

WAKSMAN FOUNDATION FOR MICROBIOLOGY
12-Year Report
Covering the Years 1996-2007

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INTRODUCTION

This report follows past practice in presenting a summary of the Foundation's activities and status, but breaks one tradition; rather than covering a five-year period, or simple multiple thereof, it covers a twelve-year period. The logic of this decision will become clear as the substance of the report unfolds. The period being covered represents a singular time in the history of the Foundation. Within these dozen years the name of the Foundation was changed, presidential leadership passed for the first time out of the Waksman family, and the focus of the Foundation shifted from primarily one of supporting (directly and indirectly) advanced research in microbiology to one of emphasis on microbial literacy. Likewise, during this same period events in the external world changed many features of microbial science, and are significant in understanding the evolution of the Foundation.

We shall consider, first, the extraordinary discoveries and developments within the science of microbiology, and the state of microbial literacy in the period just before and just after the turn of the millennium. With this context in mind, we shall turn to a description of the major aspects of the Foundation in this period: its officers and board of trustees, the resources available to the organization, and the programs that were supported. Finally, we shall project a picture, however tentative, of the future directions of the Foundation in fostering microbiology in diverse ways "*...all to the end that the science of microbiology shall progress in the service of mankind...*" as stated in its Charter of Incorporation in 1951.

MICROBIOLOGY AT THE NEW MILLENNIUM

The decades preceding entrance into the third millennium witnessed spectacular progress in our understanding of the microbial world. This progress was due in part to the use of modern genomic and imaging techniques. The ability to manipulate genomes, to sample environments and discover and learn details about microbes even without being able to cultivate them, and to peer into the world of the invisible with vastly increased power—these technical advances increased the speed of discovery and transformed the directions of microbiological inquiry.

During this time evidence grew that humans live on a planet that is dominated by microbes, as measured not only by numbers of organisms, but by their sheer mass. Most of Earth's living things are microbes, and collectively they make up approximately half the total biomass and carry out about half the total metabolic activities on our planet. Where there is life on Earth there are microbes, and in many places *only* microbes. The biosphere is defined by the presence of microbes. Microbes affect the weather, and mold the geology of Earth. Moreover, all life on Earth depends on the unceasing re-cycling of life's key elements by microbes.

New perspective was gained by the realization that many microbes live in communities—self-associations of organisms that form mats enabling the cells collectively to occupy a myriad of ecological niches. Other such *biofilms* consist of multiple-species consortia, cooperating in promoting their mutual existence in improbable environments.

Finally, the century-long dream of understanding the special property of some microbes to invade humans (and other animals, and plants), causing disease and death, came closer to being understood, not fully to be sure, but to an extent that has raised the expectations of a new generation of medical “microbe hunters.”

But if this period seemed the best of times, it was also the worst of times. Human behavior has not kept up with these new insights into our world. Consider the following:

- Science education in the U.S. continues to lag behind that of other industrialized countries. The vital nature of microbes remains invisible and unappreciated by most of society.
- Fear of microbes has been exacerbated by continued governmental research on microbes as potential weapons of biological warfare, and by the occasion of delivery, through the U.S. postal service, of envelopes deliberately contaminated by specially micronized preparations of anthrax spores.
- Advances a century ago in improved safety in food production, processing, distribution and preservation have unexpectedly been reversed. New pathogens have arisen through the selective pressures inherent in large-scale national and international food production and processing operations.
- Use of antibiotics in the meat and dairy industries, and in inappropriate medical situations, continues to promote the evolution and spread of drug-resistant microbes.
- Failure to achieve universal immunization of infants and children has resulted in an upsurge of preventable childhood diseases.

The activities of the Foundation from 1995-2007 have been in large measure motivated by advances in our understanding of the microbial world, and by the challenges posed by society's failure to grasp the implications of this information. It should not go unnoticed that Selman A. Waksman's perspective over a half century ago included the view that microbes were not simply dangerous pests, but were also collectively an integral part of the planet's biological equilibrium.

We shall first describe the administration of the Foundation during this period, and then turn attention to how it has endeavored to foster public awareness and understanding of the unseen world.

ADMINISTRATION OF THE FOUNDATION

OFFICERS AND TRUSTEES

During the 12-year period covered by this report, the direction of the **Foundation for Microbiology** underwent major changes. Dr. Byron H. Waksman, who had become President in 1970, succeeding the Foundation's founder, Selman A. Waksman, stepped down from this position December 31, 2000. Frederick C. Neidhardt, who proposed that the name of the Foundation be changed to **Waksman Foundation for Microbiology**, took office as President of the renamed organization on January 1, 2001, while Byron Waksman undertook new responsibilities as Vice President for Special Projects and as Chairman of the Board of Trustees, Nan Waksman Schanbacher continued as Vice President for K-12 Science Education, Keith A. Bostian as Treasurer, and R. Edward Townsend as Secretary and Counsel. The officers of the Foundation during this period are listed in **TABLE 1**.

The makeup of the Foundation's Board of Trustees also changed significantly, with many individuals retiring from the Board after providing outstanding leadership, and new individuals coming on board to take on the new challenges. The Foundation's strength over its entire history has in large measure derived from the service of esteemed microbiologists who have served on its Board of Trustees. The membership of the Board throughout this period is displayed in **TABLE 2**.

The Board at several times examined the long-term viability of the Foundation. After considering several options, it was agreed that the role of this family Foundation, especially with its history, its intimacy with an important branch of science, and the strong commitment of support from leaders in microbiology, continues to have relevance. Efforts were made to cope with the financial problems faced in 2001-02 (see next section), and to engage the interests of younger members of the Waksman family.

FINANCES

The operating statements for each of the 12 years are displayed in **TABLE 3**. In the first half of this period, the Foundation was in a position to expend an average of over \$260,000 annually in grants and contributions, while still maintaining assets of \$1.9-2.5 million. The stress of a national economic downturn in 2001-02 was felt particularly hard because of financial

commitments already made, including support to establish the permanent exhibit of the Selman A. Waksman Museum in his former laboratory at Rutgers University (see later section on the Exhibit).

Measures were taken in the second half of the period to meet the financial reverses of 2001-02, including (a) establishing a Finance Committee to assist the Board in overseeing income and expenses, and in recommending caps for future funding of programs; (b) deferring payment for a few years for support of programs with multiple commitments from the Foundation; (c) declaring a temporary moratorium on new grant applications; (d) reducing honoraria for officers; and, eventually, (e) transferring the Foundation's investment portfolio to a new financial management company. These measures showed progress in slowly re-building the Foundation's assets by 2007.

BY-LAW AMENDMENT

Recognizing the importance of continued involvement of the next generation of the descendents of Selman A. Waksman in this family foundation, and the necessity of having a Board of Trustees appropriate to the new initiatives of the Foundation, changes in the By-Laws of the Foundation were adopted on 2 July 2003. The version current as of this report is appended (**APPENDIX A**).

ACTIVITIES OF THE FOUNDATION

LONG-STANDING GRANTS

The Foundation has provided long-term support for certain "**cherished programs**", notably those of the American Society for Microbiology (ASM) and the Marine Biological Laboratory (MBL) in Woods Hole, Massachusetts. This support continued during most of this 12-year period.

American Society for Microbiology

The Foundation continued its support of the ASM's **Foundation for Microbiology Lectureships** program, initiated in 1963. This program, directed principally to young scientists, serves as a major area of positive interaction between the ASM and its chapters. It has grown in size and complexity as the number and diversity of fields coming under the general title of "microbiology" has grown. The panel of designated speakers, reflecting this diversity, numbered 35 in 2000-2001.

The Foundation underwrote expenses associated with the ASM's new and expanding role in public education about microorganisms, beginning with the production of a **CD** on "**Biofilms**" for use by schoolteachers. This was followed by **development of a website** entitled "**Microbe**" in 1998. The Foundation contributed, not long after, to the development of a **database** of hands-on "discovery-based" laboratory exercises by the Microbial Literacy Collaborative, a joint venture of the ASM with the National Association of Biology Teachers (NABT). This database is now available online under the title "**MicrobeWorld**."

The Waksman Foundation also helped to fund the Microbial Literacy Collaborative, a multi-partner, multi-media initiative created to bring the microbial world to the general public.

The initiative's interrelated components included a 4-hour PBS limited series broadcast in primetime in 1999 (*Intimate Strangers: Unseen Life on Earth*), a 12-part telecourse produced for the Annenberg/CPB Project (*Unseen Life on Earth: An Introduction to Microbiology*), and an award-winning web site (<http://www.microbeworld.org/>). The PBS primetime telecast, "**Intimate Strangers: Unseen Life On Earth**," was conceived as "a Formal Science Initiative, for curriculum development and teacher training, and a Community Outreach Initiative, to reach the larger public." The individual hour-long segments were entitled: *The Tree of Life*, *Keepers of the Biosphere*, *Dangerous Friends and Friendly Enemies*, and *Creators of the Future*. This series, which premiered in the spring of 1999, was a joint venture of the ASM, the NABT, the AAAS, and the Association of Science-Technology Centers. It was produced by the independent television production team of Baker and Simon Associates and Oregon Public Broadcasting, and was funded, in addition to the Waksman Foundation's modest contribution, by the DOE, the NSF, and the Annenberg Foundation.

In addition, the Microbial Literacy Collaborative conducted a 3 year series of teen science leadership development programs in partnership with science centers around the country, and produced teaching and learning aids for biology teachers and students, including a set of hands on activities (MicrobeWorld). Much of the content is still available and in use today, including *Intimate Strangers, Unseen Life on Earth* (Washington: ASM Press, 2000), the book written to accompany the television series.

Cynthia Needham, currently a trustee of the Waksman Foundation, was the project director and principal investigator for the Collaborative.

The ASM's substantial program of "**Microbial Discovery**" **workshops** for secondary school science teachers, headed by Dr. Ken Anderson (California State University, Los Angeles), was initiated in 1997 with co-funding by the Foundation and The Pfizer Company Foundation. It has grown from a small start to encompass 3 teacher enhancement workshops annually, offered at diverse sites around the country to teams of teachers and scientists from different chapters of the ASM. In 2000, workshops were held at Florida Atlantic University, the University of Idaho, and (a mini-workshop) at the meeting of the Society for the Advancement of Chicanos and Native Americans in Science. An additional workshop was set up at the University of British Columbia in Vancouver, the first ASM venture outside the boundaries of the U.S. The ASM's program is a key component in the Waksman Foundation's enlarged program of support for teacher training, described in more detail below.

The Marine Biological Laboratory

The Foundation continued its long-term funding for the **course in Microbial Diversity**, one of the core courses **offered by the MBL**. This course was begun in 1971 by Dr. Holger W. Jannasch of the Woods Hole Oceanographic Institution and supported by the Foundation from 1975 on. It has been regarded, over the 30 year period, as the outstanding microbiology course available to aspiring basic scientists in the U.S. Dr. Edward Leadbetter (University of Connecticut) and Abigail A. Salyers (University of Illinois, Urbana), in their role as Course Directors starting in 1995, shifted its emphasis to the analysis of microbial populations in coastal and marine environments with the use of DNA hybridization technology (PCR), including the cloning of genes directly from mixed-ecosystem DNA pools, backed up by more traditional enrichment, isolation, and cultivation techniques. We include here excerpts from an article by Leadbetter and Salyers in *ASM News* explaining the new look of the course:

"Although we may have forgotten the microbes, they have not forgotten us. Instead, they have been using their considerable genetic and metabolic flexibility to take advantage of new niches we have created. This has led to an array of new problems, ranging from biofouling of pipes to the appearance of new or emergent infectious diseases...as well as the increasing incidence of antibiotic resistance problems." "Another force propelling microbial diversity to the forefront is the recent development of molecular tools for characterizing diversity and for providing information about microbes that cannot yet be cultivated...fluorescently labeled nucleic acid probes are used to determine the phylogenetic identities of members of complex microbial communities, providing microbiologists with a powerful new tool to study microgeography as well as the composition of natural microbial communities." "Summer students still learn to grow many different types of bacteria, including phototrophs, methanogens, sulfate-reducing bacteria, sulfide-oxidizing bacteria, gliding bacteria, and clostridia." "Students in the course learned that the microbial community [in the accessory nidamental gland of *Loligo pealii* squid females] is highly complex and may include archaea and photosynthetic bacteria as well as vibrios and pseudomonads."

Funding for the Microbial Diversity course has expanded greatly since its inception. The Foundation's contribution has been at the level of \$20,000 annually, while the total budget for the course totaled \$255,033 in 2000! The Foundation's Trustees have also agreed to provide the MBL with endowment funds sufficient to pay the costs of a single participant in the Microbial Diversity course each year. This is a break with tradition and at the same time an indication of how highly the Trustees value this unique course.

A new team took over direction of the Microbial Diversity course in 2000, with an assurance of Foundation support for 5 years: Drs. Caroline S. Harwood (University of Iowa) and Alfred M. Spormann (Stanford University).

At the Foundation's suggestion, and with initial Foundation funding, the MBL's program for **training science journalists** was developed in 1986 by James Shreeve, who put a small number of reporters (6) directly into one or another of the formal summer science courses offered **at the MBL**. The idea was to provide an opportunity for people who write about science actually to do science and to rub elbows with working scientists, thereby acquiring a sense of their character and motivation at first hand. The participants ultimately included newspaper reporters writing about science, magazine and free-lance writers, as well as radio and TV reporters and a small number of editorial level people. The program was enhanced by the addition in 1990 of a week-long "hands-on" laboratory in cell and molecular biology for participating journalists, run by Dr. Robert Goldman, Chairman of Cell and Molecular Biology at Northwestern University. The principle was accepted that some of the participants would limit their involvement to the hands-on course, while others would spend additional weeks in one of the MBL's fundamental science courses or laboratories.

The program was further enlarged in 1999 by provision of a second intensive hands-on laboratory course in environmental science, run by Drs. Jerry Melillo and John Hobbie of the MBL's Ecosystems Center. This provided a more appropriate venue for the U.S.'s rapidly expanding population of environmental journalists and permitted enlargement of the program to a total of 19 fellows in the summer of 2000. The possibility of providing a third hands-on laboratory in brain/neuroscience, with a further expansion of the total program, is under consideration.

The training program for science journalists was directed after 1990 by Dr. Byron Waksman and, since 1995, by Dr. Robert Goldman and Boyce Rensberger, former Science Editor of the *Washington Post* who now heads the Knight Science Journalism Program at MIT. It has benefited over time from the input of an advisory committee of distinguished senior journalists and scientists, chaired successively over the last 5 years by Eugene Roberts, Managing Editor of the *New York Times*; John Carroll, Editor of the *Baltimore Sun*; and Michael Parks, Executive Editor of the *Los Angeles Times*. Expenditures for the program, since its inception in 1986, have totaled \$1,208,250, contributed by foundations, professional scientific societies, and foundations from the specific field of journalism, with lesser amounts coming from government agencies (NSF, NIH) and corporate philanthropies. The budget for 2000 was \$123,500, to which the Foundation contributed a modest \$7,000, the cost of a single Fellow in the program. At least one of the participants each summer (actually 3 in 2000) is assigned to the MBL's course in Microbial Diversity or to the course in Biology of Parasitism (1 in 2000).

A European spinoff of the MBL's science journalist program, the **European Initiative for Communicators of Science (EICOS)**, developed by Dr. Waksman in 1992 at the Max Planck Institute for Neurosciences in Martinsried, has proved highly successful, bringing together a dozen journalists each year from all the countries of Europe. It moved to a new venue at the Max Planck Institute for Biophysical Chemistry in Göttingen in 1998.

A third program supported by the Foundation at the MBL, has been an annual **teacher enhancement workshop**, directed to regional secondary school teachers, "**Living in the Microbial World.**" This project, conducted as a "trial balloon" in 1995 (again, at the Foundation's prompting), has been the model on which the Foundation's expanded program of support for teacher enhancement projects, described below, was built.

OTHER GENERAL PROGRAMS

Microbiology in The Third World

The Foundation has continued its earlier interest in the teaching and practice of microbiology in developing countries of the world by supporting both microbiologically oriented courses and book publication, funding being arranged in each case through an interested or cooperating scientist or institution in the U.S. Earlier programs, funded through the Pan-American Health and Education Foundation, the Latin-American Professorships Program of the ASM, and the tropical "Microbiology Research Centers" handled by the NSF, are in temporary abeyance. In **Africa**, a highly successful course, organized by T.G. Egwang, was offered in 1998 at the Med Biotech Laboratories in Kampala, Uganda, on "Molecular Biology Techniques in Malaria," followed in 2000 by a course in "Genomics" (funded in each case through a grant to the U. of Iowa). It is important to note that the Foundation's grant for the first course (\$5000) served as seed money; the total budget for the course was \$68,170. In **South America**, a successful course entitled "Biological Nitrogen Fixation" was conducted in 2000, to be repeated in 2001, at the Universidad de la Republica in Montevideo, Uruguay, with visiting faculty from other S. American countries, for a multinational group of students (with funding through COHEMIS, the Hemispheric Cooperation Center at the U. of Puerto Rico, Mayaguez). Books were published, with Foundation support, on cysticercosis in Peru in 1997 (with funding through Johns Hopkins University) and in Saratov, **Russia**, on microbiology for nurses (funding through the U. of North Carolina, Chapel Hill). Another book, on molecular biology and appropriate

technology transfer, intended for use in Latin America, was published with Foundation support by the U. of California, San Francisco.

Support was continued for the long established **Downs International Health Student Travel Program**, administered by the **Yale University's Committee on International Health**, which makes it possible for medical, nursing, and graduate students in microbiology, as well as graduate students from the School of Public Health, to spend as much as 3 months in a developing country carrying out research on some aspect of microbial disease pathogenesis and dissemination. Funding provided by the Foundation has been matched by the Dean's office at Yale School of Medicine, resulting in an amount sufficient to cover the expenses (transportation, immunization, drugs, and a stipend) for three to six out of a total of 12-14 participants each year. Between 1996 and 2000, the projects supported with Foundation funds dealt with such topics as group A streptococcal infection and tuberculosis; hookworm, onchocerciasis, malaria, and Wolbachia; Oropouche and Hanta Viruses and HIV/HCV; and the vectors of Chagas' disease and sleeping sickness. They made use of epidemiological, entomological, genetic, immunological, and molecular techniques and were carried out in such countries as Argentina, Australia, the Cameroons, China, Ethiopia, Guatemala, India, Madagascar, Malaysia, Senegal, and Thailand. This program remains essentially unique among programs in American medical schools that deal with international medical and public health problems from a research standpoint.

A program of Postdoctoral Fellowships in Tropical Diseases Research, managed by the **National Foundation for Infectious Diseases** and directed primarily to minority applicants, was initiated in 1982 with joint funding by the Foundation and the Rockefeller Foundation. It was suspended in 1993 for lack of funds and reinitiated in 1998 as the **Colin L. Powell Minority Postdoctoral Fellowship in Tropical Diseases Research**, with joint funding by the Foundation and Glaxo-Wellcome. This fellowship, which provides \$32,000 annually towards support of a single fellow, was awarded in 1999 to Larean Brandon, Ph.D., for studies with Marcia B. Goldberg at the Massachusetts General Hospital on mechanisms of unipolar, surface localization of Shigella IcsA; and in 2000 to John-Paul Mutebi, Ph.D., for work with Alan D.T. Barrett at the University of Texas, Medical Branch, on the infectivity of S. American and African genotypes of Yellow Fever Virus for Bolivian *Aedes aegypti*.

Publications

The tradition of supporting **publication of books related to microbiology** has continued. We list the following: H.H. García and S.M. Martínez M.: Teniasis/Cisticercosis, 1996; E. Harris: "Low Cost Approach to Appropriate Transfer of Biomolecular Techniques," 1997 (for use in developing countries, especially Latin America); J. Shreeve and R. Zare: The Seeds of Creation," 1998 (on the origins of life); L.A. Katz and M.L. Sogin: Proceedings of a symposium on "Evolutionary Relationships Among Eukaryotes," 1999; V.L. Goremykin *et al*: "A Brief Course in Microbiology for Nurses," 2000 (published in Russia); M.L. Shnayerson and M. Plotkin (Amazon Conservation Team): "The Killers Within," 2000 (on the problem of drug resistance to antibiotics).

Prizes

The **Selman A. Waksman Award in Microbiology**, initiated in 1968 and presented every two years by the **National Academy of Sciences** at its annual meeting, continues to honor

high achievement in microbiological research. **TABLE 4** indicates the awardees during the current period and their cited achievement.

The **Waksman Outstanding Teaching Award**, initiated in 1989 and originally presented in alternate years by the **Society for Industrial Microbiology** at its national meeting, is now awarded annually. **TABLE 5** indicates the awardees during the current period.

Museum Construction

The Foundation made an exception to its longstanding policy of not funding capital projects by contributing to the creation of **a permanent exhibit honoring the achievements of Dr. Selman A. Waksman**, the Foundation's founder and first president. After preliminary discussions begun in 1996, an exhibit was developed in the original laboratory where much of Dr. Waksman's groundbreaking antibiotics research was carried out, in particular the work with Albert Schatz (as a graduate student) on streptomycin, in the former Agricultural Experiment Station (now Martin Hall) at Cook College, Rutgers University.

The display, which was completed in June, 2001, includes a "Tree of Life" that illustrates biodiversity and the place of microbes in the biosphere. The display describes and illustrates early discoveries in microbiology, the history of research on soil microbiology at the Agricultural Experiment Station, the antibiotic era in the Waksman laboratory, and some of Waksman's legacies (the Waksman Institute, the Waksman Foundation for Microbiology, and Waksman Foundations in France, Italy, and Japan). Separate display space is allocated to the antibiotic discovery process, from initial screening of soil samples to industrial production; to tuberculosis in the United States and around the world and the impact of streptomycin and other wonder drugs on this disease; to events surrounding the award of the Nobel Prize in Physiology and Medicine to Waksman in 1952, and other prizes and signs of recognition showered on Waksman in his later years, from appearance on the cover of *Time* magazine to stamps and street signs.

Funding for this project came from Rutgers University and the Foundation for Microbiology, together with grants from Merck, Pfizer, and Amgen. The group responsible for planning details of the display included H. Boyd Woodruff, discoverer of actinomycin, the Waksman laboratory's first antibiotic in 1939, Hubert Lechevalier, who discovered neomycin in 1949, Douglas Eveleigh of Rutgers University (the first recipient of the SIM Waksman Outstanding Teaching Award in 1989), and Byron H. Waksman, President of the Foundation.

Miscellaneous Activities

A formal history, *The Foundation for Microbiology, 1951-1995*, which summarized the information provided in successive 5-year reports from the earliest years of the Foundation's existence, together with a good deal of previously unpublished information, was completed in 1996 and widely disseminated.

EDUCATIONAL INITIATIVES

There has been a major shift in the Foundation's educational interests from an emphasis on the education of young scientists and communication among scientists to the communication of science to the public both through science journalism and by the education of young people, non-scientists and future scientists alike, about science.

Training of Science Journalists

This is described in detail as one of the programs supported at the MBL.

Teacher Training

The outstanding new Foundation initiative, in the period covered by this report, was the granting program in pre-college education. In response to increasing concern in the scientific community about the inadequacies of science teaching in American schools, Trustees decided to invest a significant block of funds (eventually equal to or greater than the amount spent on other projects) supporting projects that encourage the use of microorganisms to teach science in the K-12 classroom. Our principal goal was, and remains raising public understanding of science and demonstrating the importance that microorganisms play in our lives. These concerns lie behind the high priority assigned by the Foundation over the last decade to professional development workshops for K-12 teachers. Other related educational activities supported by the Foundation have included the development of loan trunks, CD's, websites and equipment donations.

Virtually every type of American institution engaged in education or research has received grants in K-12 education from the Foundation: Universities; Research Institutes; Scientific Societies; Museums; Schools; Associations; Consortia and Fellowship Programs. Every successful project has provided teachers with background information and current understanding of microbial diversity and the importance of microbial processes in the biosphere and has incorporated the use of hands-on activities for students at elementary, middle, or high school level.

In addition to the granting program, The Foundation developed a number of resources for teachers available on the Foundation website. The most important is a database of field tested hands-on microbiology exercises, developed by grantees of the Foundation, for use in high schools, middle schools and even elementary schools. The Foundation believes that the excellence of the scientists and teachers who have cooperated to develop the various exercises ensures their value in conveying both basic principles of scientific research and something about the microbial world. The exercises are listed by subject matter, age or grade level, linked to the National Science Standards and certified for safety. We have also included a list of the institutional sources for these exercises. In an attempt to offer additional support for teachers, our website includes lists of other microbiology related resources for school teachers; additional enrichment programs for school teachers; teacher programs at marine laboratories; agencies promoting new programs for school teachers.

From its inception through 2000, the education initiative was directed by the Foundation's President, Byron H. Waksman, with assistance from Trustee Nan Waksman Schanbacher. Dr. Waksman was personally instrumental in securing co-sponsors for this initiative. In 2001 Mrs. Schanbacher accepted the designation VP for K-12 Science Education and directed the program with the help of an outside Working Group made up of microbiologists, science teachers and administrators. Under her leadership over \$1M dollars was invested in a large number of programs throughout the nation, as listed in **TABLE 6**. This table lists the co-sponsors that joined the Foundation in this endeavor, but does not include the investments made by the grant recipients themselves.

The education initiative was suspended in 2007, and the Foundation is now considering alternative innovative approaches to strengthening public understanding of microbiology and improving K-12 science education.

GLIMPSE OF THE FUTURE

We are increasingly aware of the sheer numbers of microbial cells, their combined mass, and their role in making all life possible on Earth. This new knowledge, together with our increased awareness of the renewed threat of infectious disease in modern society, are unquestionably the most important messages to impart to the general public in the foreseeable future. In one sense, these dual messages to the public—that we cannot live without a microbially balanced biosphere, and that we need new protections against microbial threats—are not new. Microbiologists have been teaching that for decades. Yet they are new in urgency. Human activities can dramatically alter the microbial components that nurture our biosphere, and human activities can unwittingly contribute to the emergence of new threats to human health.

The mission of the Waksman Foundation for Microbiology in the coming years will be to discover and foster the most effective means possible to improve the public's understanding of how microbes can both threaten human health and at the same time be indispensable components of our life support system.

Under the new leadership provided by President Amy Cheng Vollmer and Vice President and Board Chair Nan Waksman Schanbacher, the Board of Trustees is exploring the use of innovative approaches to public education through science museums, exhibits, and various digital programs and electronic resources.

Table 1. Waksman Foundation for Microbiology Officers During 1996-2007

President	Byron H. Waksman, 1996-2000 Frederick C. Neidhardt, 2001-2007
Vice President (Special Projects)	Byron H. Waksman 2001-2007
Vice President (K-12 Science Education)	Nan Waksman Schanbacher 1996-2007
Chair, Board of Trustees	Alice S. Huang, 1996-2000 Byron H. Waksman, 2000-2007
Treasurer	Keith A. Bostian, 1996-2007
Secretary and Counsel	R. Edward Townsend, Jr., 1996-2007

Table 3. Financial operating statements, 1996-2007

WAKSMAN FOUNDATION FOR MICROBIOLOGY, INC.

***Operating Statement for the Years Ending December 31: 1996-2007**

1996-2001

	<u>1996</u>	<u>1997</u>	<u>1998</u>	<u>1999</u>	<u>2000</u>	<u>2001</u>	<u>6-YR. TOTAL</u>
FUND BALANCE							
January 1	\$1,894,298	\$2,050,834	\$2,268,349	\$2,509,726	\$2,434,681	\$2,248,466	\$1,894,298
REVENUE							
Interest & Dividends	101,023	101,625	80,247	86,552	87,121	52,637	509,205
Capital Gains	129,025	96,642	245,486	215,157	458,665	(56,247)	1,088,728
Other	-0-	12,700	800	250	2,913	14,596	31,259
TOTAL	230,048	210,967	326,533	301,959	548,699	10,986	1,629,192
DISBURSEMENTS							
Grants & Contributions	89,350	222,284	219,025	347,262	244,590	350,711	1,473,222
Taxes	2,776	3,148	1,902	3,134	2,465	5,925	19,350
Admin. Expenses	26,364	21,879	33,014	32,755	36,115	38,695	188,822
Invest. Advisor Fees	547	9,810	9,159	15,842	8,633	3,120	47,111
TOTAL	119,037	257,121	263,100	398,993	291,803	398,451	1,728,505
UNREALIZED GAINS	45,525	263,669	177,944	21,989	(443,111)	(319,922)	(253,906)
FUND BALANCE							
December 31	\$2,050,834	\$2,268,349	\$2,509,726	\$2,434,681	\$2,248,466	\$1,541,079	\$1,541,079

2002-2007

	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006</u>	<u>2007</u>	<u>6-YR. TOTAL</u>
FUND BALANCE							
January 1	\$1,541,079	\$1,300,743	\$1,354,734	\$1,311,316	\$1,249,273	\$1,375,129	\$1,541,079
REVENUE							
Interest & Dividends	51,459	38,934	42,168	23,596	36,159	41,611	284,927
Capital Gains	(53,410)	79,699	38,546	122,951	40,956	81,307	310,049
Other	-0-	-0-	3,050	2,413	50,000	11,825	67,288
TOTAL	(1,951)	118,633	83,764	148,960	127,115	134,743	611,264
DISBURSEMENTS							
Grants & Contributions	46,700	97,100	91,957	88,226	33,621	12,000	369,604
Taxes	427	892	2,203	1,493	3,065	1,441	9,521
Admin. Expenses	31,221	34,765	35,722	40,023	13,841	30,125	185,697
Invest. Advisor Fees	1,602	1,973	1,943	5,229	9,653	10,722	31,122
TOTAL	79,950	134,730	131,825	134,971	60,180	54,288	595,944
UNREALIZED GAINS	(158,435)	70,088	4,643	(76,032)	58,921	(12,877)	(113,692)
FUND BALANCE							
December 31	\$1,300,743	\$1,354,734	\$1,311,316	\$1,249,273	\$1,375,129	\$1,442,707	\$1,442,707

National Academy of Sciences

Selman A. Waksman Award in Microbiology

Awardee	Year	Achievement Cited
Carl R. Woese	1997	"...discovering a Kingdom of Life, the Archaea, using ribosomal RNA sequences for phylogenetic studies of microorganisms, which has influenced concepts of evolution and microbial ecology, and has major technical and industrial applications."
R. John Collier	1999	"...seminal contributions to the understanding of bacterial pathogenesis by the elucidation of the action of diphtheria toxin."
Norman R. Pace	2001	"...developing methods by which microorganisms can be directly detected, identified, and phylogenetically related without the need for cultivation in the laboratory."
Stanley Falkow	2003	"...many contributions to understanding the mechanisms by which bacteria cause infection and disease."
Lucy Shapiro	2005	"...pioneering work revealing the bacterial cell as an integrated system with transcriptional circuitry interwoven with the 3-D deployment of regulatory and morphological proteins."
Richard M. Losick	2007	"...discovering alternative bacterial sigma factors and his fundamental contributions to understanding the mechanism of bacterial sporulation."

Society for Industrial Microbiology

Selman A. Waksman Outstanding Teaching Award

Awardee	Year
James M. Jay, University of Nevada, Las Vegas	1997
Joseph Cooney, University of Massachusetts, Boston	1998
Maurice Gaucher, University of Calgary, Canada	1999
Jerald Ensign, University of Wisconsin, Madison	2000
Daniel Y.C. Fung, Kansas State University, Manhattan	2001
Ronald Bentley, University of Pittsburgh	2002
Thomas D. Brock, University of Wisconsin, Madison	2003
Kenneth Nealson, University of Southern California, Los Angeles	2004
J. H. David Wu, University of Rochester	2005
Elisabeth D. Elder, Louisiana State University, Alexandria	2006
Eric Vandamme, University of Ghent, Belgium	2007

Table 6. Recipients of grants in support of pre-college education in microbiology, 1995-2007.

The financial support is listed as \$ thousands. Co-sponsorship of program awards is indicated immediately below each award, in color and italics: Bay/Paul (Bay Foundation and the Josephine Bay Paul and C. Michael Paul Foundation, New York, NY); Johnson and Johnson (Johnson & Johnson, New Brunswick, NJ); Josiah Macy (Josiah Macy, Jr. Foundation, New York, NY); Merck (Merck Company Foundation, Whitehouse Station, NJ); and Pfizer (Pfizer Foundation, Inc., New York, NY).

Institutions	Co-Sponsor	Program	Total Amount	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
American Society for Microbiology	<i>Pfizer</i>	Microbial Discovery Workshops	34.2 40.4		5.0 7.5	7.5 7.5	7.7 7.7	7.7 7.7	6.3 10.0						
Arkansas School for Mathematics & Sciences (Biology and Chemistry)		Microbiology and Immunology in the Interactive Classroom	20.0				20.0								
BSCS Keystone Science School		Biological Science Curriculum Study	1.0								1.0				
BSCS Keystone Science School		Keys to Science Summer Institute	40.0		10.0			15.0	15.0						
California State Univ., Chico		High School Science Teachers Workshop	41.2			17.0	9.2		15.0						
California State Univ., Los Angeles		Middle School Science Scholars	20.0					10.0	10.0						
Campbell University School of Pharmacy		ASM Microbial Discovery Workshop	3.3									3.3			
City Univ. of NY, Staten Island College			4.0		4.0										
Columbia Univ. College of P & S (Physiology and Cellular Biophysics)	<i>Bay/Paul</i>	Summer Research for Secondary School Teachers	40.0 8.0		4.0 4.0	4.0 4.0	8.0	8.0	10.0	3.0	3.0				
Cornell University	<i>Josiah Macy</i>	Microbiology High School Laboratory	10.0 10.0		10.0 10.0										
Cross Roads at Big Creek; Sturgeon Bay		Septic System Demonstration Project	5.0								5.0				
Des Moines University Center of Osteopathic Medicine	<i>Merck</i>	Uganda Summer Medical Microbiology Experience	66.6 5.0		5.0		19.3	12.3	20.0	10.0	5.0				
Keystone Center		Tri-State Key Issues Program	3.0									3.0			
Louisiana State University		Introduction of Microbiology into High Schools and Middle Schools	30.7		16.8	13.9									
Louisiana Technical University		Enhancing Acquisition of Microbiology Knowledge	4.4								4.4				
Marine Biological Lab., Woods Hole	<i>Pfizer</i>	Living in the Microbial World	34.5 60.0	9.5	5.0 7.5	5.0 7.5	5.0 10.0	5.0 10.0	5.0 25.0						
Miami University of Ohio, Science		Outreach Program to Public Schools	1.5								1.5				
Michigan Lakes and Streams		Watershed Monitoring Project	0.84									0.84			
Michigan Technological University		Professional Development and Student Programs	12.0								7.0		5.0		
Micropaleontology Project		Public Education Initiative	5.0										5.0		
Milwaukee School of Languages		Inquiry-Based Instruction in Microbiology	0.2									0.2			
Montana State University		Ft. Benton High School Research	18.0						9.0	9.0					
Museum Inst. For Teaching Science		Summer Institute on Cape Cod	5.0											5.0	
National Association of Biology Teachers		Microbe World Activities	3.2			3.2									
NJ Business-Industry Consortium	<i>Johnson & Johnson</i>	Summer Residential Institute	34.9 39.8				13.9	10.0	11.0						
New York Hall of Science		Museum	20.0					10.0	10.0						
Niagara University, NY		From the Ground Up - Teachers Program	21.4						11.7	9.7					
Nueces Canyon School District		Digital Microscope	0.5											0.5	
Oceanside High School, L.I., NY		Shipboard Marine Science for Teachers	18.0					9.0	9.0						
Rice University		Teacher Training in Rural Texas	5.7								5.7				
Roland Park Country School		Environmental Science Summer Experience	1.7										1.7		
Science Museum of Minnesota (Human Biology)	<i>Pfizer</i>	Enhance Microbiology Content	10.0 10.0				10.0	10.0							
Seattle Biomedical Research Institute		BioQuest Virtual Researchers	6.0										6.0		
Self Reliance Foundation		Celebra la Ciencia	10.0								10				
Southern Illinois University		High School Teacher Workshops	5.65								5.65				
Thurgood Marshall Scholarship Fund		Scholarship Study in Science Education	5.0					5.0							
University of Maine - Presque Isle		Mainely Parasites Course	5.0											5.0	
University of Maryland (Biotechnology Institute)	<i>Pfizer</i>	Science and Technology Education Program	16.8 35.0			6.8	5.0	5.0	10.0						
University of Missouri, St. Louis (Biology and SERC)	<i>Pfizer</i>	Science in the Real World: Microbes in Action	31.0 20.0		13.8			8.6	8.6						
University of Northern Colorado - MAST Institute		Microbial Explorations for Elementary Teachers	5.5										5.5		
University of the Pacific		Equipment Registry for Center for MicroEducation	3.0										3.0		
University of Rochester		Science Summer Academy	4.98											4.98	
University of Rochester		Microbial Explorations for Elementary Teachers	6.284									6.284			
University of Dakota, Sioux Falls		Interactive Exploration Stations	5.0											5.0	
University of Wisconsin, Madison		Wisconsin Teacher Enhancement Program	41.7		15.0			6.7	20.0						
University of Wisconsin (Biology, Genetics / WisTEB)	<i>Pfizer</i>		6.8					6.8							
Vanderbilt University School of Medicine		Girls and Science: Summer Camp	9.1			6.0			1.5				1.6		
Washington State University (Vet. Microbiology & Pathology)		Microbiology Experiments for Elementary School Children	25.8		12.5				13.3						
Watershed Monitoring Project, Michigan		Adding Microbial Content to Monitoring Michigan Lakes and Streams	0.83									0.83			
Woodrow Wilson Foundation			16.0						8.0	8.0					

Institutions	Co-Sponsor	Program	Total	1995	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
			Amount												
a. American Museum of Nat. History and Pace Univ., Commuter Program		Biodiversity Institute	35.0				9.5	9.5	8.0	8.0					
	<i>Bay/Paul</i>		19.0				9.5	9.5							
b. TORCH: College of Charleston		Teacher Enrichment	7.5		7.5										
	<i>Merck</i>		5.0		5.0										
c. TORCH: Jefferson Cty School District, Louisville, KY		Teacher Enrichment	4.8					4.8							
d. TORCH: Navasota High school, Navasota, TX		Teacher Enrichment	4.3					4.3							
Worcester Foundation for Biomedical Research		Use of Microorganisms to Teach Science	7.3		7.3										
	<i>Pfizer</i>		10.0		10.0										
TOTAL FROM FOUNDATION			772.42	0.0	110.9	63.4	116.2	130.9	182.8	47.7	36.9	19.56	34.08	20.48	0
TOTAL FROM CO-SPONSORS			269.00	9.5	49.0	34.0	67.2	68.9	49.9						
GRAND TOTAL			1041.42	9.50	159.90	97.40	183.40	199.80	232.70	47.70	36.90	19.56	34.08	20.48	0

BY-LAWS
(amended as of 2 July 2003)
OF
WAKSMAN FOUNDATION FOR MICROBIOLOGY

1. BOARD OF TRUSTEES

1.1 Number: Qualification; Election and Term of Trustees. The business of the Corporation shall be managed by a Board of not less than three (3) trustees, each of whom shall be at least eighteen (18) years old. Subject to the foregoing, the number of trustees shall be determined by resolution of the Board, but no decrease in the number of trustees shall shorten the term of any incumbent trustee. If not otherwise determined pursuant to this Section, the number of trustees shall be eleven (11). Trustees shall be elected at the annual meeting of the Board or at a special meeting of the Board called for that purpose, and shall hold office for a term of four (4) years and until the election of their respective successors. A trustee may be elected for one or more successive terms. In electing trustees, the Board shall, to the extent practicable, elect three (3) trustees who are descendants of Selman A. Waksman, or related to descendants by marriage.

1.2 Quorum and Manner of Acting. A majority of the entire Board shall constitute a quorum for the transaction of business at any meeting. Action of the Board shall be authorized by the vote of a majority of the trustees present at the time of the vote if there is a quorum. In the absence of a quorum, a majority of the trustees present may adjourn any meeting from time to time until a quorum is present.

1.3 Place of Meetings. Meetings of the Board may be held in or outside the State of New Jersey.

1.4 Annual and Regular Meetings. Annual meetings of the Board, for the

election of trustees and officers, and consideration of other matters, shall be held on notice as provided in Section 1.6 of these By-Laws. Regular meetings of the Board may be held without notice at such times and places as the Board determines.

1.5 Special Meetings. Special meetings of the Board may be called by the President or by any two (2) of the trustees.

1.6 Notice of Meetings; Waiver of Notice. Notice of the time and place of the annual meeting and of each special meeting of the Board shall be given to the trustees by mail to their residences or usual places of business at least ten (10) days before the meeting, or by delivering, telephoning or faxing the notice at least five (5) days before the meeting. Notice of a special meeting need not state the purposes for which the meeting is called. Notice need not be given to any trustee who submits a signed waiver of notice before or after the meeting, or who attends the meeting without protesting the lack of notice prior to the conclusion of the meeting. Notice of any adjourned meeting need not be given, other than by announcement at the meeting at which the adjournment is taken.

1.7 Resignation and Removal of Trustees. Any trustee may resign at any time by written notice to the Corporation. Any trustee may be removed for cause by a majority of the entire Board.

1.8 Vacancies. Any vacancy in the Board, including one created by an increase in the number of trustees, maybe filled for the unexpired term by a majority vote of the remaining trustees, though less than a quorum.

1.9 Compensation. Trustees shall receive such compensation as the Board determines, together with the reimbursement of their reasonable expenses in connection with the

performance of their duties. A trustee may also be paid for serving the Corporation in other capacities.

1.10 Actions of the Board. Any Board action may be taken without a meeting if all trustees consent to the action in writing.

1.11 Meeting by Conference Telephone. Any or all trustees may participate in a meeting of the Board by means of a conference telephone or similar communication equipment allowing all persons participating in the meeting to hear each other at the same time.

1.12 Chairman of the Board of Trustees. The Chairman of the Board of Trustees shall be elected at the annual meeting of the Board from among the trustees and shall serve until the election of his/her successor. The Chairman shall preside at all meetings of the Board, and shall be an *ex officio* member of each committee of the Board.

2. COMMITTEES

2.1 Executive Committees. The Board, by resolution adopted by a majority of the entire Board, may designate an executive committee of two (2) or more trustees which shall have all the authority of the Board, except as otherwise provided by resolution, by-law or law, and which shall serve at the pleasure of the Board. All action of the executive committee shall be reported to the Board at its next meeting.

2.2 Other Committees. The Board, by resolution adopted by a majority of the entire Board, may designate other committees of two (2) or more trustees to serve at the Board's pleasure, with such powers and duties as the Board determines. The Board, in its discretion, may appoint one or more individuals who are not trustees to such committees.

3. OFFICERS

3.1 Number; Security. The executive officers of the Corporation shall be the President, one or more Vice Presidents, a Secretary and a Treasurer. Any two (2) or more offices may be held by the same person. The Board may require any officer agent or employee to give security for the faithful performance of his/her duties.

3.2 Election; Term of Office. The executive officers of the Corporation shall be elected annually by the Board, and each such officer shall hold office until the next annual meeting of the Board and until the election of his/her successor. The President and the Vice Presidents shall be elected from the trustees. Whenever a vacancy in the office of the President occurs, the Board, in deliberating over who shall fill the vacancy, shall first consider whether it is appropriate or desirable, but shall not be obligated, to appoint a member of the Byron H. Waksman family to the position. In so doing, the Board shall consider as candidates for the Presidency descendants of Selman A. Waksman, or persons related to descendants by marriage, who have served as trustees for not less than three (3) years.

3.3 Subordinate Officers. The Board may appoint subordinate officers (including Assistant Secretaries and Assistant Treasurers), agents or employees, each of whom shall hold office for such period and have such powers and duties as the Board determines. The Board may delegate to any executive officer or to any committee the power to appoint and define the powers and duties of any subordinate officers, agents or employees.

3.4 Resignation and Removal of Officers. Any officer may resign at any time by written notice to the Corporation. Any officer elected or appointed by the Board or appointed by an executive officer or by a committee may be removed by the Board either with or without

cause.

3.5 Vacancies. A vacancy in any office may be filled for the unexpired term in the manner prescribed in Sections 3.2 and 3.3 of these By-Laws for election or appointment to the office.

3.6 The President. The President shall be the chief executive officer of the Corporation. Subject to the control of the Board, he shall have general supervision over the business of the Corporation and shall have such other powers and duties as presidents of corporations usually have or as the Board assigns to him/her.

3.7 Vice President. Each Vice President shall have such powers and duties as the Board or the President assigns to him/her.

3.8 The Treasurer. The Treasurer shall be the chief financial officer of the Corporation and shall be in charge of the Corporation's books and accounts. Subject to the control of the Board, he/she shall have such other powers and duties as the Board or the President assigns to him/her.

3.9 The Secretary. The Secretary shall be the secretary, and keep the minutes of all meetings of the Board, shall be responsible for giving notice of all meetings of the Board, shall keep the seal and, when authorized by the Board, shall apply it to any instrument requiring it.

3.10 Salaries. The Board may fix the officers' salaries, if any, or it may authorize the President to fix the salary of any other officer.

4. INDEMNIFICATION

Each person who by reason of the fact that he or she is or was a trustee or officer

of the Corporation who is threatened to be or is made a party to any threatened, pending or completed action, suit or proceeding shall be indemnified against expenses (including attorney's fees), judgments, fines and other amounts actually and reasonably incurred by him or her in connection with such action, suit or proceeding to the full extent permitted by law. The foregoing right of indemnification shall in no way be exclusive of any other rights of indemnification to which such person may be entitled under any agreement, vote of disinterested trustees or otherwise and shall inure to the benefit of the heirs, executors and administrators of such person.

5. MISCELLANEOUS

5.1 Seal. The Board shall adopt a corporate seal, which shall be in the form of a circle and shall bear the Corporation's name and the year and state in which it was incorporated.

5.2 Fiscal Year. The Board may determine the Corporation's fiscal year.

5.3 Amendments. The By-Laws may be amended, repealed or adopted by a majority of the entire Board.

5.4 Dissolution. In case of dissolution after all debts have been fully satisfied, the assets of the Corporation shall be distributed to corporations organized and operated exclusively for charitable, scientific, literary or educational purposes, no part of the net earnings of which inures to the benefit of any private shareholder or individual, no substantial part of the activities of which is carrying on propaganda or otherwise attempting to influence legislation, and which does not participate in or intervene in (including the publishing or distributing of statements) any political campaigns on behalf of any candidate for public office.