunct Scientist
Trimarchi, James, Adjunct Scientist

Laboratory of Osamu Shimomura

Aequorin, from the jellyfish Aequorea aequorea, was the first calcium-sensitive photoprotein discovered by us in 1961. Because of its high sensitivity to Ca^{2+} and biological harmlessness, the protein has been widely used as a probe to monitor intracellular free calcium levels. Aequorin is a unique protein that contains a high level of energy for light emission in the molecule, and its structure has been the target of many studies in the past. The complete 3-dimensional structure of aequorin was finally obtained by X-ray crystallography 38 years after its discovery, in collaboration with three other laboratories. Aequorin is found to be a globular molecule having four helix-loop-helix “EF-hand” domains, of which three can bind Ca^{2+}. The molecule contains coelenterazine-2-hydroperoxide in its hydrophobic core cavity, as the chromophores ligand which decomposes into coelenteramide and carbon dioxide accompanied by the emission of blue light.

Staff
Shimomura, Osamu, Senior Scientist, MBL, and Boston University School of Medicine
Shimomura, Akemi, Research Assistant

Laboratory of Robert B. Silver

The members of this laboratory study how living cells make decisions. The focus of the research, typically using marine models, is on two main areas: the role of calcium in the regulation of mitotic cell division (sea urchins, sand dollars, etc.) and structure and function relationships of hair cell stereociliary movements in vestibular physiology (oyster toadfish). Other related areas of study, i.e. synaptic transmission (squid), are also, at times, pursued. Tools include video light microscopy, multispectral, subwavelength, and very high-speed (sub-millisecond frame rate) photon counting video light microscopy, telemanipulation of living cells and tissues, and modeling of decision processes. A cornerstone of the laboratory’s analytical efforts is high performance computational processing and analysis of video light microscopy images and modeling. With luminescent, fluorescent, and absorptive probes, both empirical observation and computational modeling of cellular, biochemical, and biophysical processes permit interpretation and mapping of space-time patterns of intracellular chemical reactions and calcium signaling in living cells. A variety of in vitro biochemical, biophysical, and immunological methods are used. In addition to fundamental biological studies, the staff designs and fabricates optical hardware, and designs software for large video image data processing, analysis, and modeling.

Staff
Silver, Robert, Associate Scientist

Visiting Investigators
Hummel, John, Argonne National Laboratory
Jiang, Yi, Los Alamos National Laboratory
Keller, Bruce, SUNY Upstate Medical University
Kriebel, Mahlon, SUNY Upstate Medical University
Pappas, George, University of Illinois School of Medicine
Pearson, John, Los Alamos National Laboratory

Laboratory of Norman Wainwright

The mission of the laboratory is to understand the molecular defense mechanisms exhibited by marine invertebrates in response to invasion by bacteria, fungi, and viruses. The primitive immune systems demonstrate unique and powerful strategies for survival in diverse marine environments. The key model has been the horseshoe crab Limulus polyphemus. Limulus hemocytes exhibit a very sensitive LPS-triggered protease cascade which results in blood coagulation. Several proteins found in the hemocyte and hemolymph display microbial binding proteins that contribute to antimicrobial defense. Commensal or symbiotic microorganisms may also augment the antimicrobial mechanisms of macroscopic marine species. Secondary metabolites are being isolated from diverse marine microbial strains in an attempt to understand their role. Microbial participation in oxidation of the toxic gas hydrogen sulfide is also being studied.

Staff
Wainwright, Norman, Senior Scientist
Child, Alice, Research Assistant
Williams, Kendra, Research Assistant

Visiting Investigator
Anderson, Porter, University of Rochester
Laboratory of Seymour Zigman

This laboratory is investigating basic mechanisms of photooxidative stress to the ocular lens due to environmentally compatible UVA radiation. This type of oxidative stress contributes to human cataract formation. Other studies are the search for and use of chemical antioxidants to retard the damage that occurs. Cultured mammalian lens epithelial cells and whole lenses in vitro are exposed to environmentally compatible UVA radiation with or without previous antioxidant feeding. The following parameters of lens damage are examined: molecular excitation to singlet states via NADPH (the absorber); cell growth inhibition and cell death; catalase inactivation; cytoskeletal description of actin, tubulin, integrins; and cell membrane damage (lipid oxidation, loss of gap junction integrity and intercellular chemical communications). Thus far, the most successful antioxidant to reduce these deficiencies is alpha-tocopherol (10 μg/ml) and tea polyphenols (especially green tea). The preliminary phases of the research are usually carried out using marine animal eyes (i.e., smooth dogfish) as models. Our goal is to provide information that will suggest means to retard human cataract formation.

Staff
Zigman, Seymour, Laboratory Director, Professor of Ophthalmology, Boston University Medical School
Rafferty, Keen, Research Associate, Boston University Medical School
Rafferty, Nancy S., Research Associate, Boston University Medical School
Zigman, Bunnie R., Laboratory Manager, Boston University Medical School

The Marine Resources Center

The Marine Resources Center (MRC)—a modern, 32,000-square-foot structure—features advanced facilities for maintaining and culturing aquatic organisms essential to advanced biological, biomedical, and ecological research. In addition to research, the MRC provides a variety of important, complementary services to the MBL community through its Aquatic Resources Division, its Aquaculture and Engineering Division, and its administrative division.

The MRC and its life support systems have increased the ability of MBL scientists to conduct research and have inspired new concepts in scientific experiments. Vigorous research programs focusing on basic biological and biomedical aquatic models are currently being developed at the Center, including the Program in Scientific Aquaculture and the Program in Sensory Biology and Neuroethology.

Research and educational opportunities for established investigators, postdoctoral fellows, and graduate and undergraduate students are available at the MRC. Investigators and students find that the MRC’s unique life support and seawater engineering systems make this a favorable environment in which to conduct research using a variety of aquatic organisms and flexible tank space for customized experimentation on live animals.

Staff
Hanlon, Roger, Director and Senior Scientist
Carroll, James, Life Support Technical Assistant
Enos, Edward, Aquatic Resources Division Superintendent
Gilland, Edwin, Research Associate
Grossman, William, Marine Specimen Collector/Diving Safety Officer
Hanley, Janice, Water Quality and Animal Health Technician
Klimm, William, Licensed Boat Captain—RV Gemma
Kazirian, Alan, Associate Scientist
Linnon, Beth, Special Projects Coordinator
Mebane, William, Aquaculture and Engineering Division Superintendent
Santore, Gabrielle, Executive Assistant
Sexton, Andrew, Marine Organism Shipper
Smolowitz, Roxanna, MBL Veterinarian
Sullivan, Daniel, Boat Captain
Tassini, Eugene, Senior Biological Collector
Whelan, Sean, Diver/Marine Specimen Collector

Summer and Fall Employees and Volunteers
Baynevich, Artem, Work-study Student, Boston University
Carroll, Amanda, Volunteer
Dimond, Jay, Diver/Collector
Douton, Kate, AmeriCorps Assistant
Faloon, Kristine, Work-study Student, Boston University
Gudas, Chris, Diver/Collector
Kavountzis, Erol, Work-study Student, Boston University
Miraglia, Valentina, Volunteer, Universita di Napoli “Federico II,” Italy
Potter, Chris, Diver/Collector
Reynolds, Justin, Diver/Collector
Robbins, Gillian, Volunteer
Robbergha, Lynne, Work-study Student, Boston University
Tubbs, Mollie, Work-study Student, Boston University
Zuccini, Mossimo, Volunteer, Universita di Napoli “Federico II,” Italy

Laboratory of Roger Hanlon

This laboratory investigates the behavior of cephalopods and other marine organisms with an integrative biology approach focused at the individual level. Molecular, cellular, and ecological approaches are used to complement this organismal approach, and there is emphasis on sensory biology and behavioral ecology.

Laboratory studies on the mechanisms and functions of polarized light sensitivity in cephalopods are underway. Olfactory signaling by Nautilus (which functions in food detection and location as well as mate choice) is being studied in the laboratory. Visible features that octopuses use for maze learning are also being investigated. Lab experiments in large indoor seawater tanks are being conducted to determine how male squid, Loligo pealei, use visual, then contact, chemical cues in egg capsules to initiate highly robust agonistic behavior.

The functional morphology and neurobiology of the chromatophore system of cephalopod skin is being conducted in a variety of cephalopod species, and image analysis techniques are being developed to study crypts and the mechanisms that enable cryptic body patterns to be neurally and environmentally regulated. Various aspects of predation, antipredator defenses, and reproduction are conducted in field sites worldwide.

Sexual selection theory is being tested using squid and cuttlefish. Field and laboratory studies focus on mechanisms of agonistic behavior,
female mate choice, and sperm competition. The latter studies involve DNA fingerprinting to determine paternity and help assess alternative mating tactics.

Population structure and reproductive success in several highly valuable squid fisheries (Loligo vulgaris reynaudii in South Africa, Loligo pealeii in the N.E. United States, Loligo opalescens in California) are being assessed for fishery management and conservation. We also culture species of commercial and biomedical importance. For example, the toadfish Opsanus beta is used in vestibular research related to human medicine, yet the species is difficult to obtain from nature. Thus, we are performing the first mariculture experiments to culture toadfish through the life cycle to provide the biomedical community with high-quality experimental animals. Such an approach lightens the impact of collecting toadfish from the natural environment.

**Staff**

Hanlon, Roger, Senior Scientist
Ament, Seth, Summer Research Assistant, Harvard University
Boal, Jean, Adjunct Scientist
Buresch, Kendra, Research Assistant
Corroy, Lou-Anne, Summer Research Assistant, Dartmouth College
Gilles, Nicole, REU Intern, University of Minnesota, Duluth
Lee, Tony, REU Intern, Duke University
Richmond, Hazel, Research Assistant
Shashar, Nadav, Adjunct Scientist
Sussman, Raquel, Investigator
Vaughn, Katrina, Summer Research Assistant, University of Wales, Swansea

**Visiting Investigators**

Baddeley, Roland, University of Sussex, England
Baker, Robert, New York University
Cavanaugh, Joseph, Boston University Marine Program
Chiao, Chuan-Chin, Grass Fellow, University of Maryland, Baltimore County
Cronin, Thomas, University of Maryland, Baltimore County
Grable, Melissa, Boston University Marine Program
Hall, Karina, University of Alberta, Australia
Hatfield, Emma, FRS Marine Laboratory, Aberdeen, Scotland
Karson, Miranda, Michigan State University
Kier, William, University of North Carolina
Mensing, Allen, University of Minnesota, Duluth
Messenger, John, University of Cambridge, England
Osorio, Daniel, Investigator, University of Sussex, England
Saidel, William, Rutgers University
Schmolesky, Matthew, Grass Fellow, University of Utah

**Laboratory of Roxanna Smolowitz**

This laboratory investigated the pathogenesis of aquatic animal diseases using traditional pathological methods combined with in situ molecular methods. Research conducted during 2000 included 1) examination of hard-clam-strain susceptibility to a protistan disease agent named Quahog Parasite Unknown, and the methods of transmission of that organism between infected and uninfected animals; 2) detection of disease-causing, protozoan organisms (MSX and SSO) in eastern oysters using PCR and in situ hybridization techniques; and 3) evaluation of inbred strains of oysters for resistance to disease vs. productivity as commercial aquaculture stock. Work began on the determination of possible causes of lobster shell disease in the northeast.

**Staff**

Smolowitz, Roxanna, MBL Veterinarian
Brothers, Christine, Laboratory Assistant
Cavanaugh, Joseph, Laboratory Assistant
Marks, Ernie, AmeriCorps member
Stuckey, Jetley, Laboratory Assistant
Summers, Erin, Laboratory Assistant
Tirrell, Kerri-Ann, AmeriCorps member
Honors

Friday Evening Lectures

June 16      Edward Pearce, Cornell University
             “Life-long Enemies—The Relationship Between Schistosomes and Their Hosts”
June 23      Stephen Farrand, University of Illinois at Champaign-Urbana
             “Agrobacterium tumefaciens: Nature’s Own Genetic Engineer”
June 30      Judith Eisen, University of Oregon
             “From Lobster to Zebrafish: Development of Identified Neurons” (Lang Lecture)
July 7       David Anderson, California Institute of Technology
             “Stem Cells from the Mammalian Nervous System: Basic Biology and Implications for Tissue Repair”
July 14      Sallie Chisholm (Penny), Massachusetts Institute of Technology
             “The Invisible Forest: Marine Phytoplankton and Climate”
July 20-21   Eve Marder, Brandeis University
             1) “Activity-dependent Tuning of Neurons and Synapses in Adult and Developing Circuits” 2)
             “Neurotransmitter Modulation of Neural Networks” (Forbes Lectures)
July 28      Jean-Pierre Changeux, Institut Pasteur
             “Chemical Communications in the Brain: Nicotine, Receptors, and Learning” (Glassman Lecture)
August 4     Susan Middleton/David Liittschwager
             “Paradise Up Close: Hawaii—Endangered Eden”
August 11    Titia de Lange, The Rockefeller University
             “At the Ends of Our Chromosomes: the Key to Immortality”

Fellowships and Scholarships

In 2000, the MBL awarded research fellowships to 22 scientists from around the world. The MBL awarded scholarships to 77 students in the MBL’s summer courses as well as 4 post-course research awards. Donors provided gifts for endowed and expendable funds amounting to $256,090 in support of the research fellowships program and an additional $738,107 to provide scholarships to students in MBL courses. Those funds that received donations in 2000 are listed below. The individuals who received fellowships and scholarships are listed beginning on p. R58.

Robert Day Allen Fellowship Fund
Dr. Joseph and Jean Sanger

The American Society for Cell Biology Scholarships
The American Society for Cell Biology

Frederik B. Bang Fellowship Fund
Mrs. Betsy G. Bang

Max Burger Endowed Scholarship for the Embryology Course
Dr. Max M. Burger

Jean and Katsuma Dan Fellowship Fund
Drs. Joseph and Jean Sanger
Mrs. Eleanor Steenbach

Bernard Davis Fellowship Fund
Mrs. Elizabeth M. Davis

The Mac V. Edds, Jr. Endowed Scholarship Fund
Dr. and Mrs. James D.
Dr. and Mrs. Kenneth T. Edds
Dr. Louise M. Luckenhill-Edds

Gerald D. and Ruth L. Fischbach Endowed Scholarship Fund
Drs. Gerald and Ruth Fischbach

Thomas B. Grave and Elizabeth F. Grave Scholarship
Estate of Elizabeth F. Grave

Daniel S. and Edith T. Grosch Scholarship Fund
Mr. Gustav Grosch
Ms. Laura Grosch and Mr. Herb Jackson

Aline D. Gross Scholarship Fund
Dr. and Mrs. Paul R. Gross
Dr. and Mrs. Benjamin Kaminer
Technic, Inc.

E. E. Just Endowed Research Fellowship Fund
The Cole Memorial Family Fund
Fred Karush Endowed Library Readership
Dr. and Mrs. Laszlo Lorand
Dr. and Mrs. Arthur M. Silverstein

Keffler Hartline Fellowship Fund
Mrs. Elizabeth K. Hartline
Dr. and Mrs. Edward F. MacNichol, Jr.
Dr. William H. Miller
Dr. Torsten Wiesel and Ms. Jean Stein
Dr. and Mrs. Stephen Yeandle

MBL Associates Endowed Scholarship Fund
MBL Associates
Mrs. Anne L. Meigs-Brown

James A. and Faith Miller Fellowship Fund
Drs. David and Virginia Miller

Frank Morrell Endowed Memorial Scholarship
Dr. Leyla deToledo-Morrell

Mountain Memorial Fund
Dr. and Mrs. Dean C. Allard, Jr.
Ms. Brenda J. Bodian
Dr. and Mrs. Benjamin Kaminer
Mr. and Mrs. Thomas H. Roberts
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Drs. Mary Atkinson and Joel White
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Drs. Matthew and Jeanne Meselson
Dr. and Mrs. Philip Person
Drs. Dorothy Skinner and John Cook
Drs. Ann Stuart and John Moore
Mr. and Mrs. Richard Yoder

MBL Summer Research Fellows

- Srdjan Antic, M.D., is a post-doctoral fellow in the Department of Cellular and Molecular Physiology at Yale University School of Medicine, New Haven, CT. The title of his project is “Selective modulation of the dendritic membrane potential.” Dr. Antic is funded by the Baxter Postdoctoral Fellowship, the Charles R. Crane Fellowship Fund, the MBL Associates Fellowship Fund, and the James A. and Faith Miller Memorial Fund.
• Roberto Bruzzone, Ph.D., is an Associate Professor at the Institut Pasteur in Paris, France. The title of this research is “Molecular analysis of the biophysical properties of connexin channels that mediate cell–cell communication between neurons of the vertebrate retina and CNS.” Dr. Bruzzone is funded by the Erik B. Fries Endowed Fellowship, the MBL Associates Fellowship Fund, and the H. B. Steinbach Fellowship Fund.

• Mario H. Burgos, M.D., is an Emeritus Professor of the Medical School at the Universidad Nacional de Cuyo and Director of the Instituto de Histologia y Embriología, National Council of Research (CONICET), Argentina. His research project is titled, “Mechanism of release of spermatozoa from the Sertoli cells.” He is also collaborating with Dr. Shinya Inoue in the identification of the birefringent zones in Arbacia eggs after centrifuge polarizing microscopy. Dr. Burgos is funded by the Chairman’s Fellowship.

• Jean-Pierre Changeux is a Professor at the College de France and Director of the Unit of Molecular Neurobiology at the Institut Pasteur in Paris. He is the author of Neuronal Man: The Biology of Mind (1990). Dr. Changeux has been awarded a Herbert W. Rand Fellowship for his research.

• Debra Ann Fadool, Ph.D., is an Associate Professor in the Biomedical Research Facility at Florida State University, Tallahassee, FL. The title of her research project is “Chemosensory transduction in the vomeronasal organ.” Dr. Fadool is funded by the Frederik B. Bang Fellowship Fund, the Ann E. Kammer Memorial Fellowship Fund, and the MBL Associates Fellowship Fund.

• Mariano A. Garcia-Bilanco, M.D., Ph.D., is Associate Professor of Genetics, Microbiology, and Medicine at Duke University Medical Center, Durham, NC. He is a Raymond and Beverly Sackler Scholar and is a member of the Biochemistry Study Section of the National Institutes of Health. The Josiah Macy, Jr. Foundation is funding his research.

• George G. Holz, Ph.D., has been appointed Associate Professor at New York University School of Medicine to establish a Diabetes Research Laboratory at New York University Medical Center. His summer research project is “Spatio-temporal dynamics of pancreatic β-cells.” Dr. Holz is funded by the Erik B. Fries Endowed Fellowship, the Frank R. Lillie Fellowship Fund, and the MBL Associates Fellowship Fund.

• Peter Koulou, Ph.D., is a postdoctoral associate in the Department of Pharmacology at Yale University School of Medicine, New Haven, CT. The title of his research project is “Calcium signaling in zebrafish neurons mediated by differentially distributed intracellular calcium channels.” Dr. Koulou has received funding from the Erik B. Fries Endowed Fellowship and the Lucasta Lemann Fellowship Fund.

• George Langford, Ph.D., is the Ernest Everett Just Professor of Natural Sciences and Professor of Biological Sciences at Dartmouth College, Hanover, NH. His research project is titled “Actin-based vesicle transport in the squid giant axon.” Dr. Langford is funded by the Josiah Macy, Jr. Foundation.

• Jennifer LaVail, Ph.D., is Professor of Anatomy/Ophthalmology at the University of California, San Francisco. She is spending her second summer at the MBL. Her research project is titled “HIV tegument proteins in axonal transport and microtubule architecture.” Dr. LaVail is funded by an MBL Research Fellowship and the Evelyn and Melvin Spiegel Fellowship Fund.

• Carolyn Lesser has published eight children’s books and numerous articles. She has also served as a consultant and lecturer. Ms. Lesser was awarded a Science Writing Fellowship in 1999, and is a Desk Reader at the MBL/WHOI Library in 2000. Ms. Lesser is funded by the Fred Karush Endowed Library Readership.

• Jeffrey Magee, Ph.D., is an Assistant Professor in the Neuroscience Center at Louisiana State University Medical Center, New Orleans, Louisiana. The title of his research is “Mechanisms of Ca²⁺ entry into hippocampal neurons.” Dr. Magee is funded by the MBL Associates Fellowship Fund and the Lucasta Lemann Fellowship Fund.

• Antonio Malagoli, Ph.D., is a Professor in the Unit of Neurobiology of Learning at the University of San Raffaele, Milan, Italy. The title of his summer research is “Presynaptically silent synapses in the hippocampus.” Dr. Malagoli is funded by the Herbert W. Rand Fellowship and the Frank R. Lillie Fellowship Fund.

• Mark Messerli, Ph.D., is a Research Associate in the Department of Biological Sciences at Purdue University, West Lafayette, IN. The title of his research project is “Regulation of cytoplasmic pH in eucaryotic acidophiles.” Dr. Messerli is funded by a NASA Life Sciences Program Fellowship.

• Timothy Mitchison, M.D., is a Professor in the Department of Cell Biology at Harvard Medical School, Boston, MA. His research project is titled “Optical Approaches to Cell Division.” The Universal Imaging Corporation is funding Dr. Mitchison.

• David Ogden, Ph.D., is a Principal Investigator at the National Institute for Medical Research in London, England. The title of his research is “Central electroreceptive processing in the skate.” Dr. Ogden is funded by an MBL Associates Fellowship.

• Oladele A. Ogunseitan, Ph.D., is an Associate Professor in the Department of Environmental Analysis and Design at the University of California, Irvine. Dr. Ogunseitan returns to the MBL to study “Toxic metal resistance, swimming phenotype, and enzyme polymorphism in Vibrio alginolyticus.” Dr. Ogunseitan is funded by the Josiah Macy, Jr. Foundation.

• David Paydarfar, Ph.D., is an Associate Professor at the Department of Neurobiology at the University of Massachusetts Medical School in Worcester. The title of his research project is “Can noise regulate oscillatory state? In vivo and in vitro analysis of squid axon membrane.” Dr. Paydarfar is funded by the Frederick B. Bang Fellowship Fund, the M. G. F. Fuertes Memorial Fellowship Fund, the MBL Associates Fellowship Fund, and the John O. Crane Fellowship Fund.

• Peter Saggau, Ph.D., is an Associate Professor in the Division of Neuroscience at Baylor College of Medicine, Houston, Texas. The title of his summer research project is “Transmission and plasticity at single hippocampal synapses.” Dr. Saggau received the Nikon Fellowship.

• Midunuru Srinivas, Ph.D., is a Research Associate at the Albert Einstein College of Medicine, Bronx, New York. His research project for the summer is titled “Biophysical properties of gap junctions in the retina.” Dr. Srinivas is funded by the Erik B. Fries Endowed Fellowship and the H. Kuffer Hartline Fellowship Fund.

• Thomas W. White, Ph.D., is an Instructor in the Department of Neurobiology at Harvard Medical School, Boston, MA. His research project is titled “Gap junctional communication in the retina.” Dr. White is funded by the H. Kuffer Hartline Fellowship Fund, the Stephen W. Kuffler Fellowship Fund, and the Frank R. Lillie Fellowship Fund.

• Ian Stuart Young, Ph.D., is a Research Associate in the Department of Biology at the University of Pennsylvania, Philadelphia. The title of Dr. Young’s summer research is “The molecular mechanisms of relaxation in superfasc muscles.” Dr. Young is funded by the Robert Day Allen Fellowship Fund, the MBL Research Fellowship Fund, the H. B. Steinbach Memorial Fellowship Fund, and the Lucy B. Lemann Fellowship Fund.

Grass Fellows

• Leonardo Belluscio, Ph.D., Duke University Medical Center. Project: "The role of spontaneous activity in the olfactory system."

• Chun-Chin Chiao, University of Maryland, Baltimore County.
Project: “Camouflage in cephalopods: visual control and effectiveness when viewed by predators.”
- Melina Hale, Ph.D., State University of New York at Stony Brook. Project: “The neural basis of startle behavior and its development in the toadfish (Opsanus tau).”
- Johann Hofmann, Ph.D., Stanford University. Project: “The consequences of socially induced differential growth on the retina.”
- Thomas Kuner, M.D., Duke University Medical Center. Project: “The timing of NSF action in neurotransmitter release probed with photolysis of caged peptides.”
- Matthew B. McFarlane, Ph.D., New York University Medical Center. Project: “Central pathways mediating the horizontal vestibulo-ocular reflex in an elasmobranch, Scyllorhinus canicula.”

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Ben-Ari, Elia, BioScience

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Triggs, Veronica, University of Wisconsin, Madison

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Gorman, Jessica, Discover magazine
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Melillo, Jerry, Marine Biological Laboratory, Environment Hands-On Laboratory Co-Director
Palazzo, Robert, University of Kansas, Biomedical Hands-On Laboratory Associate Director

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D’Angelo, Maximiliano, University of Buenos Aires
Dolezal, Pavel, Charles University
Ferreira, Lurdes, Universidade Federal de Minas Gerais
Figueiredo, Luisa, University of Porto
Gil, Stacey, University of Vermont
Lowell, Joanna, Rockefeller University
Matins, Gislaine, Faculdade de Medicina de Ribeirao Preto
Murtuza, Silvane, Centro de Pesquisas René Rachou-FIOCRUZ
Sehgal, Ali, Tata Institute of Fundamental Research
Ulbert, Sebastian, Netherlands Cancer Institute
Villarino, Alejandro, University of Pennsylvania

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Uppal, Hirdesh, Punjab Agricultural University
Genick, Ulrich, The Salk Institute for Biological Studies
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Mosavi, Leila, University of Connecticut Health Center

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Mol, Pieternella, University of Amsterdam
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Perea, Sofia, The University of Texas Health Science Center
Spellberg, Brad, Harbor-UCLA Medical Center
Speghini, Elisabetta, Yale University School of Medicine
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Menna, Elisabetta, Institute of Neurophysiology, Pisa

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O’Donnell, Rebecca, University of Melbourne
Ralph, Stuart, University of Melbourne
Triggs, Veronica, University of Wisconsin, Madison
Villarino, Alejandro, University of Pennsylvania

The Ellison Medical Foundation
Molecular Biology of Aging Course

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Bordone, Laura, University of Minnesota Medical School
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Cypser, James, University of Colorado
Filosa, Stefania, JGB-CNR
Furfaro, Joyce, Pennsylvania State University College of Medicine
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Podlutsky, Andrej, National Institute on Aging, NIH
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Srivivasan, Chandra, University of California, Los Angeles
Tong, Jiayuan (James), Cold Spring Harbor Laboratory
Zaid, Ahmed, Stockholm University

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Prud’homme, Benjamin, Centre de Genetique Moleculaire

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International Brain Research Organization

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Marrari, Yannick, Observatoire Océanographique
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Worden, Mary Kate, University of Virginia, Department of Neuroscience, McKim Hall Box 230, Charlottesville, VA 22908

Worgul, Basil V., Columbia University, Department of Ophthalmology, 630 West 168 Street, New York, NY 10032

Wu, Chau Ihsiang, Northwestern University Medical School, Department of Pharmacology (S215), 303 East Chicago Avenue, Chicago, IL 60611-3008

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Zakon, Harold H., University of Texas, Section of Neurobiology, School of Life Science, Austin, TX 78712

Zigman, Seymour, Marine Park Condominiums, 174 Queen Street, Unit 10-F, Falmouth, MA 02540

Zigmond, Michael J., University of Pittsburgh, S-526 Biomedical Science Tower, 3500 Terrace Street, Pittsburgh, PA 15213

Zimmerberg, Joshua J., National Institutes of Health, LCMB, NICHD, Building 10, Room 10D14, 10 Center Drive, Bethesda, MD 20892

Zottoli, Steven J., Williams College, Department of Biology, Williamstown, MA 01267

Zucker, Robert S., University of California, Neurobiology Division, Molecular and Cellular Biology Department, Berkeley, CA 94720
MBL Associates

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Julie Child
Nancy Fraser
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Lincoln Kraeuter
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Jennifer Machado
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Howard Redpath
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Pucky Rosansky
Suzanne Thomas
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Gloria Borgese
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Certificate of Organization

Articles of Amendment

Bylaws

Certificate of Organization

(On File in the Office of the Secretary of the Commonwealth)

No. 3170

We, Alpheus Hyatt, President, William Stanford Stevens, Treasurer, and William T. Sedgwick, Edward G. Gardiner, Susan Mims and Charles Sedgwick Minot being a majority of the Trustees of the Marine Biological Laboratory in compliance with the requirements of the fourth section of chapter one hundred and fifteen of the Public Statutes, do hereby certify that the following is a true copy of the agreement of association to constitute said Corporation, with the names of the subscribers thereto:

We, whose names are hereunto subscribed, do, by this agreement, associate ourselves with the intention to constitute a Corporation according to the provisions of the one hundred and fifteenth chapter of the Public Statutes of the Commonwealth of Massachusetts, and the Acts in amendment thereof and in addition thereto.

The name by which the Corporation shall be known is THE MARINE BIOLOGICAL LABORATORY.

The purpose for which the Corporation is constituted is to establish and maintain a laboratory or station for scientific study and investigations, and a school for instruction in biology and natural history.

The place within which the Corporation is established or located is the city of Boston within said Commonwealth.

The amount of its capital stock is none.

In Witness Whereof, we have hereunto set our hands, this twenty seventh day of February in the year eighteen hundred and eighty-eight, Alpheus Hyatt, Samuel Mills, William T. Sedgwick, Edward G. Gardiner, Charles Sedgwick Minot, William G. Farlow, William Stanford Stevens, Anna D. Phillips, Susan Mims, B. H. Van Vleck.

That the first meeting of the subscribers to said agreement was held on the thirteenth day of March in the year eighteen hundred and eighty-eight.

In Witness Whereof, we have hereunto signed our names, this thirteenth day of March in the year eighteen hundred and eighty-eight, Alpheus Hyatt, President, William Stanford Stevens, Treasurer, Edward G. Gardiner, William T. Sedgwick, Susan Mims, Charles Sedgwick Minot.

(Approved on March 20, 1888 as follows: I hereby certify that it appears upon an examination of the within written certificate and the records of the corporation duly submitted to my inspection, that the requirements of sections one, two and three of chapter one hundred and fifteen, and sections eighteen, twenty and twenty-one of chapter one hundred and six, of the Public Statutes, have been complied with and I hereby approve said certificate this twelfth day of March A.D. eighteen hundred and eighty-eight.

Charles Endicott
Commissioner of Corporations)

Articles of Amendment

(On File in the Office of the Secretary of the Commonwealth)

We, James D. Ebert, President, and David Shepro, Clerk of the Marine Biological Laboratory, located at Woods Hole, Massachusetts 02543, do hereby certify that the following amendment to the Articles of Organization of the Corporation was duly adopted at a meeting held on August 15, 1975, as adjourned to August 29, 1975, by vote of 444 members, being at least two-thirds of its members legally qualified to vote in the meeting of the corporation:

Voted: That the Certificate of Organization of this corporation be and it hereby is amended by the addition of the following provisions:

"No Officer, Trustee or Corporate Member of the corporation shall be personally liable for the payment or satisfaction of any obligation or liabilities incurred as a result of, or otherwise in connection with, any commitments, agreements, activities or affairs of the corporation.

"Except as otherwise specifically provided by the Bylaws of the corporation, meetings of the Corporate Members of the corporation may be held anywhere in the United States.

"The Trustees of the corporation may make, amend or repeal the Bylaws of the corporation in whole or in part, except with respect to any provisions thereof which shall by law, this Certificate or the bylaws of the corporation, require action by the Corporate Members."

The foregoing amendment will become effective when these articles of amendment are filed in accordance with Chapter 180, Section 7 of the General Laws unless these articles specify, in accordance with the vote adopting the amendment, a later effective date not more than thirty days after such filing, in which event the amendment will become effective on such later date.

In Witness Whereof and Under the Penalties of Perjury, we have hereunto signed our names this 2nd day of September, in the year 1975, James D. Ebert, President; David Shepro, Clerk.

(Approved on October 24, 1975, as follows: I hereby approve the within articles of amendment and, the filing fee in the amount of $50 having been paid, said articles are deemed to have been filed with me this 24th day of October, 1975.

Paul Guzzi
Secretary of the Commonwealth)

Bylaws

(Revised August 7, 1992 and December 10, 1992)

ARTICLE I—THE CORPORATION

A. Name and Purpose: The name of the Corporation shall be The Marine Biological Laboratory. The Corporation's purpose shall be to establish and maintain a
laboratory or station for scientific study and investigation and a school for instruction in biology and natural history.

B. Nondiscrimination. The Corporation shall not discriminate on the basis of age, religion, color, race, national or ethnic origin, sex or sexual preference in its policies on employment and administration or in its educational and other programs.

ARTICLE II—MEMBERSHIP

A. Members. The Members of the Corporation ("Members") shall consist of persons elected by the Board of Trustees (the "Board"), upon such terms and conditions and in accordance with such procedures, not inconsistent with law or these Bylaws, as may be determined by the Board. At any regular or special meeting of the Board, the Board may elect new Members. Members shall have no voting or other rights with respect to the Corporation or its activities except as specified in these Bylaws, and any Member may vote at any meeting of the Members in person only and not by proxy. Members shall serve until their death or resignation unless earlier removed with or without cause by the affirmative vote of two-thirds of the Trustees then in office. Any Member who has retired from his or her home institution may, upon written request to the Corporation, be designated a Life Member. Life Members shall not have the right to vote and shall not be assessed for dues.

B. Meetings. The annual meeting of the Members shall be held on the Friday following the first Tuesday in August of each year, at the Laboratory of the Corporation in Woods Hole, Massachusetts, at 9:30 a.m. The Chairperson of the Board shall preside at meetings of the Corporation. If no annual meeting is held in accordance with the foregoing provision, a special meeting may be held in lieu thereof with the same effect as the annual meeting, and in such case all references in these Bylaws, except in this Article II B., to the annual meeting of the Members shall be deemed to refer to such special meeting. Members shall transact business as may properly come before the meeting. Special meetings of the Members may be called by the Chairperson or the Trustees, and shall be called by the Clerk, or in the case of the death, absence, incapacity or refusal by the Clerk, by any other officer, upon written application of Members representing at least ten percent of the smallest quorum of Members required for a vote upon any matter at the annual meeting of the Members, to be held at such time and place as may be designated.

C. Quorum. One hundred (100) Members shall constitute a quorum in any meeting. Except as otherwise required by law or these Bylaws, the affirmative vote of a majority of the Members voting in person at a meeting attended by a quorum shall constitute action on behalf of the Members.

D. Notice of Meetings. Notice of any annual meeting or special meeting of Members, if necessary, shall be given by the Clerk, by mailing notice of the time and place of such purpose of such meeting at least 15 days before such meeting to each Member at his or her address as shown on the records of the Corporation.

E. Waiver of Notice. Whenever notice of a meeting is required to be given a Member, under any provision of the Articles or Organization or Bylaws of the Corporation, a written waiver thereof, executed before or after the Meeting by such Member, or his or her duly authorized attorney, shall be deemed equivalent to such notice.

F. Adjournments. Any meeting of the Members may be adjourned to any other time and place by the vote of a majority of those Members present at the meeting, whether or not such Members constitute a quorum, or by any officer entitled to preside at or to act as Chair of such meeting, if no Member is present or represented. It shall not be necessary to notify any Members of any adjournment unless no Member is present or represented at the meeting which is adjourned, in which case, notice of the adjournment shall be given in accordance with Article II D. Any business which could have been transacted at any meeting of the Members as originally called may be transacted at an adjournment thereof.

ARTICLE III—ASSOCIATES OF THE CORPORATION

Associates of the Corporation. The Associates of the Marine Biological Laboratory shall be an unincorporated group of persons (including associations and corporations) interested in the Laboratory and shall be organized and operated under the general supervision and authority of the Trustees. The Associates of the Marine Biological Laboratory shall have no voting rights.

ARTICLE IV—BOARD OF TRUSTEES

A. Powers. The Board of Trustees shall have the control and management of the affairs of the Corporation. The Trustees shall elect a Chairperson of the Board who shall serve until his or her successor is elected and qualified. They shall annually elect a President of the Corporation. They shall annually elect a Vice Chairperson of the Board who shall be Vice Chairperson of the meetings of the Corporation. They shall annually elect a Clerk, who shall be a resident of Massachusetts. They shall elect Trustees—at-large as specified in this Article IV. They shall appoint a Director of the Laboratory for a term not to exceed five years, provided the term shall not exceed one year if the candidate has attained the age of 65 years prior to the date of the appointment. They shall choose such other officers and agents as they shall think best. They may fix the compensation of all officers and agents of the Corporation and may remove them at any time. They may fill vacancies occurring in any of the offices. The Board shall have the power to choose an Executive Committee from their own number as provided in Article V, and to delegate to such Committee such of their own powers as they may deem expedient in addition to those powers conferred by Article V. They shall, from time to time, elect Members to the Corporation upon such terms and conditions as they shall have determined, not inconsistent with law or these Bylaws.

B. Composition and Election.

(1) The Board shall include 24 Trustees elected by the Board as provided below:

(a) At least six Trustees ("Corporate Trustees") shall be Members who are scientists, and the other Trustees ("Trustees-at-Large") shall be individuals who need not be Members or otherwise affiliated with the Corporation.

(b) The 24 elected Trustees shall be divided into four classes of six Trustees each, with one class to be elected each year to serve a term of four years, and with each such class to include at least one Corporate Trustee. Such classes of Trustees shall be designated by the year of expiration of their respective terms.

(2) The Board shall also include the Chief Executive Officer, Treasurer and the Chairperson of the Science Council, who shall be ex officio voting members of the Board.

(3) Although Members or Trustees may recommend individuals for nomination as Trustees, nominations for Trustee elections shall be made by the Nominating Committee in its sole discretion. The Board may also elect Trustees who have not been nominated by the Nominating Committee.

C. Eligibility. A Corporate Trustee or a Trustee-at-Large who has been elected to an initial four-year term or remaining portion thereof, of which he/she has served at least two years, shall be eligible for re-election to a second four-year term, but shall be ineligible for re-election to any subsequent term until one year has elapsed after he/she has last served as a Trustee.

D. Removal. Any Trustee may be removed from office at any time with or without cause, by vote of a majority of the Members entitled to vote in the election of Trustees; or for cause, by vote of two-thirds of the Trustees then in office. A Trustee may be removed for cause only if notice of such action shall have been given to all of the Trustees or Members entitled to vote, as the case may be, prior to the meeting at which such action is to be taken and if the Trustee to be so removed shall have been given reasonable notice and opportunity to be heard before the body proposing to remove him or her.

E. Vacancies. Any vacancy in the Board may be filled by vote of a majority of the remaining Trustees present at a meeting of Trustees at which a quorum is present. Any vacancy in the Board resulting from the resignation or removal of a Corporate Trustee shall be filled by a Member who is a scientist.

F. Meetings. Any meeting of such Board shall be held from time to time, not less frequently than twice annually, as determined by the Board. Special meetings of Trustees may be called by the Chairperson, or by any seven Trustees, to be held at such time and place as may be designated. The Chairperson of the Board, when present, shall preside over all meetings of the Trustees. Written notice shall be sent to a Trustee's usual or last known place of residence at least two weeks before the meeting. Notice of a meeting need not be given to any Trustee if a written waiver of notice executed by such Trustee before or after the meeting is filed with the records of the meeting, or if such Trustee shall attend the meeting without protesting prior thereto or at its commencement the lack of notice given to him or her.

G. Quorum and Action by Trustees. A majority of all Trustees then in office shall constitute a quorum. Any meeting of Trustees may be adjourned by vote of a majority of Trustees present, whether or not a quorum is present, and the meeting may be held as adjourned without further notice. When a quorum is present at any meeting of the Trustees, a majority of the Trustees present and voting (excluding abstentions) shall decide any question, including the election of officers, unless otherwise required by law, the Articles of Organization or these Bylaws.

H. Transfers of Interests in Land. There shall be no transfer of title nor long-term lease of real property held by the Corporation without prior approval of not less than two-thirds of the Trustees. Such real property transactions shall be finally acted upon at a meeting of the Board only if presented and discussed at a prior meeting of the Board. Either meeting may be a special meeting and no less than four weeks shall elapse between the two meetings. Any property acquired by the Corporation after December 1, 1989 may be sold, any mortgage or pledge of real property regardless
of when acquired) to secure borrowings by the Corporation may be granted, and any transfer of title or interest in real property pursuant to the foreclosure or enforcement of any such mortgage or pledge of real property may be effected by any holder of a mortgage or pledge of real property of the Corporation, with the prior approval of not less than two thirds of the Trustees (other than any Trustee or Trustees with a direct or indirect financial interest in the transaction being considered for approval) who are present at a regular or special meeting of the Board at which there is a quorum.

ARTICLE V—COMMITTEES

A. Executive Committee. There shall be an Executive Committee of the Board of Trustees which shall consist of not more than eleven (11) Trustees, including ex officio Trustees, elected by the Board.

The Chairperson of the Board shall act as Chairperson of the Executive Committee and the Vice Chairperson as Vice Chairperson. The Executive Committee shall meet at such times and places and upon such notice and appoint such subcommittees as the Committee shall determine.

The Executive Committee shall have and may exercise all the powers of the Board during the intervals between meetings of the Board except those powers specifically withheld, from time to time, by vote of the Board or by law. The Executive Committee may also appoint such committees, including persons who are not Trustees, as it may, from time to time, approve to make recommendations with respect to matters to be acted upon by the Executive Committee or the Board.

The Executive Committee shall keep appropriate minutes of its meetings, which shall be reported to the Board. Any actions taken by the Executive Committee shall also be reported to the Board.

B. Nominating Committee. There shall be a Nominating Committee which shall consist of not fewer than four nor more than six Trustees appointed by the Board in a manner which shall reflect the balance between Corporate Trustees and Trustees-at-Large on the Board. The Nominating Committee shall nominate persons for election as Corporate Trustees and Trustees-at-Large, Chairperson of the Board, Vice Chairperson of the Board, President, Treasurer, Clerk, Director of the Laboratory, and such other officers, if any, as needed, in accordance with the requirements of these Bylaws. The Nominating Committee shall also be responsible for overseeing the training of new Trustees. The Chairperson of the Board of Trustees shall appoint the Chairperson of the Nominating Committee. The Chairperson of the Nominating Committee shall be an ex officio voting member of the Nominating Committee.

C. Science Council. There shall be a Science Council (the “Council”) which shall consist of Members of the Corporation elected to the Council by vote of the Members of the Corporation, and which shall advise the Board with respect to matters concerning the Corporation’s mission, its scientific and instructional endeavors, and the appointment and promotions of persons or committees with responsibility for matters requiring scientific expertise. Unless otherwise approved by a majority of the members of the Council, the Chairperson of the Council shall be elected annually by the Council. The chair executive officer of the Corporation shall be an ex officio voting member of the Council.

D. Board of Overseers. There shall be a Board of Overseers which shall consist of not fewer than five nor more than eight scientists who have expertise concerning matters with which the Corporation is involved. Members of the Board of Overseers may or may not be Members of the Corporation and may be appointed by the Board of Trustees on the basis of recommendations submitted from scientists and scientific organizations or societies. The Board of Overseers shall be available to review and recommend to the officers, Trustees and Science Council regarding scientific activities conducted or proposed by the Corporation and shall meet from time to time, not less frequently than annually, as determined by the Board of Trustees.

E. Board Committees Generally. The Trustees may elect or appoint one or more other committees (including, but not limited to, an Investment Committee, a Development Committee, an Audit Committee, a Facilities and Capital Equipment Committee and a Long-Range Planning Committee) and may delegate to any such committee or committees any or all of their powers, except those which by law, the Articles of Organization, or these Bylaws of the Trustees are prohibited from delegating; provided that any committee to which the powers of the Trustees are delegated shall consist solely of Trustees. The members of any such committee shall have such tenure and duties as the Trustees shall determine. The Investment Committee, which shall oversee the management of the Corporation’s endowment funds and marketable securities shall include as ex officio members, the Chairperson of the Board, the Treasurer and the Chairperson of the Audit Committee, together with such Trustees as may be required for not less than two-thirds of the Investment Committee to consist of Trustees. Except as otherwise provided by these Bylaws or determined by the Trustees, any such committee may make rules for the conduct of its business, but, unless otherwise provided by the Trustees or in such rules, its business shall be conducted as nearly as possible in the same manner as is provided by these Bylaws for the Trustees.

F. Actions Without a Meeting. Any action required or permitted to be taken at any meeting of the Executive Committee or any other committee elected by the Trustees may be taken without a meeting if all members of such committees consent to the action in writing and such written consents are filed with the records of meetings. Members of the Executive Committee or any other committee elected by the Trustees may also participate in any meeting by means of a telephone conference call, or otherwise take action in such a manner as may, from time to time, be permitted by law.

G. Manual of Procedures. The Board of Trustees, on the recommendation of the Executive Committee, shall establish guidelines and modifications thereof to be recorded in a Manual of Procedures. Guidelines shall establish procedures for: (1) Nomination and election of members of the Corporation, Board of Trustees and Executive Committee; (2) Election of Officers; (3) Formation and Function of Standing Committees.

ARTICLE VI—OFFICERS

A. Enumeration. The officers of the Corporation shall consist of a President, a Treasurer and a Clerk, and such other officers having the powers of President, Treasurer and Clerk as the Board may determine, and a Director of the Laboratory. The Corporation may have such other officers and assistant officers as the Board may determine, including (without limitation) a Chairperson of the Board, Vice Chairperson, one or more Vice Presidents, Assistant Treasurers or Assistant Clerks. Any two or more officers may be held by the same person. The Chairperson and Vice Chairperson of the Board shall be elected by and from the Trustees, but other officers of the Corporation need not be Trustees or Members. If required by the Trustees, any officer shall give the Corporation a bond for the faithful performance of his or her duties in such amount and with such surety or sureties as shall be satisfactory to the Trustees.

B. Tenure. Except as otherwise provided by law, by the Articles of Organization or by these Bylaws, the President, Treasurer, and other officers shall hold office until the first meeting of the Board following the annual meeting of Members and thereafter, until his or her successor is chosen and qualified.

C. Resignation. Any officer may resign by delivering his or her written resignation to the Corporation at its principal office or to the President or Clerk and such resignation shall be effective upon receipt unless it is specified to be effective at some other time or upon the happening of some other event.

D. Removal. The Board may remove any officer with or without cause by a vote of a majority of the entire number of Trustees then in office, at a meeting of the Board called for that purpose and for which notice of the purpose thereof has been given, provided that an officer may be removed for cause only after having an opportunity to be heard by the Board at a meeting of the Board at which a quorum is personally present and voting.

E. Vacancy. A vacancy in any office may be filled for the unexpired balance of the term by vote of a majority of the Trustees present at any meeting of Trustees at which a quorum is present or by written consent of all of the Trustees, if less than a quorum of Trustees shall remain in office.

F. Chairperson. The Chairperson shall have such powers and duties as may be determined by the Board and, unless otherwise determined by the Board, shall serve in that capacity for a term coextensive with his or her term as Trustee.

G. Vice Chairperson. The Vice Chairperson shall perform the duties and exercise the powers of the Chairperson in the absence or disability of the Chairperson, and shall perform such other duties and possess such other powers as may be determined by the Board. Unless otherwise determined by the Board, the Vice Chairperson shall serve for a one-year term.

H. Director. The Director shall be the chief operating officer and, unless otherwise voted by the Trustees, the chief executive officer of the Corporation. The Director shall, subject to the direction of the Trustees, have general supervision of the Laboratory and control of the business of the Corporation. At the annual meeting, the Director shall submit a report of the operations of the Corporation for such year and a statement of its affairs, and shall, from time to time, report to the Board all matters within his or her knowledge which the interests of the Corporation may require to be brought to its notice.

I. Deputy Director. The Deputy Director, if any, or if there shall be more than one, the Deputy Directors in the order determined by the Trustees, shall, in the absence or disability of the Director, perform the duties and exercise the powers of the Director and shall perform such other duties and shall have such other powers as the Trustees may, from time to time, prescribe.
3. President. The President shall have the powers and duties as may be vested in him or her by the Board.

K. Treasurer and Assistant Treasurer. The Treasurer shall, subject to the direction of the Trustees, have general charge of the financial affairs of the Corporation, including its long-range financial planning, and shall cause to be kept accurate books of account. The Treasurer shall prepare a yearly report on the financial status of the Corporation to be delivered at the annual meeting. The Treasurer shall also prepare or oversee all things required by the Commonwealth of Massachusetts, the Internal Revenue Service, or other Federal and State Agencies. The account of the Treasurer shall be audited annually by a certified public accountant.

The Assistant Treasurer, if any, or if there shall be more than one, the Assistant Treasurers in the order determined by the Trustees, shall, in the absence or disability of the Treasurer, perform the duties and exercise the powers of the Treasurer, shall perform such other duties and shall have such other powers as the Trustees may, from time to time, prescribe.

L. Clerk and Assistant Clerk. The Clerk shall be a resident of the Commonwealth of Massachusetts, unless the Corporation has designated a resident agent in the manner provided by law. The minutes or records of all meetings of the Trustees and Members shall be kept by the Clerk who shall record, upon the record books of the Corporation, minutes of the proceedings at such meetings. He or she shall have custody of the record books of the Corporation and shall have such other powers and shall perform such other duties as the Trustees may, from time to time, prescribe.

The Assistant Clerk, if any, or if there shall be more than one, the Assistant Clerks in the order determined by the Trustees, shall, in the absence or disability of the Clerk, perform the duties and exercise the powers of the Clerk and shall perform such other duties and shall have such other powers as the Trustees may, from time to time, prescribe.

In the absence of the Clerk and an Assistant Clerk from any meeting, a temporary Clerk shall be appointed at the meeting.

M. Other Powers and Duties. Each officer shall have in addition to the duties and powers specifically set forth in these Bylaws, such duties and powers as are customarily incident to his or her office, and such duties and powers as the Trustees may, from time to time, designate.

ARTICLE VII—AMENDMENTS

These Bylaws may be amended by the affirmative vote of the Members at any meeting, provided that notice of the substance of the proposed amendment is stated in the notice of such meeting. As authorized by the Articles of Organization, the Trustees, by a majority of their number then in office, may also make, amend or repeal these Bylaws, in whole or in part, except with respect to (a) the provisions of these Bylaws governing (i) the removal of Trustees and (ii) the amendment of these Bylaws and (b) any provisions of these Bylaws which by law, the Articles of Organization or these Bylaws, requires action by the Members.

No later than the time of giving notice of meeting of Members next following the making, amending or repealing by the Trustees of any Bylaw, notice thereof stating the substance of such change shall be given to all Members entitled to vote on amending the Bylaws.

Any Bylaw adopted by the Trustees may be amended or repealed by the Members entitled to vote on amending the Bylaws.

ARTICLE VIII—INDEMNITY

Except as otherwise provided below, the Corporation shall, to the extent legally permissible, indemnify each person who is, or shall have been, a Trustee, director or officer of the Corporation or who is serving, or shall have served at the request of the Corporation as a Trustee, director or officer of another organization in which the Corporation directly or indirectly has any interest as a shareholder, creditor or otherwise, against all liabilities and expenses (including judgments, fines, penalties, and reasonable attorneys’ fees and all amounts paid, other than to the Corporation or such other organization, in compromise or settlement) imposed upon or incurred by any such person in connection with, or arising out of, the defense or disposition of any action, suit or other proceeding, whether civil or criminal, in which he or she may be a defendant or with which he or she may be threatened or otherwise involved, directly or indirectly, by reason of his or her being or having been such a Trustee, director or officer.

The Corporation shall provide no indemnification with respect to any matter as to which any such Trustee, director or officer shall be finally adjudicated in such action, suit or proceeding not to have acted in good faith in the reasonable belief that his or her action was in the best interests of the Corporation. The Corporation shall provide no indemnification with respect to any matter settled or comprised unless such matter shall have been approved as in the best interests of the Corporation, after notice that indemnification is involved, by (i) a disinterested majority of the Board of the Executive Committee, or (ii) a majority of the Members.

Indemnification may include payment by the Corporation of expenses in defending a civil or criminal action or proceeding in advance of the final disposition of such action or proceeding upon receipt of an undertaking by the person indemnified to repay such payment if it is ultimately determined that such person is not entitled to indemnification under the provisions of this Article VIII, or under any applicable law.

As used in the Article VIII, the terms “Trustee,” “director,” and “officer” include their respective heirs, executors, administrators and legal representatives, and an “interested” Trustee, director or officer is one against whom in such capacity the proceeding in question or another proceeding on the same or similar grounds is then pending.

To assure indemnification under this Article VIII of all persons who are determined by the Corporation or otherwise to be or to have been “fiduciaries” of any employee benefits plan of the Corporation which may exist, from time to time, this Article VIII shall be interpreted as follows: (i) “another organization” shall be deemed to include such an employee benefit plan, including without limitation, any plan of the Corporation which is governed by the Act of Congress entitled “Employee Retirement Income Security Act of 1974,” as amended, from time to time. (‘ERISA’); (ii) “Trustee” shall be deemed to include any person requested by the Corporation to serve as such for an employee benefit plan where the performance by such person of his or her duties to the Corporation also imposes duties on, or otherwise involves services by, such person to the plan or participants or beneficiaries of the plan; (iii) “fines” shall be deemed to include any excise tax plan pursuant to ERISA; and (iv) actions taken or omitted by a person with respect to an employee benefit plan in the performance of such person’s duties for a purpose reasonably believed by such person to be in the interest of the participants and beneficiaries of the plan shall be deemed to be for a purpose which is in the best interests of the Corporation.

The right of indemnification provided in this Article VIII shall not be exclusive of or affect any other rights to which any Trustee, director or officer may be entitled under any agreement, statute, vote of Members or otherwise. The Corporation’s obligation to provide indemnification under this Article VIII shall be offset to the extent of any other source of indemnification of any otherwise applicable insurance coverage under a policy maintained by the Corporation or any other person. Nothing contained in the Article shall affect any rights to which employees and corporate personnel other than Trustees, directors or officers may be entitled by contract, by vote of the Board or of the Executive Committee or otherwise.

ARTICLE IX—DISSOLUTION

The consent of every Trustee shall be necessary to effect a dissolution of the Marine Biological Laboratory. In case of dissolution, the property shall be disposed of in such a manner and upon such terms as shall be determined by the affirmative vote of two-thirds of the Trustees then in office in accordance with the laws of the Commonwealth of Massachusetts.

ARTICLE X—MISCELLANEOUS PROVISIONS

A. Fiscal Year. Except as otherwise determined by the Trustees, the fiscal year of the Corporation shall end on December 31st of each year.

B. Seal. Unless otherwise determined by the Trustees, the Corporation may have a seal in such form as the Trustees may determine, from time to time.

C. Execution of Instruments. All checks, deeds, leases, transfers, contracts, bonds, notes and other obligations authorized to be executed by an officer of the Corporation in its behalf shall be signed by the Director or the Treasurer except as the Trustees may generally or in particular cases otherwise determine. A certificate by the Clerk or an Assistant Clerk, or a temporary Clerk, as to any action taken by the Members, Board of Trustees or any officer or representative of the Corporation shall as to all persons who rely thereon in good faith be conclusive evidence of such action.

D. Corporate Records. The original, or attested copies, of the Articles of Organization, Bylaws and records of all meetings of the Members shall be kept in Massachusetts at the principal office of the Corporation, or at an office of the Corporation’s Clerk or resident agent. Said copies and records need not all be kept in the same office. They shall be available at all reasonable times for inspection by any Member for any proper purpose, but not to secure a list of Members for a purpose other than in the interest of the applicant, as a Member, relative to the affairs of the Corporation.

E. Articles of Organization. All references in these Bylaws to the Articles of Organization shall be deemed to refer to the Articles of Organization of the Corporation, as amended and in effect, from time to time.

F. Transactions with Interested Parties. In the absence of fraud, no contract or other
transaction between this Corporation and any other corporation or any firm, association, partnership or person shall be affected or invalidated by the fact that any Trustee or officer of this Corporation is pecuniarily or otherwise interested in or is a director, member or officer of such other corporation or of such firm, association or partnership or in a party to or is pecuniarily or otherwise interested in such contract or other transaction or is in any way connected with any person or person, firm, association, partnership, or corporation pecuniarily or otherwise interested therein; provided that the fact that he or she individually or as a director, member or officer of such corporation, firm, association or partnership in such a party or is so interested shall be disclosed to or shall have been known by the Board of Trustees or a majority of such Members thereof as shall be present at a meeting of the Board of Trustees at which action upon any such contract or transaction shall be taken, any Trustee may be counted in determining the existence of a quorum and may vote at any meeting of the Board of Trustees for the purpose of authorizing any such contract or transaction with like force and effect as if he/she were not so interested, or were not a director, member or officer of such other corporation, firm, association or partnership, provided that any vote with respect to such contract or transaction must be adopted by a majority of the Trustees then in office who have no interest in such contract or transaction.


Cospeciation between bacterial endosymbionts (Buchnera) and a recent radiation of aphids (Uroleucon) and pitfalls of testing for phylogenetic congruence. Evolution 54: 517–525.


Nitrogen controls on fine root substrate quality in temperate forest ecosystems. Ecosystems 3: 57–69.


