2002 Annual Report

BURROUGHS
WELLCOME
FUND

The Burroughs Wellcome Fund
is an independent private foundation
dedicated to advancing the biomedical sciences
by supporting research and other
scientific and educational
activities.

Depicted in BWF's logo, the eye of the
ancient Egyptian god Horus is considered a symbol of health.

2002 Annual Report

Burroughs Wellcome Fund

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About the Burroughs Wellcome Fund

The Burroughs Wellcome Fund is an independent private foundation dedicated to advancing the biomedical sciences by supporting research and other scientific and educational activities.

Within this broad mission, we seek to accomplish two primary goals—to help scientists early in their careers develop as independent investigators, and to advance fields in the basic biomedical sciences that are undervalued or in need of particular encouragement.

BWF has an endowment of about $500 million, and we award approximately $25 million in grants annually in the United States and Canada. We channel our financial support primarily through competitive peer-reviewed award programs, which encompass five major categories—basic biomedical sciences, infectious diseases, interfaces in science, translational research, and science education. BWF makes grants primarily to degree-granting institutions on behalf of individual researchers, who must be nominated by their institutions. To complement these competitive award programs, we also make grants to nonprofit organizations conducting activities intended to improve the general environment for science.

The Burroughs Wellcome Fund was founded in 1955 as the corporate foundation of Burroughs Wellcome Co., the U.S. branch of the Wellcome pharmaceutical enterprise, based in the United Kingdom. The Wellcome enterprise was started in 1880 by two young American pharmacists, Henry Wellcome and Silas Burroughs, who had moved to London to manufacture and sell "compressed medicines"—that is, pills—which the pair believed could replace the potions and powders of the day.

Their firm prospered. After Silas Burroughs died in 1895, Henry Wellcome directed the growth of the company into an international network with subsidiaries in numerous countries on several continents. As the business grew, Henry Wellcome held firm to his strong belief that research was fundamental to the development of excellent pharmaceutical products—a belief he put into practice by establishing the industry's first research laboratories.

When Henry Wellcome died in 1936, his will vested all of the corporate shares in a new organization—the Wellcome Trust—devoted to supporting research in medicine and allied sciences and to maintaining museums and libraries dedicated to these fields. Over the decades, the Trust grew to become the world's largest charitable foundation devoted exclusively to the biomedical sciences.

In 1955, leaders at the Wellcome Trust and Burroughs Wellcome Co.-USA envisioned an extension of this effort in the United States—and so was born the Burroughs Wellcome Fund. After nearly four decades as a corporate foundation, BWF in 1993 received from the Trust a $400 million gift that enabled us to become a foundation fully independent of the Wellcome Trust and the Burroughs Wellcome Company. Though we are today an independent philanthropy, our history and joint program activities allow us to maintain productive ties with the Wellcome Trust.

With this increase in assets resulting from the Wellcome Trust endowment, BWF has been able to play a larger role in funding biomedical research, including extending our support into Canada. In carrying out this work, BWF is governed by a Board of Directors composed of distinguished scientists and business leaders, and our competitive award programs are guided by advisory committees composed of leading researchers and educators.

The importance of curiosity-driven research, as endorsed by Henry Wellcome, continues to be our guide. Thus, more than a century after two enterprising American pharmacists set in motion their pioneering partnership, the Burroughs Wellcome Fund remains committed to the belief that fostering research by the best and brightest scientists offers the fullest promise for improving human health.

President's Message

In August 2002, the House of Representatives approved a Science Committee bill to address the decline in the nation's technical workforce and to improve undergraduate science and mathematics education.

The Tech Talent Act (H.R. 3130) would establish or enhance programs at the National Science Foundation to expand the number of U.S. students majoring in science, mathematics, engineering, and technology. The bill's sponsor, Science Committee Chairman Sherwood Boehlert (R-NY), said: "The problem is that fewer and fewer American college students are majoring in mathematics, engineering, technology, or science, particularly in the physical sciences. This is a source of growing concern for many reasons. First, and most obviously, the nation needs to have a workforce that can compete in this increasingly technological world. But the problem goes beyond filling jobs that explicitly call for someone with a science degree. In today's world, just about every job has a component that is informed by science and technology, from the assembly line to the boardroom. And yet, we have fewer and fewer Americans who have the background to understand and analyze technical information."

While American students are staying away from science, mathematics, and technology in droves, large numbers of foreign science and engineering students and postdoctoral fellows are boosting the American scientific enterprise as they come to the United States for training and often stay to work throughout their careers. In 1998 more than 50 percent of science and engineering postdoctoral fellows working in U.S. academic institutions—about 20,100 individuals—were non-U.S. citizens or permanent residents. Following the terrorist attacks of September 11, 2001, some U.S. policymakers concerned about national security called for greater restrictions on foreign students. But the strong reliance of the U.S. academic research enterprise on foreign-born scientists raises questions about the heavy inflow of foreign talent and the policy implications of any change in their willingness to stay in the United States. Would the research enterprise be able to continue to contribute to the nation's economy and to the advance of knowledge given the lack of U.S. students selecting careers in mathematics, science, and engineering?

BWF's mission is to advance the biomedical sciences by supporting research and other scientific and educational activities. Our major strategy for carrying out this mission is to target support to young scientists and to investigators entering and working in areas of science that are undervalued or under funded. For this reason, BWF has deep concerns about the current state of mathematics, science, and technology education and the human capital needed to sustain the nation's research enterprise.

Our five core program areas—**science education, infectious diseases, translational research, basic biomedical sciences, and interfaces in science**—all emphasize the recruitment and support of top-notch scientists who can advance the biomedical sciences.

In the following sections, I will provide a brief overview of each program area. In each section, we've added profiles of a few of our many outstanding awardees whose research is making a difference in the lives of people around the world and advancing the field of biomedical science.

Science Education

The education and training of young scientists, as well as the policy issues that affect them, are primary concerns of BWF. While the National Institutes of Health has doubled its budget in recent years, thereby increasing federal support for biomedical research, the soft economy and the falling stock market have decreased BWF's ability to make investments. As a result, we have faced an even greater need to sharpen our focus and steer our grants into those areas where we can make the most impact.

The cornerstone of a strong research enterprise rests on educational programs that interest students in science and help them gain the knowledge and skills necessary to pursue a scientific career. The pipeline for careers in science is a long one: It begins with a pre K-12 education system that is rich in curriculum and that has well-trained and well-equipped teachers who are able to prepare students for careers in science. Knowing that BWF's resources would not permit impact on a national scale, we have targeted our interest in pre K-12 science and mathematics education to North Carolina. BWF's Student Science Enrichment Program (SSEP) awards enable middle- and high school students across North Carolina to learn firsthand about science and the excitement of research. Digging into a variety of activities, the students work alongside leading health scientists in such activities as exploring aquatic environments and assisting in museums.

The projects give students the opportunity to participate in hands-on, minds-on, inquiry-based avenues of exploration—an educational approach that BWF believes to be an effective way to increase students' grasp of science. Museums, schools, community organizations, and universities have formed a variety of partnerships to provide students with access to resources not readily available to most secondary school students. Since 1996, a total of 36 organizations have received SSEP awards amounting to $7.3 million, and the programs have reached more than 23,000 middle- and high school students. Each year, the SSEP program directors gather to discuss best practices such as student recruitment, program sustainability, and program evaluation as well as to build a network of such activities. Recognizing the importance of linking these programs to one another and of broadening their reach to include parents, teachers, and students not directly exposed to their benefits, BWF has expanded a special SSEP website (http://ssep.bwfund.org). Administered by the Shodor Education Foundation, which conducts one of our SSEP programs, this site provides information on experiential science programs for students, offers a variety of activities, and enables students, parents, and SSEP project directors to communicate with one another.

As part of BWF's expanding commitment to science education, we are partnering with various organizations by providing grants and staff support to further develop an infrastructure to improve science, mathematics, and technology education across North Carolina.

Over the years we have supported:

- **The N.C. Institute for Education Policymakers**, the first such initiative in the U.S., to build the capacity and the relationships of policymakers including legislators, State Board of Education members, and members of the media who cover education in areas related to school improvement. The Public School Forum of North Carolina founded the Institute.
- **The Education Future Center (EFC)** at the North Carolina School of Science and Mathematics to provide support for multimedia technologies to interconnect schools across the state. Through seven cyber campuses in low-wealth counties, the EFC is used to train teachers and share tools and curricula for institutional reform and improvement in science and mathematics education.

Everything starts here.

"The goal is to provide all students with the necessary knowledge and skills to have successful careers, be good citizens, and advance the economy of the state."

High school students investigate potato blight at North Carolina State University's Science House.

- **The Grassroots Science Museum Collaborative** that links over 16 member science museum programs and activities in North Carolina to enhance hands-on science learning across the state—the first such museum collaborative in the nation.
- **A K-12 Outreach from University Science Departments Conference** that annually convenes scientists, educators, community leaders, and program directors of science outreach programs to share experiences, identify areas of success, and create a collective vision for development and dissemination. The outreach conference is organized by North Carolina State University.

Last year, encouraged by our SSEP Advisory Committee to champion science and mathematics K-12 education in North Carolina and with the blessing of our Board of Directors, the Fund took the first steps toward establishing a new organization—the North Carolina Science, Mathematics, and Technology Education Center. We are delighted to be incubating this new 501(c)(3) non-profit entity whose mission is to systematically improve performance in science, mathematics, and technology pre K-12 education in North Carolina. The intent is to provide all students with the necessary knowledge and skills to have successful careers, be good citizens, and advance the economy of the state. The Board of the new Center held its inaugural meeting at the end of June and adopted the aforementioned mission. A search committee is now working to select a president for the Center while a program committee develops activities to enable the Center to carry out its mission. You will learn more about this SMT Education Center on p.23.

Both the terrorist attacks of September 11 and the subsequent anthrax attacks have heightened the nation's concern about security and bio-terrorism, leading to substantial new federal investments in the science underlying control of biological agents. BWF's Board of Directors was almost prescient this year when it reshaped our programs to promote innovation and to ramp up our investment in infectious diseases research. A first round of nine career development awards totaling $3.6 million was made this year to encourage investigators early in their careers (assistant professors) to study the host/pathogen interface using new tools from genomics, immunology, and other areas. These investigators will bring aggressive multidisciplinary approaches to understanding how infectious agents interact with the human body. In July, John J. McGowan, director of extramural affairs at the National Institute of Allergy and Infectious Diseases, made a presentation to the BWF Board of Directors on how federal bio-terrorism dollars will be directed; his presentation reassured us that our investments in this host/pathogen interface—between viral, bacterial, parasitic, and fungal organisms and the human host—do not duplicate federal efforts. We believe that continuing to invest in the career development of first class scientists exploring the host/pathogen interface is an appropriate way for a private foundation to complement federal efforts.

BWF continues to support two courses, conducted at the Marine Biological Laboratory in Woods Hole, Massachusetts that are focused on training researchers to work in parasitology and mycology. The courses are tailored to provide advanced independent investigators, graduate students, and postdoctoral fellows with practical laboratory skills, pedagogical lectures, research seminars, and informal interactions with top researchers in these fields.

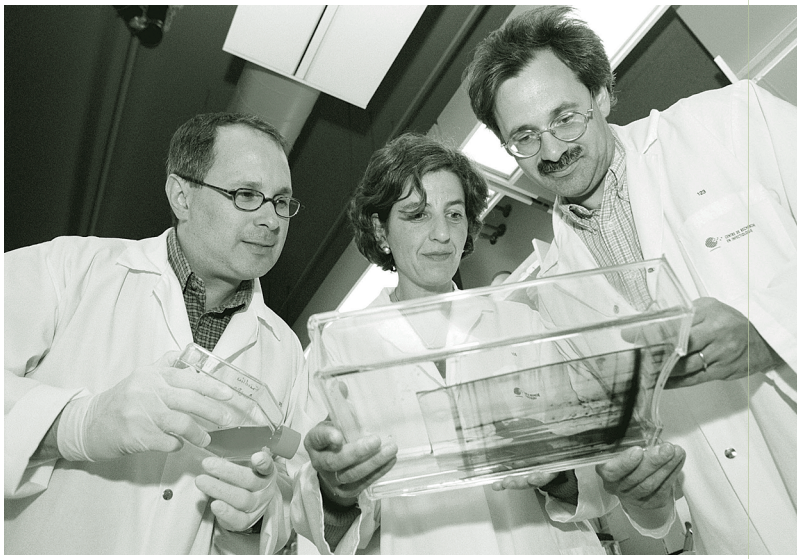
Our advisory committees continue to review the progress reports of scientists funded through our past programs, including the New Investigator and Scholar Awards in Molecular Parasitology, the New Investigator and Scholar Awards in Molecular Pathogenic Mycology, and the New Initiatives in Malaria Research programs. These scientists are still an important part of the BWF family of investigators. The Board also renewed our support of a fellowship administered through the American Society for Tropical Medicine and Hygiene for clinician-scientists interested in pursuing work in the tropical developing world.

The ongoing Wellcome Trust-Burroughs Wellcome Fund Infectious Diseases Initiative has made awards totaling $26 million to support trilateral international collaborations among researchers in the United States or Canada, the United Kingdom, and developing countries to study diseases afflicting the developing world. A significant component of the selection process is a demonstrated commitment by the investigators to train scientists on-site in the developing country, thereby increasing the research capacity of scientists in the countries most affected by tropical infectious diseases. At the end of five years, we hope to convene a group of investigators and other experts to assess the impact of the program and best practices.

Finally, the success of the international effort to sequence the genome of *Plasmodium falciparum*, the most dangerous form of the parasite that causes malaria, was announced in October 2002, at the same time as the release of the sequence of the anopheles mosquito that transmits malaria. The Plasmodium project has been a collaboration supported by BWF, the Wellcome Trust, the National Institute of Allergy and Infectious Diseases, the Department of Defense, and the World Health Organization. Another BWF investment supports the development of the project's database, PlasmoDB, which brings together all the information generated by the *Plasmodium falciparum* genome project and provides the research community with on-line tools for analyzing the data.

Dr. Martin Olivier: Probing *Leishmania's* Ability to Subvert the Human Immune System

During millions of years of evolution, parasites have come up with crafty methods to avoid the watchful eyes of their hosts.



From left, Drs. Martin Olivier, Barbara Papadopoulou, and Marc Ouellette each study a different aspect of the Leishmania *parasite to better understand how it invades the body, evades the human immune system, and becomes resistant to medicine.*

Leishmania, a microbe that afflicts millions of people around the world each year, has developed ways to lodge itself in the host immune system, as have other pathogens with similar strategies.

Dr. Martin Olivier, a parasitologist at Quebec's Laval University, studies how *Leishmania* subverts the cell's immune system—and plots ways to fight back. Touching on basic questions of parasitology and the human immune system, Dr. Olivier's research has been supported by a 1998 BWF New Investigator in Molecular Parasitology Award.

Leishmania's attack on human macrophage cells is an especially effective method of colonization. Microphages, which operate in the intra-cellular spaces of the body, usually work by eating foreign matter in the body and processing the parts for disposal or recycling. But when seized by a *Leishmania* microbe, macrophages lose their ability to break down the *Leishmania* invader cells. While disabling the macrophage, *Leishmania* also manages to prevent the human host's elaborate array of immune machinery from kicking into gear.

"When the macrophage eats the *Leishmania*, it's a bad problem," says Dr. Olivier. "The killing function of the macrophage is inhibited, and the usual capacity of the macrophage to trigger other immune cells to respond is dramatically shut down."

Dr. Olivier focuses on the debilitating job *Leishmania* does on the signaling network that keeps the human immune system working. In 1998, Dr. Olivier published results of a study of a protein found in macrophage cells called SHP-1. That protein, Dr. Olivier postulated, plays a key role in how the intruder manages to proliferate. Somehow, after being consumed by the macrophage, *Leishmania* activates SHP-1, which, in turn, deactivates a key signaling protein called JAK-2.

JAK-2 is a major player in the signaling cascade that makes the cell's immune system work. It increases levels of nitric oxide, another key player in the immune response. Nitric oxide activates molecules that summon lymphocytes, important immune cells that respond to antigens. In suppressing JAK-2, *Leishmania* begins to subvert the human immune system.

Dr. Olivier says BWF funding helped pay for expensive microchip arrays that enable scientists in his lab to monitor which genes are "transcribed" into RNA-infected cells. "The financial help gave me freedom, permitted me to become more known in the field, and to do research quickly," Dr. Olivier adds.

Having established that SHP-1 likely plays a vital role in *Leishmania's* attack on the immune system, Dr. Olivier's next challenge is to learn just how the parasite activates the host macrophage's SHP-1 to start wreaking havoc. "Following the initial contact, the parasite may interact with an unknown receptor," he explains. "We have some clues about the triggering mechanism but it's too preliminary to present a clear picture."

Outside the lab, "I consider myself a zoologist, with an insect collection, and I like to observe animals," Dr. Olivier says. When visiting his wife's family in Ecuador, Dr. Olivier loves to journey into the jungle with his son. "In the Amazon you see things that perhaps you are the first ever to see," he says.

In the lab Dr. Olivier similarly values the thrill of pure discovery. "My research is more about finding out how things work, but if my work leads to something that will treat humans or animals, that's good," he says.

Dr. Olivier, who received his Ph.D. in immuno-parasitology from McGill University in 1988, became interested in microbes long before he became a researcher. In a college class on protozoology at the University of Montreal, he first became fascinated by the ability of microbes to adapt and thrive within the harsh conditions of the body.

Twenty years later, the subject still captures his imagination. "It can be interesting to put yourself in the place of the parasite," he explains. "You say to yourself, 'If I was a parasite how would I survive in a host?'"

Recent work has further verified the role of SHP-1. Researchers in Dr. Olivier's lab, using lab mice infected with

Leishmania, have found that chemical inhibitors of SHP-1 can stop the parasites from disrupting the signaling pathway on which the immune system so heavily depends. Consequently, the animals' immune systems are fully able to defeat their infections.

"That kind of inhibitor may be used to fight infectious disease," says Dr. Olivier. SHP-1 and other related proteins are thought to play an important role in tuberculosis and amoebiasis, two diseases that also involve direct attacks on the immune system.

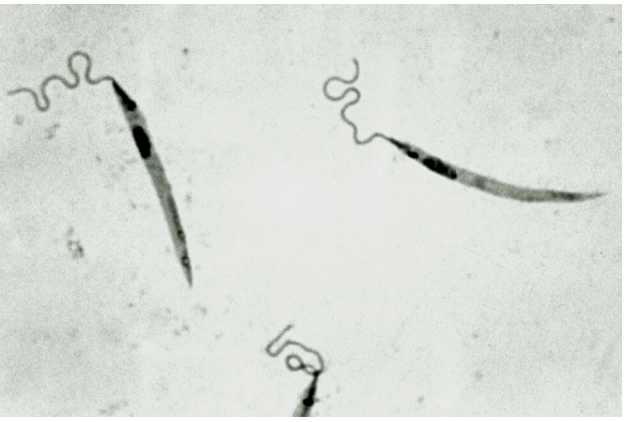
Dr. Marc Ouellette: Tackling *Leishmania's* Growing Drug Resistance

How do parasites become resistant to medicine? With millions of people world wide facing drug-resistant strains of malaria, tuberculosis, and pneumonia, it is a crucial question.

Scientists have known for a century that antimony (Sb) metal can kill the *Leishmania* parasite. Since the 1950s, doctors have used an antimony-based drug called pentostam to treat *Leishmania* infection; metal-based drugs, starting with arsenicals, were the first kind of medicines to effectively kill parasites in their human hosts. But scientists have not really understood how pentostam works. And now, with microbial resistance to the drug increasing in third-world areas where *Leishmania* affects millions of people each year, understanding how the microbe has evolved to be resistant to the drug has taken on a renewed urgency.

Dr. Marc Ouellette of Laval University in Quebec City is probing these important questions. In the past decade, his lab team has identified and isolated several resistant cell lines and examined which genes help the parasite avoid the drug's effects.

"It's a combination of genes that will lead to resistance," says Dr. Ouellette, who received a Burroughs Wellcome Fund Scholar Award in Molecular Parasitology in 2001.



Leishmania *promastigotes multiply in the sandfly's gut and change into amastigotes once they enter the host's body—human or animal.*

Although scientists are unsure how antimony works as a drug, they do have a general idea of how the bug survives the metal: *Leishmania* chemically reduces the antimony. Then, Dr. Ouellette's team has found, the antimony is bonded to a molecule called trypanothione produced by the parasite. Identifying the role of trypanothione was an important breakthrough, one that will hopefully help scientists better understand and even overcome resistance.

In a series of experiments over a number of years, Dr. Ouellette and his team have shown that the parasitic cell deals with the trypanothione-antimony conjugate in a number of ways. First, several studies have shown that the conjugate is pumped out of the microbe by efflux pumps, molecular machines on the wall of the parasite that push specific material out. This suggests that the binding of trypanothione signals the cell to remove the antimony. Studies also have hinted that the conjugate is transported to a vacuole, a kind of pouch found inside cells.

Dr. Ouellette hopes that these conclusions, drawn by using resistant batches of *Leishmania* in the test tube, will be applicable when his team works with parasites found in patients fighting resistant strains of *Leishmania*. "Now we have a testable model of resistance that we can test in field strains," says Dr. Ouellette.

Understanding how resistance to pentostam works is crucial for a number of third-world regions. In areas such as the poverty-stricken state of Bihar in India and the Pacific coast of Colombia, where resistance is spreading, there is an alternative medicine to antimony, but it can help only a privileged few.

"Where the disease is prevalent people cannot afford the alternative medicine," says Dr. Ouellette. In Bihar, for example, resistance has cropped up only in the last decade, but the World Health Organization says the problem is already threatening an estimated 40 percent of patients infected with *Leishmania* in the region.

With resistance to drugs such a problem worldwide, Dr. Ouellette's work is shedding light on other diseases that have evolved to become drug resistant. Some drugs used to treat malaria, cancer, and urinary tract infections work by targeting metabolites called folates in the invader cells. Dr. Ouellette and his team are studying the mechanisms by which *Leishmania* resist antifolates. In addition, he is applying the methods he's used to examine *Leishmania* to study antibiotic resistance in selected bacteria.

The sandfly transmits the Leishmania *parasite when it bites a human or animal.* Leishmania *is endemic in 88 countries.*

Through the BWF grant, a number of important laboratory technologies have been available to Dr. Ouellette's team. Among them, high-tech protein separation techniques have been crucial for his laboratory to analyze new, unknown proteins that *Leishmania* uses in its resistance response. In addition, DNA microarrays have enabled the scientists to analyze the expression of more than 50 genes thought to be important to resistance, including several genes recently found to be linked to trypanothione biosynthesis. "These are expensive techniques," says Dr. Ouellette. "This research would not be possible without BWF support.

"All the time you discover new things," he says when asked why he loves being a researcher. "Ninety-nine percent of the time I'm wrong and one percent of the time I'm right with the hypothesis. But even when you're wrong you learn something." Dr. Ouellette also enjoys training students. "They come into the lab at the beginning and may have trouble interpreting data. But when they leave the lab, and after a good post-doc experience, they'll be great scientists."

Outside the lab, Dr. Ouellette, who's married to BWF awardee Dr. Barbara Papadopoulou, likes to play sports—skiing, baseball, ice hockey, and tennis—with his 9- and 12-year-old sons. He also likes to jog, he says, and often gets good ideas for his research during such outings.

Dr. Barbara Papadopoulou: Exploring How *Leishmania* Becomes an Uninvited Guest in the Human Body

Parasites use a variety of strategies to gain access to our bodies. Dr. Barbara Papadopoulou, a 2001 Burroughs Wellcome Fund Investigator in Pathogenesis of Infectious Disease, is trying to learn how the genes of a particularly clever kind of microbe help it take up residence in our bodies.

Before infecting humans, the tiny *Leishmania* lives in sandflies where the microbe travels along the gut and salivary glands, using its flagella for propulsion. When the sandfly—found in tropical or sub-tropical regions—bites an animal or human, the parasite can travel into the body of its new host. There it is taken up by a macrophage, an immune system cell that helps clean out and recycle used components between cells.

Having made it to the macrophage, the *Leishmania* microbe undergoes the physical change in which Dr. Papadopoulou is most intrigued. In a period of just a few hours, the parasite manages to shed its flagella and take up a round form called an amastigote. Then it multiplies and moves on to cause a number of possible diseases ranging from nasty skin lesions to life-threatening infections that ravage organs throughout the body. The World Health Organization estimates that some 15 million people worldwide are infected, with the highest-risk areas being Africa and South America.

"The parasite is extremely ingenious in how it manages to survive in different conditions," says Dr. Papadopoulou, an assistant professor at the Center for Infectious Diseases at Laval University in Quebec, who has been studying *Leishmania* since 1991.

Using methods of protein separation, Dr. Papadopoulou has succeeded in identifying 62 proteins found in the amastigote stage but not in the earlier life stages of the bug. These, she postulates, are key proteins that are coded by genes seemingly "turned on" after the parasite enters the macrophage.

But how does this work? Careful analysis of the genetic sequences of these genes this year found that the different pieces of mRNA transcribed from several of these genes all shared an odd code sequence encoded after the protein sequence. This 450-base-long code sequence in the RNA seems to help these genes get translated into proteins more readily. Citing recent studies, Dr. Papadopoulou believes that this sequence somehow responds to changes in the pH of the environment around the parasite—signaling the cell to react to its new neighborhood.

That sequence, and the mechanism by which it works, offer a compelling subject for further biomedical study. "By targeting this one mechanism and using an inhibitor, we could block hundreds of genes," she says. "We have a fantastic opportunity." This key sequence is also considered a potentially useful tool for physicians because it isn't found in the human genome—making the molecules that interact with it strong possibilities as targets for developing effective new drugs. Moreover, affiliated proteins could be promising candidates for a possible future vaccine.

With a completed *Leishmania* genome due out next year, Dr. Papadopoulou hopes to have new opportunities for learning more about the microbe. In the initial genetic sequence already available, for example, surface proteins seem to be among the candidate genes regulated by the code sequence. These surface proteins could play an important role in *Leishmania's* understanding of its changing environment. "They might be sensors that actually say to the cell what is going on outside of the cell," says Dr. Papadopoulou. Other possible genes that are more quickly made into proteins in the body's macrophages include proteins that repair other proteins, metabolic proteins that could supply needed energy to help the cell along, and transporter proteins that could bring in nutrients from the outside to help the parasite grow.

While research into the pathogenesis of *Leishmania* sheds light on other diseases, it's an important area of study in its own right. In its most severe form, *Leishmania* can cause death; third-world patients battling HIV, the virus that causes AIDS, are feared to be particularly vulnerable to the microbe's opportunistic infections.

But the research in Dr. Papadopoulou's lab is also important because other parasites may share mechanisms similar to *Leishmania's* for adapting to the host environment. *Trypanosoma cruzi*, *Tuberculosis*, *Salmonella*, and *Listeria* are several of the many microbes that live within the macrophages in human bodies.

Dr. Papadopoulou received her bachelor's degree at the University of Athens and her doctorate in molecular microbiology at the Pasteur Institute in Paris. In addition to BWF funding, her laboratory has been supported by the Medical Research Council of Canada and the World Health Organization.

Now a Canadian citizen, Dr. Papadopoulou is married to another BWF awardee, Dr. Marc Ouellette, a *Leishmania* specialist with whom she worked before she began her own lab at Laval. Mother of two boys, Dr. Papadopoulou says that being married to a scientific colleague has made child rearing challenging, because the couple both work long hours. On the other hand, she says, it's easier to juggle the twin demands of job and family when parents work together. "We have been able to split time with the kids," she says. "It's hard and easy at the same time." When she's relaxing from it all, she likes to read modern poetry in Greek, her native language.

Apart from important uses in understanding parasite behavior within mammalian hosts, Dr. Papadopoulou's research has an important basic-research angle: Like *Leishmania*, our cells are constantly sensing and reacting to their changing environments. If Dr. Papadopoulou can uncover how simple cells transmit information from outside their walls and adjust which proteins are made in response, this information could be useful for better understanding how human cells adapt to different stress conditions. Also, non-coding RNA sequences that control gene expression under stress—such as the sequences that Dr. Papadopoulou is studying as part of another project—have yet to be studied fully, making her work a boon to a poorly understood phenomena in many kinds of cells.

Translational Research

The Fund's long-standing commitment to experimental therapeutics and clinical pharmacology has put us at the forefront in urging both public and private research funders to help shore up the ranks of clinical researchers and encourage them to serve as mentors to the next generation of physician-scientists. In 1998, BWF established the Clinical Scientist Awards in Translational Research program, providing professors at the late-assistant or early-associate levels with dollars that can be used flexibly to buy their time for research and for mentoring the next generation of clinical scientists.

We recognize that career support is critical for physician-scientists, given their many clinical obligations that make it difficult to find time for basic or clinical research. This past year we made seven awards totaling $5.25 million. To date, BWF's total commitment to this program has been $34.5 million. As we reported last year, BWF, together with the Juvenile Diabetes Research Foundation International, formed the Clinical Research Alliance, an informal association of 11 private foundations that have a common interest in strengthening career development opportunities for physicians interested in pursuing patient-oriented research.

Among the BWF physician-scientists who are conducting groundbreaking translational research are Dr. Robert Darnell and Dr. Brian Druker. Dr. Darnell, who is head of Rockefeller University's Laboratory of Molecular Neuro-Oncology, is being recognized as one of the leaders in molecular medicine. He and his research team have been studying a group of patients with rare brain diseases caused by the body's immune response to breast, ovarian, and lung tumors. Their work could lead to important discoveries about such autoimmune brain diseases as multiple sclerosis. Dr. Druker, a professor of medicine at the Oregon Health & Science University, helped develop a new leukemia drug, marketed under the name Gleevec, which has shown great promise in treating chronic myelogenous leukemia. Gleevec is one of the first of a new generation of cancer drugs that targets only the cancerous cells, leaving normal cells alone. BWF believes that supporting such work enables new treatments to make it more quickly into the clinical setting.

BWF staff members are working closely with staff members at the Doris Duke Charitable Foundation, The Howard Hughes Medical Institute, the Juvenile Diabetes Research Foundation, the Robert Wood Johnson Foundation, and the Damon Runyon Cancer Research Foundation on a number of issues aimed at improving the environment for clinical investigators. These issues include, among others:

- Fostering appropriate incentives at academic health centers to more appropriately reward clinician-scientists who work in teams.
- Working with the NIH to better understand the career development pathways of clinician-scientists and how to better support them; one effort, for example, involves following the progress of recipients of K-awards who "dropped out" of the system in order to understand the factors that influenced their decisions.
- Convening focus groups of clinical investigators-in-training to determine the factors influencing their career decisions and the potential utility of a Web-based career and funding resource.
- Publicizing the response of the foundation community to the issues facing clinical investigators (N.Engl.J.Med.Vol.346, No.25, June 20,2002).
- Exploring the merits of creating a loose federation of professional societies serving clinical investigators and restructuring "Grantsnet" to include clinical research categories.
- Planning for the Clinical Research 2003 meeting, which will bring together the directors of the NIH-supported General Clinical Research Centers and K-30 training programs, as well as the directors of the American Federation for Medical Research and the Association for Patient-Oriented Research. This meeting has the potential to reach more than 600 clinical research trainees. In 2004, two prestigious research societies, the American Society for Clinical Investigation and the Association of American Physicians, will join this effort.

In addition, we continue to support the Institute of Medicine's Clinical Research Roundtable (CRR), which I chair. The Roundtable provides a forum and sponsors workshops to discuss how to resolve both acute and long-term issues affecting clinical research. Most recently, the CRR held a workshop on the role of professional societies in advancing women's careers in science and clinical research. It also has been looking more broadly at the obstacles and challenges present in the clinical research enterprise.

Dr. Robert Darnell: Learning How the Human Body Fights Cancer Cells

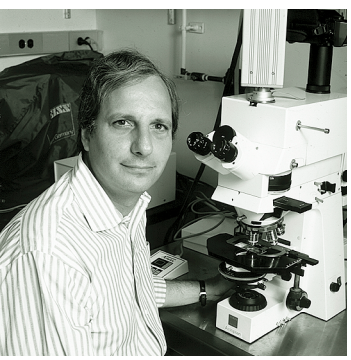
Dr. Robert Darnell believes the best cancer-fighter may be right under our noses. The body's own immune system may do a better job of finding, isolating, and removing tumor cells than any medical technique currently available. It's a vigorous and efficient defense mechanism, one whose secrets cancer researchers would love to unlock.

But it's difficult to study just how the body polices itself against a regular onslaught of potentially dangerous cancer cells that may constantly pop up. Healthy individuals who withstand their own cells' attempts to develop into cancer don't end up at the doctor's office, and animal studies have been difficult to translate for use with human patients.

Dr. Darnell, a 2000 recipient of a BWF Clinical Scientist Award for Translational Research, comes at the problem by focusing on a set of diseases called paraneoplastic neurologic disorders (PNDs). These rare disorders present as neurological problems affecting different areas of the nervous system but they really stem from cancers within the body. What makes the diseases even stranger—and important to study—is that the cancers in PND patients seem to trigger the immune system to destroy the cancers themselves, while the symptoms affecting the brain or spinal cord persist. The odd tumors of PND patients can teach scientists how the immune system, under normal circumstances, wages war with potential cancer cells.

"In this one rare incidence, these diseases have the potential to teach us how the body can recognize and eradicate cancer cells," says Dr. Darnell, who currently is a physician at Rockefeller University Hospital in New York. "Our laboratory is interested in using PNDs as a Rosetta stone to understand how the body fights cancer."

"We're trying to learn what goes right in paraneoplastic disease patients and apply this to the general population."



Dr. Robert Darnell studies rare neurological problems, paraneoplastic neurologic disorders (PNDs), which are sometimes caused by the body's immune response to breast, lung, and ovarian cancer. His work may shed light on other disorders that involve the brain, such as multiples sclerosis.

For more than 100 years, neurologists have known that PNDs have had a link to breast, lung, or ovarian cancers. But scientists, including Dr. Darnell, are only now finding out just how the disorders work. In the mid-1990s, working with tumors from PND patients, Dr. Darnell used antibodies to locate and identify the genes associated with PND. These genes, it turned out, were expressed within the tumors of PND patients and corresponded with structural and functional proteins found in neurons in the brain. More recent studies by Dr. Darnell's lab have hinted that tumor cells in PND patients manage to undergo cell death on their own, a process that triggers the immune system to remove the dangerous cells. How this works is an area of active study supported by BWF funding. Dr. Darnell suspects the system mimics the ways in which key immune system cells, called T-cells, are called in to fight viral infections.

In addition, BWF funding will support an upcoming "phase 1" clinical study of cancer patients. In the study, which is designed only to test safety and basic principles, Dr. Darnell's research team will force tumor cells to undergo cell death. Those cells will then be fed to patients' immune stimulatory cells as a vaccine. The process is analogous to what the researchers have found stimulates PND tumor immune responses in the patient's body, and the scientists hope the vaccines will encourage the immune system to clean out the cancerous cells.

"We're trying to learn what goes right in paraneoplastic disease patients and apply this to the general population," says Dr. Darnell.

Work on PNDs could shine light on other disorders that, like PND, strike when the body's immune system makes a good immune response that subsequently triggers disease. Dr. Darnell believes study of PNDs could especially pay off in autoimmune diseases, such as multiple sclerosis, that involve the brain.

Despite the fact that his work touches on so many disparate fields, Dr. Darnell considers his "Rosetta stone" an effective way to channel research toward understanding how cancer affects the body. Other work done in Dr. Darnell's 26-person laboratory focuses on understanding the normal function of the neuron-specific proteins that cancer cells turn on to initiate the PND. One group of these proteins is involved in regulating RNA (the molecules that help translate DNA to generate proteins). One important recent finding suggested ways that a key RNA-binding protein might cause cognitive and behavioral problems in what is called the fragile X mental retardation

syndrome. Dr. Darnell's group has found that the PNDs are identifying a host of new brain genes that serve such important functions as binding RNA and transmitting signals through the brain.

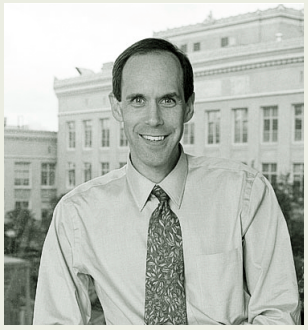
Dr. Darnell became immersed in the unique world of PNDs in the early 1990s, working with Dr. Jerome Posner at Memorial Sloan-Kettering Cancer Center. Dr. Darnell, who currently is an attending neurologist at Memorial, received the Derek Denny-Brown Young Neurological Scholar Award from the American Neurological Association. He was recently named a Howard Hughes Medical Investigator as part of a nationwide search for scientists who conduct patient-oriented research. Along with backing from BWF and HHMI, Dr. Darnell's research team also receives support from the National Institutes of Health.

"Free time, what's that?" jokes Dr. Darnell when asked about his extracurricular activities. But in addition to his considerable professional commitments, the father of four makes time out of the lab to coach his children's sports teams and help them with their homework. Two years ago he started a local chamber orchestra that had a brief but successful run. "I love to breathe in music and art," he says, naming literature and astronomy as other interests. "Seeing the intensity others put into life is a source of inspiration I draw from all of these areas."

Dr. Brian Druker's Magnificent Obsession: Working for a Cure

Curing cancer is Dr. Brian Druker's only business, and he has reached a significant milestone: He helped get a revolutionary type of cancer drug onto the market and into the hands of patients suffering from chronic mylogenous leukemia (CML). Unlike traditional chemotherapy, the new drug, marketed as Gleevec, targets the genetic abnormality that causes the cancer and leaves healthy cells alone, thereby causing far fewer side effects.

The drug's approval by the U.S. Food and Drug Administration (FDA) in June 2001 prompted intense media coverage, and some observers hailed Gleevec as a possible cure for CML. Many patients have achieved complete remission of the disease while on the drug. Consequently, Dr. Druker found himself in the media's high beams.



Dr. Brian Druker was instrumental in getting the new leukemia drug, Gleevec, onto the market and into the hands of patients suffering from chronic mylogenous leukemia (CML). The drug has proved effective in fighting the genetic abnormality that causes CML.

Dr. Druker, a 2000 BWF Clinical Scientist Awardee in Translational Research, has received numerous awards and accolades for his work but is modest about all the hoopla. "I always tried to focus on what this meant for cancer research," he says, "not only hope for CML patients, but hope for everyone." Dr. Druker believes, and is devoting his career to the belief, that understanding the molecular basis for a disease can lead to specific and effective treatment.

"This discovery validated years and years of research and the efforts of hundreds, if not thousands, of researchers," he adds. "If talking about this achievement can translate into more funding and more research and discoveries, then the media coverage was being put to good use."

Dr. Druker became interested in leukemia during medical school at the University of California–San Diego. "During my first year, I took an elective class where we learned about the history of chemotherapy," he recalls. "In the 1940s and '50s, it was common for new treatments to be tested in children. Acute lymphoblastic leukemia (ALL) is the commonest form of childhood bone marrow cancer, and children suffering from ALL would die within weeks. Then treatment began to include methotrexate and prednisone and these drugs doubled the survival rate. In the course of 20 years, this type of leukemia became curable."

Fascinated by the scientific achievement of moving a disease from being fatal to curable, Dr. Druker says he felt that medicine was nevertheless using a harsh therapy to achieve results. "There had to be a better way," he says. "And that's what sparked my interest in cancer research."

After medical school, a residency in internal medicine at Washington University's Barnes Hospital, and a clinical oncology fellowship at Dana-Farber Cancer Institute, Dr. Druker decided he needed to get basic lab training. "Cancer treatment then was still chemotherapy and surgery-based and non-targeted," he says. "Though chemotherapy had come a long way, we still didn't have a precise understanding of how and why it worked, and it still had lots of toxicity. We needed to understand cancer at the molecular level in order to make inroads."

Dr. Druker recalls that it was Dr. David Kipnis, currently outgoing chair of the BWF Board of Directors and then chair of medicine at Barnes, who suggested that he pursue his career in the emerging field of oncogenes. "He was absolutely right," says Dr. Druker, who then began working in the lab of Dr. Thomas Roberts—one of the world's leading experts on tyrosine kinases—at Dana-Farber. Tyrosine kinases are proteins that control cell growth and can trigger the wild proliferation of white blood cells seen in CML. While there, Dr. Druker also collaborated with leukemia expert Dr. James Griffin on signaling in white blood cells.

"I still want to do better than 80 percent of CML patients alive and well in 10 years. I want to see 80 percent cured."

In 1993, Dr. Druker moved to the Oregon Health & Science University and set up his own lab. By that time, he was already working on CML and things were about to snowball. Scientists from the drug company Novartis (then Ciba-Geigy) approached Dr. Roberts at Dana-Farber about setting up a drug discovery program to inhibit tyrosine kinases, because such a drug would be useful in treating cancer and other diseases. "Since I had been the only oncologist in Dr. Robert's lab, it was natural for the Novartis scientists to get my opinion about what the potential therapeutic targets would be in the field of tyrosine kinases," Dr. Druker recalls. "I thought CML would be one of the first diseases that would be treated [with a kinase inhibitor]."

Convincing the drug company to develop an inhibitor specifically targeting CML was another matter, but Dr. Druker says he was ultimately able to persuade the drug maker that getting a CML drug into the market would make the compound available as a possible treatment for other cancers. It was only a matter of time before Gleevec was developed, entered into clinical trials and, after showing such promise in treating CML, fast-tracked for FDA approval.

One of the key issues Dr. Druker is still grappling with is whether he and others can cure CML. "I think Gleevec is one of the major building blocks to get there," he says.

Dr. Druker's focus now is on improving upon Gleevec as a single agent. "I still want to do better than 80 percent of CML patients alive and well in 10 years," he emphasizes. "I want to see 80 percent cured."

He is also scrutinizing how CML becomes resistant to Gleevec and says he and others are learning that the cancer mutates to evade Gleevec's attack. "We're working with drug companies to develop new inhibitors," he says. "We're also trying to predict how people will do in treatment. If we think someone has the potential to become resistant, we want to know that as soon as possible so we can intervene as soon as possible."

Dr. Druker says he also is looking at other targets in other cancers, particularly a similar target in acute myeloid leukemia that has also been identified by other research groups. "Four different drug companies are working on new inhibitors for this target," Dr. Druker says. "Because of Gleevec's success, people believe in the new paradigm and are willing to commit to it now. What's exciting is that as we identify more and more targets for therapy, it's just a matter of coming up with the right compound to modulate that target."

Aside from his dedication to cancer research, Dr. Druker's other passion is running. He's qualified for the spring 2003 Boston Marathon but can't run because he and his wife are expecting the birth of a baby at roughly the same time. Characteristically, Dr. Druker is not deterred. He's planning on running another qualifying marathon and tackling Boston in 2004.

When asked about juggling work and family, Dr. Druker says, "Now that I've achieved a modicum of success, I can spend more time focusing on my family; I can accomplish my research with people working for me and with me; and I can leverage my success into success for other people."

Our signature program—Career Awards in the Biomedical Sciences—embodies our philosophy of providing support to young scientists to enable them to take innovative risks and to support them during a critical transition period.

The program was established in honor of two pioneering Nobel laureates, Drs. George Hitchings and Gertrude Elion.

CABS provides five years of salary and research support for biomedical scientists during their advanced postdoctoral training and initial faculty years. Each year, we make 12 to 20 awards of $500,000 each to degree-granting institutions in the United States and Canada on behalf of individual scientists. Since the program's inception in 1995, we have made 166 awards totaling $80 million. This past year, we made 17 awards totaling $5.5 million.

The Fund has collected information to evaluate the impact of this popular competitive award program. We are proud of the fact that virtually all awardees who have become eligible for faculty appointments have received tenure-track or equivalent positions. Awardees report receiving faculty start-up packages from the hiring university of about $500,000. As young faculty, they run labs with significant external grant support and an average of six laboratory staff. We continue to evaluate this program carefully and an article titled, "Bridging Postdoctoral Training and a Faculty Position: Initial Outcomes of the Burroughs Wellcome Fund Career Awards in the Biomedical Sciences," is currently in press in *Academic Medicine* 2003 78:2.

A guiding principle of BWF's grant making is that fostering the careers of our awardees extends well beyond the grant support provided. From our interactions with awardees over the years, it became clear that gaining the skills necessary to manage a laboratory is high on their list of concerns. Because of BWF's significant financial and staff investment in each awardee, we determined that a comprehensive laboratory management course would contribute to their scientific productivity. The Howard Hughes Medical Institute (HHMI) has a similar set of career development goals for its awardees, and we have found the Institute to be a wonderful partner in other activities. Consequently, BWF and HHMI staff members worked collaboratively to develop the laboratory management course, the first ever of its type, for about 130 awardees in July. The course was held over three and a half days to rave reviews, covering topics such as project management, budget, personnel management, career development, and ethics. We are now evaluating how to provide this kind of course to a larger community of scientists, and we certainly intend to continue making it available to our own awardees.

The most recent awardees from this program and our Career Awards at the Scientific Interface also met in August to cover topics related to negotiating a faculty position, to discuss their science, and to develop a larger network of potential collaborators.

Dr. Kristin Scott: Discovering How the Brain Perceives the Sensory World

Dr. Kristin Scott is studying the fly brain to understand how flies are attracted to sweet substances, avoid bitter substances, and really seem to like alcohol—in short, how the fly brain knows what the fly is tasting. "I'm looking at sensory perception in the fly because it's a very simple system," Dr. Scott explains. "The idea is that if you understand how a simple system works, your understanding will have more general application."

Dr. Scott, a 2002 BWF Career Awardee in the Biomedical Sciences, says she chose taste perception to study first, "because defined chemical substances—like sucrose or quinine—produce different behaviors (to eat or not-to-eat) in the fly. We can then study how different tastes are processed in the brain, from a taste neuron detecting a chemical to the behavioral response."

Dr. Kristin Scott's research on taste perception in the common housefly is designed to understand how sensory perception works in the brain.

In her research, Dr. Scott says she has discovered that the fly has about 60 candidate taste receptors, the molecules that recognize ligands. "There were a much greater number of receptors than we expected," she adds. "Then we learned that each taste neuron expresses only one taste receptor gene. The fly has a large number of different taste neurons and each one is likely to recognize only a small subset of taste cues."

Her discovery means that the fly does discriminate between tastes. It also means, she says, that the different taste neurons are molecularly distinct, which enables her and her colleagues to label the neurons with different colors and see how tastes are mapped higher in the brain.

"Eventually, I can imagine building on my taste research to explore how tastes are based on learning, experience, and even starvation experience."

"This research is designed to answer a basic question: how does sensory perception work?" Dr. Scott explains. This will tell us something about how brains in general work." It might also have some future application to insect pest control, she adds.

As a graduate student at the University of California-San Diego, Dr. Scott says she was interested in cellular signaling. When she took up her postdoctoral fellowship at Columbia University, she decided to investigate intercellular communication —how neurons interact with each other. "The taste system seemed like a simple system to begin to look at that," she says.

It was her brother's chemistry set that first sparked Dr. Scott's interest in science, she recalls. Then, when she was 12, she read James Watson's *Double Helix*. "I really liked the idea that there was an interactive community of scientists who would test models," she relates. "It sounded like a great life." But it wasn't until she'd graduated from the University of Chicago with a biology degree and began working as a lab technician in San Diego that she thought about having her own lab some day.

Now, after years of study, that dream is a reality. In October 2002, Dr. Scott set up her lab and took up her post as an assistant professor in the department of molecular and cell biology at the Helen Wills Neuroscience Institute at the University of California–Berkeley.

Asked why she chose to focus on neuroscience, Dr. Scott replies, "I'm interested in how the brain works. Neuroscience allows you to take a scientific approach to basic philosophical questions such as how the brain sees the outside world," she says. "Such questions have been debated from the time of the ancient Greeks onward." She adds that her father, a philosophy professor, may have had something to do with her interest in philosophical issues.

In her first year at Berkeley, Dr. Scott will have no teaching duties and will be able to focus on setting up her lab and continuing her research. "The BWF award has been essential for my beginning phase as a faculty member," she says. "It frees me to think about scientific problems instead of scientific funding, and it allows me to take on risky projects and turn them into tractable projects. I can focus on the research rather than peripheral things."

Though she says most of her life revolves around the lab, she does love to read and travel. During her year as a lab technician, Dr. Scott worked for nine months and then took three months off to travel alone in Indonesia and Thailand, which, she says, were spectacular and exotic. Her current choice of reading material includes books on the American Revolution and the Civil War. Her biggest luxury, she says, was reading Tolstoy's *War and Peace*.

Looking to the future, Dr. Scott says she hopes to be able to answer more and more complex questions about the fly brain. "Eventually," she says, "I can imagine building on my taste research to explore how tastes are based on learning, experience, and even starvation experience. I want to see how the olfactory sense modifies taste behavior and also look at other systems and complex neural integration."

Dr. Todd Golub Pioneers Work in Fingerprinting Cancer

Imagine taking the guesswork out of treating cancer. Imagine a time when an oncologist can run a DNA profile on a patient's tumor and then consult a database to find exactly the right treatment for that particular patient.

Dr. Todd Golub is leading a team of researchers whose aim is to make reality of such a scenario—to personalize cancer treatment by using genetic data to map each type of cancer, from cancers of the blood and marrow to solid tumors. By "fingerprinting" cancers, these researchers hope to identify new treatments for cancer patients.

A 1995 Career Awardee in the Biomedical Sciences, Dr. Golub was one of the first group of career awardees. With his BWF award, Dr. Golub began his pioneering work on the genetics of a particular type of childhood leukemia. Under the microscope, acute lymphocytic leukemia (ACL) looks the same in every patient. But by using DNA chips (tiny chips of silicon embedded with samples of genetic material) to analyze the genetics of the leukemia, Dr. Golub discovered two distinct subsets of ACL and could predict which patients with which subset would respond to treatment.

"This is an extraordinary period in the history of biomedical research," Dr. Golub says. "We have the genome sequence for the first time. Fifty years from now it will be old hat, but 10 years ago, you couldn't have imagined it.

"What I primarily think of myself as doing is trying to bring together different scientific disciplines to focus on problems," he adds. "Bringing together medical, biological, and computer backgrounds is what we need to do."

From leukemia, Dr. Golub moved on to test DNA profiling in a solid tumor, working with young patients suffering from brain tumors identified as medulloblastomas. Once again, Dr. Golub and his team were able to predict treatment outcomes.

Dr. Golub says that using DNA chips for analyzing the genetic basis of cancer has turned out to be a powerful approach.

"It's an approach that allows us to classify cancers based not on their appearance under the microscope but on their genetic signals," he explains. "We've done this in preliminary studies in prostate cancer and lung cancer" [as well as in leukemia and brain tumors].

Getting into his particular area of cancer research, Dr. Golub says, was a gradual process. "I'd been drawn to the midpoint between medicine and biology for a long time and decided early on that I wanted to be at the interface between basic biology and clinical applications," he explains. "You really can't ask for anything more interesting; you're basically trying to solve crossword puzzles for living and for something that's going to make a difference for patients."

About the intensity of his work, Dr. Golub says, "I have to learn to be more efficient with my time at work, and I'm trying to be more disciplined about not working all the time, especially since I have a wife and a two-year-old daughter. To unwind, I need nothing more than to see how spectacular the development of an infant into a toddler can be. It's genetics and biology right in front of you."

Earlier in 2002, Dr. Golub received a Howard Hughes Medical Institute Investigator award to continue his groundbreaking research in the genetics of cancer. "The Howard Hughes funding will allow us to take our preliminary work to the next level," he says. According to Dr. Golub, that means bringing the genetic approaches he and his team have pioneered from the research lab to the clinic. Secondly, Dr. Golub says, "We need to think not only about making observations about the genetic patterns in cancer but also about manipulating those patterns and identifying new therapeutic strategies for specific types of cancer."

Dr. Golub is director of the Cancer Genomics program at the Whitehead Institute Center for Genome Research, as well as the Charles A. Dana Investigator in Human Cancer Genetics at the Dana-Farber Cancer Institute and an associate professor of pediatrics at Harvard Medical School.

He conducts his research on both the Whitehead and Dana Farber campuses. The dual nature of his research affiliation, he says, "reflects the emerging multi-disciplinary nature of genomics research, which requires activity both on the traditional biomedical side and the technology computation side and creates a powerful synergy between the two."

Using DNA chips, Dr. Todd Golub analyzes the genetic characteristics of certain cancers, which one day may lead to more targeted, and successful, treatment of many types of cancer.

Interfaces in Science

Bringing the physical and biological sciences closer together has been the focus of BWF's Interfaces in Science Program. Interfaces began as a program to support "experimental" institutional training programs that created prototypes for a new kind of graduate and post-doctoral training, one that crosses departmental boundaries and provides a much-needed bridge among scientific disciplines—in effect, changing the culture of science.

In July, program directors of six BWF-supported programs met to draft a forum article—aimed at the research and funding community—that describes the lessons learned for improving interdisciplinary training. Although specific outcomes—measured by the success of program alumni in getting jobs, obtaining research funding, and gaining tenure, as well as the impact of their work—will take years to materialize, the program directors have gained much insight as they've established and developed their programs. The directors noted that achieving broad, cross-departmental involvement will be necessary if the scientific culture is to be changed, and that having independent, non-departmental funding for trainees is the best way to encourage these interactions. Furthermore, dual mentorship of trainees is key, as is an individualized training package for all trainees, taking into account their scientific backgrounds and interests. Trainees with non-biological backgrounds must "get their hands wet" in the biology, so that their understanding of biological systems goes deep enough to participate in forming new scientific questions. Lastly, the program directors pointed out that different visions can work, and that funding agencies should expect agile adaptation as programs evolve within institutions and in response to the rapid pace of change in science.

BWF evaluates the program with a Web-based system that enables trainees to submit their annual progress reports and thoughts on their training experiences directly to the Fund. This information is summarized and reported back to the program directors to help them assess their individual program's progress.

Based on the success of this training program and realizing that many of these young scientists are now beginning to move into faculty positions, BWF created a new program similar to our Career Awards in the Biomedical Sciences—Career Awards at the Scientific Interface (CASI). This program makes awards to physical and mathematical scientists pursuing biologically relevant questions. The CASI award provides research support that bridges the late postdoctoral years and early faculty years in hope of accelerating the development of new directions in science by providing seed capital to these young scientists working at the boundaries of fields. This past year, we made eight awards totaling approximately $4.3 million.

We also convened trainees from our Interfaces training programs. In January, the Program in Mathematics and Molecular Biology hosted a meeting, "Modeling Across The Scales: Atoms to Organisms" in Santa Fe, New Mexico. Over 250 people attended with more than 60 percent of them being graduate students and postdoctoral fellows supported by the BWF Interfaces Program, or the National Science Foundation, or through the Alfred P. Sloan/Department of Education (DOE) Fellowships in Computational Molecular Biology, and DOE Computational Science Graduate Fellowships. Trainees from all 10 of the BWF- supported Interfaces institutional programs attended and presented posters or talks at the meeting.

In addition to its scientific sessions, the meeting included career development sessions organized by the BWF staff. On the schedule were a panel discussion on "Using your postdoctoral fellowship to launch your career," a breakfast for women scientists, roundtable discussions on six career-related topics chosen by meeting participants, and a lecture on academic-industry collaborations. The meeting provided valuable opportunities for interaction among trainees and the invited speakers, many of whom were members of the National Academy of Sciences. As noted above, the first eight CASI awardees met with the newest group of CABS awardees at BWF in August for additional mentoring and networking.

Dr. Michael Elowitz: Harnessing Cells to Discover How Genes Work Together

Genetic researcher Dr. Michael Elowitz has designed his own biological clock, not the kind that has to do with reproduction, but a genetic clock he calls the "repressilator." The clock, which is based on the bacterium *Escherichia coli*, works according to the oscillations of a series of three genes that are programmed to turn each other on and off. Each of these genes makes repressors that control the expression of the other two. The oscillation is analogous to genetic time-keeping systems found in organisms from *Cyanobacteria* to humans. Dr. Elowitz and his graduate advisor Dr. Stanislas Leibler published the results of their work on the repressilator in 2000. For the two researchers, it was an opportunity to design a genetic loop from scratch.

A 2002 BWF Career Awardee at the Scientific Interface, Dr. Elowitz is embarking on an exciting new approach to biological research that focuses not only on gene networks found in nature, but also on working from the ground up to build models of these genetic systems.

"It's not a very good clock," Dr. Elowitz admits, chuckling. But the primitive system, a first of its kind, has a lot to teach scientists. In cells, genes are decoded to make proteins in a process called expression. Expression is controlled by repressors, molecules that slow the decoding process by binding to DNA, thus halting the machinery that decodes our genes. Gene networks function because the genes themselves code the repressors—setting up interwoven and constantly reacting systems of expression.

But the erratic repressilator lacks those systems' accuracy. That raised a fundamental question for Dr. Elowitz: to what extent is a cell's erratic expression of certain genes due to inherent noise in the cell's machinery?

Scientists studying a host of diseases, from cancer to anthrax, are constantly identifying the outside factors that lead to inconsistent gene expression. After designing his own genetic clock, however, Dr. Elowitz wanted to see how well the cell's expression machinery operates when left to its own devices. "In a sense we were getting down to the 'operational' level—when the inherent randomness of molecular events affects cellular operations," says Dr. Elowitz. "What we were trying to figure out, on a basic level, was how well cells are able to control themselves."

Dr. Michael Elowitz built a genetic clock based on a series of three genes that turn each other on and off. His investigation of how genes work together has broad implications for the new field of biocomputing.

Again, Dr. Elowitz designed his own genetic system, collaborating with three researchers at Rockefeller University—Dr. Peter Swain, Dr. Eric Siggia, and Dr. Arnold Levine—to tackle the problem. This time, the researchers put two virtually identical copies of a gene that makes colored protein onto a single DNA chromosome in an *E. coli* cell. By monitoring how the different genes, under identical conditions, would express their colored proteins at different rates, Dr. Elowitz was able to quantify just how inaccurate a cell can be at gene expression.

Dr. Elowitz's research, still at the basic level, has broad implications for genetics researchers, since he is furthering scientific understanding of how genes work together. But Dr. Elowitz also is laying the groundwork for an exciting new area of research: biological computing.

The nascent biocomputing movement links the rapidly growing computer and biotech industries. Biocomputing researchers aim to use designed genetic circuits as components in futuristic cell-based computers. Though still fanciful, biological computing components, based in living cells, could offer a stunning array of possibilities.

First, unlike conventional electronic devices, which can fail if even a single circuit blows, biocomputers could be flexible and adaptable, not crashing after a single error. Second, they could be inexpensive to make—genetically designed by scientists and then grown in giant batches. Third, they could be lightening fast and flexible, usable as controls for large-scale vats of bacteria to make chemicals or combined with silicon chips to make powerful biosensors.

"What we were trying to figure out, on a basic level, was how well cells are able to control themselves."

The genetic networks in human cells already contain what bio-computing researchers consider genetic circuits that perform computations. Many genetic circuits, for instance, make decisions based on the concentrations of various chemicals in the cell's environment. Dr. Elowitz's clock is an important man-made circuit. Several years ago, a Boston University graduate student designed a genetic system that could store a one or zero as information. Other researchers, mimicking natural systems that do much the same thing in cells, have created microbial genetic switches that can stay on or off, depending on exterior stimuli. Researchers foresee such simple genetic circuits as building blocks in novel biological devices.

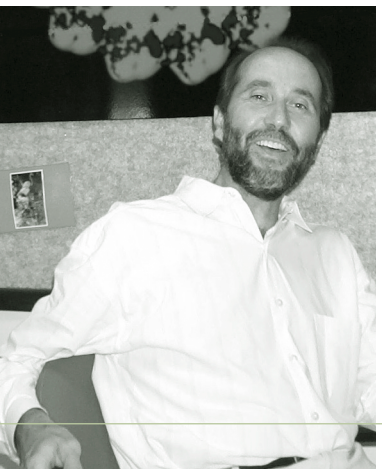
Beyond the exciting and still fictional possibilities, a number of tasks remain on the horizon for Dr. Elowitz, who says he enjoys drawing as a way to unwind after long hours in the laboratory.

He hopes to study whether certain kinds of gene networks in cells work with less noise—less inherent inconsistency—than others, and whether some cells have actually evolved to amplify noise as a way of creating a more diverse population. He then wants to choose several existing gene networks in the body and build synthetic models of the networks. BWF funding, says Dr. Elowitz, has enabled him to explore the unorthodox and yet unexplored field of modeling systems.

Dr. Elowitz says he feels a constant tug between his urge to search for universal principles, as in physics, and the necessity to characterize and understand particular biological systems. "The challenge is to become a good biologist," he says, "without giving up the belief that simplifying principles exist in some form and can be discovered."

In the meantime, this biologist is focusing on the basics. "Now we want to know how to make—and how cells make—a reliable circuit, and the clock is a good example," Dr. Elowitz says.

Drs. José Onuchic and Elizabeth Getzoff run the La Jolla Interfaces in Science Program, which has helped young researchers make the transition to biological fields, where their expertise is crucial for research on neural networks, genetics, and other areas of biomedical investigation.



Drs. José Onuchic and Elizabeth Getzoff Run La Jolla Program That Weds Hard and Biological Sciences

Biology is going numbers crazy, and as high-tech and high-throughput experiments spit out data, the industry is dying for number-crunchers. Engineers are analyzing protein structure, physicists de-mystifying neural networks, and mathematicians and computer scientists helping make sense of burgeoning databases on new genes and endless proteins.

Gone are the days of purely descriptive biology. "You cannot work with a simple hypothesis and check with a simple experiment any more," says Dr. José Onuchic, a biological physicist at the University of California-San Diego (UCSD). "There is a need for theoretical tools to analyze."

Amidst this growing tide of data—and a real shortage of physicists, engineers, and mathematicians entering the biological sciences—the La Jolla Interfaces in Sciences (LJIS) program has served an important purpose. Founded in 1996 with a BWF Institutional Award for Interdisciplinary Science Training, the program has eased the entry of dozens of young researchers into biological fields. LJIS offers grants to students and postdoctoral fellows—in mathematics, physics, chemistry or engineering—who agree to pursue research in biology. The program also runs special seminars, pays for books, and supports travel to scientific meetings for its grant recipients.

According to the co-directors of the program, Drs. Onuchic and Elizabeth Getzoff of The Scripps Research Institute (TSRI), LJIS was born out of the vibrant scientific community in La Jolla. The idea for the program came out of monthly "town meetings" among scientists from UCSD, TSRI, the Salk Institute, and the San Diego Supercomputer Center. The problem: how to encourage more students of mathematics, physics, chemistry, and engineering to enter biology and medicine. The solution, with BWF backing, was LJIS.

By 1997, the first batch of fellows was selected for the program and its grant awards. Success stories ensued. More than a dozen of the post-doctoral fellows have gone on to assistant professorships or industrial research jobs.

Dr. Robert Dickson, with a chemistry background, went through the program from 1997 to 1998. He's now an assistant professor at the Georgia Institute of Technology and a leader in the burgeoning field of single-molecule spectroscopy. Dr. Willy Wriggers, now an assistant professor in TSRI's Department of Molecular Biology, was a trainee in the program four years ago after a earning a Ph.D. in physics from the University of Illinois at Urbana-Champaign. Dr. Wriggers won the *Journal of Structural Biology's* Paper of the Year award for a report on combining X-ray crystallography and microscope data to find new protein structures. Now Dr. Wriggers is giving back to LJIS, serving as a mentor for postdoctoral trainee Dr. Pablo Chacón, the program's first "second generation" trainee. "The major success has been the caliber of the fellows and what they have accomplished," says Dr. Getzoff.

In the five years of its existence, the program has hosted over 50 trainees, including graduate students and post-doctoral fellows. UCSD administers the program, and graduate students who wish to become LJIS trainees must first be accepted as graduate students at UCSD or TSRI. Post-docs who are accepted apply directly to specific area laboratories.

Trainees in LJIS have dual mentors—one professor in a "hard science" lab and another who is doing biological research. "That triggers the bosses to get together and talk and push new interdisciplinary collaborations forward," says Dr. Getzoff. "I've learned a lot about quantum chemistry from my bridging postdoc."

Dr. Onuchic says BWF support came at a time when the science establishment didn't fully grasp the growing importance of interdisciplinary training. "Some people thought our idea was interesting, but no one thought the National Science Foundation or the National Institutes of Health would fund it," he says.

Drs. Onuchic and Getzoff themselves have a strong background in interdisciplinary approaches to science. Dr. Onuchic, who was trained in theoretical physics in Brazil, is an expert in the statistical physics surrounding how proteins fold from their initial state into final form. Dr. Getzoff, with a background in X-ray crystallography, studies how proteins change form to facilitate reactions. She runs a research team comprising both scientists in the "wet lab" as well as computer scientists and physicists who analyze structural data to determine exactly how certain proteins work.

"BWF was ahead of its time," says Dr. Getzoff, adding that BWF funding could be used with a flexibility rare in such grants, applicable either for graduate students or postdoctoral fellows. A number of foreign trainees, who often have difficulty obtaining research grants in the United States, also joined the program. Dr. Onuchic calls the success of the LJIS program a "proof of concept" for interdisciplinary training. BWF's original five-year, $2.5 million grant has been extended for another two years. Additionally, in an effort to build on LJIS's success, the National Science Foundation has granted funding for a new Center of Theoretical Biological Physics at UCSD.

A Final Word

To complement our competitive award programs and our efforts to provide our awardees with career-development advice, BWF also works to improve the way we carry out our programs. In June, we convened a group of private and public funders of science to consider the state of electronic grant making in these different sectors and to learn from each other how to improve such practices. BWF will begin to adopt electronic approaches to our grant application and review process over the next year. We also have laid out a five-year plan to convert to an all-electronic format.

Last October, BWF noted that we needed to improve our outreach to Canada, to ensure that we are attracting the best and brightest applicants for our programs. We have been working closely with the Canadian Institutes of Health Research and the university communities to publicize our competitive programs.

In an uncertain world, our Board of Directors has reaffirmed BWF's commitment to promoting the research and careers of scientists who can build on ever-accelerating discoveries and help promote the health and well-being of people around the globe. At the end of the day, it's top-notch people who will advance our knowledge and translate their findings to patient benefit.

Science Education: The Need and the Vision

In a world filled with the products of scientific inquiry, scientific literacy is a necessity. We need to be able to use scientific information to make choices daily and to engage intelligently in public discourse on issues that involve science, mathematics, engineering, and technology.

Everyone deserves to share in the excitement and personal fulfillment that can come from understanding and learning about the natural world. In this context, we must consider how well we are educating our children generally—and specifically in the areas of science and mathematics.

The Burroughs Wellcome Fund has spent the past two years investigating how best to improve science and mathematics education in our home state of North Carolina. Since the Fund became an independent, private foundation in 1994, we have sponsored a science education program aimed at engaging students in hands-on science inquiry. During this time, despite advances in pre K-12 education, a number of educational advisors who work with BWF have lamented the fact that North Carolina lacks a champion for science, mathematics, engineering, and technology education. Additionally, a consensus report, *The State of Disconnectedness: An Examination of Mathematics and Science Instruction in the North Carolina Public Schools*, developed by the Public School Forum of North Carolina in 1995, indicated that poor communication, blurred lines of accountability, and a failure to marshal the state's wealth of resources have made it less likely that science and mathematics education in the state will make substantial progress. On the national front, the Glenn Commission released a report from the National Commission on Mathematics and Science Teaching for the 21st Century titled *Before It's Too Late*. The report's findings were alarming—in an age driven by science and technology, U.S. students receive inadequate preparation in mathematics and science.

Status of North Carolina

James B. Hunt Jr., past governor of North Carolina, commissioned a study to assess the critical role that science and technology play in the state's economy. The study—*Vision 2030: Science and Technology* (N.C. Board of Science and Technology, 2000)—involved 800 citizens from all walks of life and was conducted over 15 months in every region of the state. The study highlighted the role that North Carolina's public and private universities play as national leaders in the biological and health sciences. Coupled with university strengths, the health sciences represent one of North Carolina's most competitive and dynamic knowledge-based industries.

While a large share of the bachelor's degrees awarded by N.C. colleges and universities were in the sciences and engineering, the share of the state's residents with such degrees remained comparatively low. This gap may suggest that the state is not retaining its graduates or is playing catch-up from an era when science and technology were not emphasized. The study compared North Carolina's performance to that of six other states: two leading technology states (Massachusetts and Texas), two major manufacturing states (Pennsylvania and Michigan), and two southeastern states (Georgia and Virginia). Among peer states, North Carolina fared best on measures of performance (employment and income) and economic structure (export activity and technology intensity). The state fared worst on indicators of individual preparation such as education and Internet access. Especially weak was the preparation of K-12 students in science and mathematics.

North Carolina has 100 counties and 117 public school systems that serve nearly 1.4 million students. One hundred of the school systems are countywide systems, while 17 are city school systems. The state's growing population requires that North Carolina add approximately 7,000 new teachers each year for the next decade to educate the students on whom the state's future depends. While population growth has fueled the state's economy, it has also placed a heavy burden on its school systems.

North Carolina compares favorably to other states in equipping schools with technology; however, technology use across the state is uneven. Large, wealthy school districts are outfitting schools with state-of-the-art technology but smaller, poorer school districts are moving at a slow pace. As new jobs become increasingly technical, this situation has grave economic implications for future growth. Because college graduates with mathematics and science degrees are in high demand for well-paying jobs, schools across the state are having an increasingly difficult time attracting qualified mathematics and science teachers. This problem is compounded in poor, rural counties with low teacher salaries. In North Carolina, 85 percent of the counties are rural with 51 percent of the state's population living within these counties. Many rural families earn less than the national minimum living income standards (N.C. Rural Economic Center, personal communication).

Schools that have the equipment needed to offer course-work via long distance technology have an alternative to recruiting mathematics and science teachers. For example, the North Carolina School of Science and Mathematics' Educational Future Center (EFC), established in 1996, connects educators and students to resources that can significantly improve how mathematics and science are taught and learned. Seven cyber campuses with sophisticated electronic resources are electronically connected to the EFC in low economic zones across the state. Although this effort has improved distance-learning opportunities in some areas of the state, much more is needed.

Despite the challenges faced by North Carolina's educational system, the state's high school seniors have continued to demonstrate significant progress in mathematics and verbal skills as measured by the national Scholastic Aptitude Test (SAT). According to the N.C. State Board of Education, the senior class of 2002 raised North Carolina's average SAT performance by six points, continuing a 12-year trend that has seen the state's average rise by 50 points. North Carolina has gained more points on the SAT during the last decade than any other state where at least 50 percent of graduates take the test.

North Carolina's Disconnect

In North Carolina, there is no single voice advocating for the importance of science, mathematics, and technology in the curriculum; no organization drawing attention to the issue in a coherent, strategic way; no group pulling the resources together to generate collective action. This point was underscored by the State of Disconnectedness report, which made specific recommendations to improve pre K-12 education in the state. The report made clear that there were a number of exciting, ongoing programs to enhance science and mathematics education in North Carolina; however, it emphasized, as its title implies, that what is missing is a unifying entity that pulls together, as one statewide resource, all the materials and knowledge gained from diverse success stories.

> "Rather than being a problem of woefully few resources, the problem is more one of woefully little coordination between the myriad numbers of governmental and private organizations attempting to improve mathematics and science instruction in North Carolina" (N.C. Public School Forum, 1995, p.11).

Further, the report outlines the need to take these "lessons learned" and apply them in a systematic fashion to improve educational offerings and teacher development across the state.

The state's educational leaders with whom we have met have also echoed the need for one group or organization to serve as a resource for "best practices." These leaders advised that such a group serve not only to disseminate successful programmatic approaches, but also conduct research and convene discussions of statewide education policy issues.

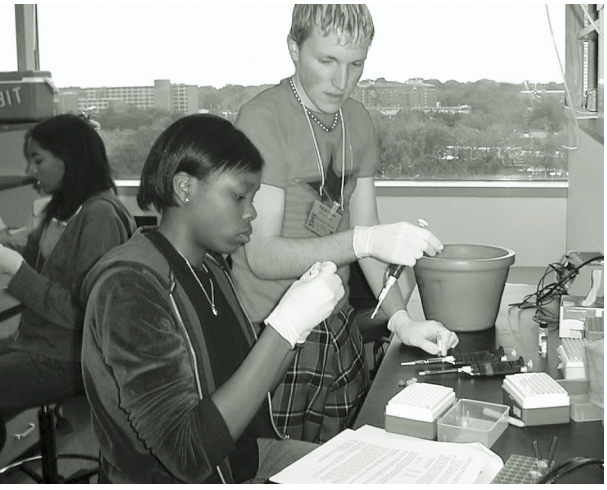
Creation of a Champion

The vision of creating a North Carolina Science, Mathematics, and Technology Education Center became a reality when 501(c)3 status was granted and the Center's board of directors convened its first meeting in June. The Center's mission is to systematically improve performance in science, mathematics, and technology in pre K-12 education as a means of providing all children in North Carolina with the necessary knowledge and skills in science, mathematics, and technology to have successful careers, be good citizens, and advance the economy of the state. The goals of the Center are:

- To articulate a vision for science, mathematics, and technology education in North Carolina in order to broaden awareness and solicit support on the part of all N.C. citizens for the importance and characteristics of high-quality programs of instruction and the need for a scientifically literate workforce.
- To work with government, industry, the education community, and parents to facilitate the steady improvement of performance in science, mathematics, and technology by all children in pre K-12; and to advocate for equitable and adequate resources for all pre K-12 children.
- To mobilize expertise and leverage resources to reach all pre K-12 children in every school system, in order to foster comprehensive and challenging programs in science, mathematics, and technology instruction; this will include disseminating effective tools and learning methods and providing technical assistance to teachers and administrators.
- To work with existing organizations to research, develop, and disseminate information on the state of science, mathematics, and technology pre K-12 education to policymakers and the media to improve decision-making and to identify gaps that need to be addressed.

The SMT Education Center will accomplish its mission and goals by serving as an advocate for research-based and comprehensive programs of instruction; as a broker of educational initiatives and resources that can help ensure that academic success is systemic, continuous, and sustainable; as a catalyst for innovation and change; as a provider and supporter of strategic programs; as a facilitator of existing networks and groups; and as a communicator of accurate and timely information about the status of science, mathematics, and technology education. During the planning phase of program and operational development, the board of directors will set the course for the Center's activities.

This is an exciting time for students in North Carolina and across the United States. With President George W. Bush's *No Child Left Behind Act*, which is the most sweeping reform of federal education policy in a generation, schools will be forced to make improvements in educational systems. We view this as a challenging opportunity to think out of the box in order to give our students the best education possible.



"We view this as a challenging opportunity to think out of the box in order to give our students the best education possible."

Report on Finance

At the end of our fiscal year, August 31, 2002, the Burroughs Wellcome Fund's investments totaled $549.7 million. BWF's primary financial goal is to pursue an investment strategy that will support annual spending needs and maintain a constant real level of assets over the long term. To achieve this goal, a high percentage of our investments is placed in strategies that derive the bulk of their returns from exposure to U.S. and international capital markets. Hence, fluctuations in BWF's investment results will be due largely to variability in capital market returns.

BWF's investment policies are developed with the recommendations and review of the Investment Committee, which is appointed by and reports to BWF's Board of Directors. The committee, which meets three times a year, has six voting members, including four representatives from outside BWF and two representatives of our board. The board's chair, BWF's president, and BWF's vice president for finance also serve on the committee as nonvoting members.

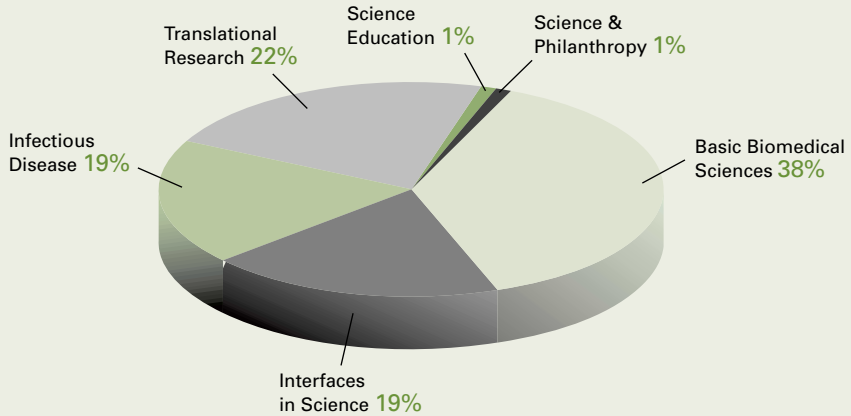
As part of BWF's investment strategy, we have established "allocation targets"—that is, percentages of our total assets to be invested in particular asset classes. Investment managers hired by BWF pursue more focused mandates within each sector. As of the end of the fiscal year, BWF's asset mix and market values were:

- U.S. large capitalization equity assets had a market value of $140.3 million. The sector's target allocation was 31 percent, and actual holdings stood at 25.5 percent.
- U.S. small capitalization equity assets had a market value of $67.5 million. The sector's target allocation was 14 percent, and actual holdings stood at 12.3 percent.
- International equity assets had a market value of $148.9 million. The sector's target allocation was 30 percent, and actual holdings stood at 27.1 percent.
- Fixed income assets had a market value of $128.7 million. The sector's target allocation was 22 percent, and actual holdings stood at 23.4 percent.
- Cash equivalent assets had a market value of $14.9 million. The sector's target allocation was 3 percent, and actual holdings stood at 2.7 percent.
- Alternative assets had a market value of $49.4 million. The sector did not have a target allocation, and actual holdings stood at 9 percent. The maximum permitted allocation to alternative assets stood at 8 percent at cost.

The total market value of BWF's investments decreased by $89.9 million, or 14.1 percent, from the end of the previous fiscal year. This large decrease in assets was due primarily to poor returns in world equity markets over the course of the fiscal year. BWF's total investment return for the fiscal year was -8.7 percent. Returns in all three equity sectors primarily drove this result. The U.S. large capitalization equity sector returned -19.9 percent, the U.S. small capitalization equity sector had a -12.1 percent result, and the international equity sector posted a return of -12.0 percent for the fiscal year. Fixed income produced a +8.6 percent result. Alternative assets as a group produced a -1.4 percent return.

As of August 31, 2002, BWF employed 11 investment managers. In the U.S. large capitalization equity sector, the managers were Independence Investment Associates; LSV Asset Management; and Cohen, Klingenstein and Marks. Credit Suisse Asset Management, Kennedy Capital Management, and Scudder Kemper Investments managed U.S. small capitalization equities. Pacific Investment Management Company and Smith Breeden Associates were the fixed income managers. Capital Guardian Trust Company and Hansberger Global Investors managed international equities. State Street Global Advisors managed a hedge fund. BWF also held investments in six venture capital funds: Intersouth Partners IV and V, the Spray Venture Fund, Mission Ventures II, the North Carolina Bioscience Investment Fund and Tech Amp II. Finally, Quellos Capital Management managed a fund of absolute return strategies.

In October 2002, the Fund's finance staff conducted an asset allocation study and presented recommendations to the Investment Committee and Board of Directors. From an investment perspective, the Fund is interested in achieving the financial goal with as little year-to-year volatility of returns as possible. To this end, the study could lead to changes in the target allocations of the asset classes, including alternative investments.



Report of Independent Accountants

To the Board of Directors of
The Burroughs Wellcome Fund

In our opinion, the accompanying statements of financial position and the related statements of activities and of cash flows present fairly, in all material respects, the financial position of The Burroughs Wellcome Fund (the "Fund") at August 31, 2002 and 2001, and the changes in its net assets and its cash flows for the years then ended in conformity with accounting principles generally accepted in the United States of America. These financial statements are the responsibility of the Fund's management; our responsibility is to express an opinion on these financial statements based on our audits. We conducted our audits of these statements in accordance with auditing standards generally accepted in the United States of America, which 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, assessing the accounting principles used and significant estimates made by management, and evaluating the overall financial statement presentation. We believe that our audits provide a reasonable basis for our opinion.

Our 2002 audit was conducted for the purpose of forming an opinion on the basic financial statements taken as a whole. The information presented in Schedules I and II is presented for purposes 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.

PricewaterhouseCoopers LLP

Raleigh, North Carolina
October 11, 2002

Statements of Financial Position

August 31, 2002 and 2001

(All dollar amounts presented in thousands)

	2002	2001
Assets		
Cash and cash equivalents	$25,045	$44,825
Marketable securities	538,392	635,880
Accrued interest and dividends receivable	2,134	2,156
Federal excise tax receivable	-	1,403
Other assets	28	22
Total current assets	565,599	684,286
Property and equipment, net	13,870	14,590
Total assets	$579,469	$698,876
Liabilities and Net Assets		
Transactions payable, net	$15,459	$42,544
Accounts payable and other liabilities	723	960
Unpaid awards	70,940	78,888
Total liabilities	87,122	122,392
Unrestricted net assets	492,347	576,484
Total liabilities and net assets	$579,469	$698,876

The accompanying notes are an integral part of these financial statements.

Statements of Activities

Years Ended August 31, 2002 and 2001

(All dollar amounts presented in thousands)

	2002	2001
Revenues:		
Interest and dividends, less investment expenses of $3,289 and $4,254 in 2002 and 2001, respectively	$12,879	$14,848
Net realized (loss) gain on sales of marketable securities	(34,896)	3,654
Total revenues	(22,017)	18,502
Expenses:		
Program services	22,793	42,655
Management and general	4,564	4,960
Total expenses before net depreciation and federal excise tax	27,357	47,615
Net unrealized depreciation of marketable securities, net of benefit from for deferred federal excise taxes of $0 and $1,985 in 2002 and 2001, respectively	(34,763)	(102,449)
Federal excise tax benefit	-	1,403
Total net unrealized depreciation and federal excise tax benefit	(34,763)	(101,046)
Change in net assets	(84,137)	(130,159)
Net assets at beginning of year	576,484	706,643
Net assets at end of year	$492,347	$576,484

The accompanying notes are an integral part of these financial statements.

Statements of Cash Flows

Years Ended August 31, 2002 and 2001

(All dollar amounts presented in thousands)

	2002	2001
Cash flows from operating activities:		
Change in net assets	$(84,137)	$(130,159)
Adjustments to reconcile change in net assets to net cash (used in) provided by operating activities:		
Depreciation	742	730
Net realized loss (gain) on sales of marketable securities	34,896	(3,654)
Net unrealized depreciation of marketable securities	34,763	104,434
Benefit from deferred federal excise taxes	-	(1,985)
Awards granted, net of cancellations and change in unamortized discount	23,525	42,943
Award payments made	(31,473)	(34,083)
Changes in operating assets and liabilities:		
Accrued interest and dividends receivable	22	324
Federal excise tax receivable	1,403	(1,403)
Other assets	(6)	9
Transactions payable, net	(27,085)	(9,881)
Accounts payable and other liabilities	(237)	(104)
Net cash used in operating activities	(47,587)	(32,829)
Cash flows from investing activities:		
Purchases of marketable securities	(1,235,953)	(1,434,649)
Proceeds from sales of marketable securities	1,263,782	1,479,151
Purchase of property and equipment	(22)	(321)
Net cash provided by investing activities	27,807	44,181
Net (decrease) increase in cash and cash equivalents	(19,780)	11,352
Cash and cash equivalents at beginning of year	44,825	33,473
Cash and cash equivalents at end of year	$25,045	$44,825
Supplemental disclosure of cash flow information:		
Cash paid during the year for federal excise taxes	$ -	$ -

The accompanying notes are an integral part of these financial statements.

Years Ended August 31, 2002 and 2001

(All dollar amounts presented in thousands)

1. Organization and Summary of Significant Accounting Policies

The Burroughs Wellcome Fund (the "Fund") is a private foundation established to advance the biomedical sciences by supporting research and other scientific and educational activities.

Cash equivalents

Cash equivalents are short-term, highly liquid investments that are readily convertible to known amounts of cash and have a maturity of three months or less at the time of purchase.

Forward currency contracts

The Fund enters into financial instruments with off-balance sheet risk in the normal course of its investment activity, primarily forward contracts, to reduce the Fund's exposure to fluctuations in foreign currency exchange rates. These contracts are for delivery or sale of a specified amount of foreign currency at a fixed future date and a fixed exchange rate. Gains or losses on these contracts occur due to fluctuations in exchange rates between the commencement date and the settlement date. Gains and losses on settled contracts are included within "net realized gains or losses on sales of marketable securities," and the changes in market value of open contracts is included within "net unrealized depreciation of marketable securities" in the accompanying statements of activities. It is the Fund's policy to utilize forward contracts to reduce foreign exchange rate risk when foreign-based investment purchases or sales are anticipated.

The contract amount of these forward currency contracts totaled $14,132 and $5,152 at August 31, 2002 and 2001, respectively. Realized gains on forward currency contracts totaled $748 and $669 in 2002 and 2001, respectively. The market value of open forward currency contracts at August 31, 2002 and 2001 was $92 and $298, respectively. The market value is recorded as an asset in the Fund's financial statements. The average market value of open foreign currency contracts totaled $226 and $233 for the years ending August 31, 2002 and 2001, respectively.

Futures contracts

The Fund enters into futures contracts in the normal course of its investment activity to manage the exposure to interest rate risk associated with bonds and mortgage backed securities. The Fund is required to pledge collateral to enter into these contracts. The amounts pledged for futures contracts at August 31, 2002 and 2001 were $1,304 and $1,777, respectively. It is the Fund's intention to terminate these contracts prior to final settlement. Gains and losses on the contracts are settled on a daily basis. Included in transactions payable at August 31, 2002 and 2001 is the net settlement relating to these contracts of ($120) and $11, respectively.

Options

The Fund utilizes options to manage the exposure to interest rate risk associated with mortgage backed securities. The market value of these options totaled $1 and $1,504 at August 31, 2002 and 2001, respectively, which is recorded as an asset in the Fund's financial statements. The average fair value of open contracts totaled $871 and $610 for the years ending August 31, 2002 and 2001. Realized losses on options totaled $732 and $214 for the years ending August 31, 2002 and 2001, respectively.

Marketable securities

Marketable securities are carried at estimated market values based on quoted prices. Gains and losses from sales of securities are determined on an average cost basis and are recognized when realized. Changes in the estimated market value of securities are reflected as unrealized appreciation or depreciation in the accompanying statements of activities. The Fund has investment advisors which manage its portfolio of marketable securities. The Fund's management critically evaluates investment advisor performance and compliance with established diversification and investment policies.

Property and Equipment
Property and equipment is primarily comprised of a building, furniture, and computer equipment which are stated at cost less accumulated depreciation and are being depreciated over their estimated useful lives using the straight-line method. Ordinary maintenance and repair costs are expensed as incurred.

Building	40 years
Furniture and Fixtures	7 years
Computer Equipment	3 years

Transactions receivable and transactions payable, net
These amounts represent the net receivable or payable resulting from investment transactions with trade dates prior to August 31 and settlement dates subsequent to August 31.

Awards granted and unpaid awards
Grants are expensed at their fair value in the year in which the award is granted. Grants payable over several years are expensed, and carried on the statements of financial position, at the present value of their estimated future cash flows, using a risk free discount rate determined at the time the award is granted.

Functional allocation of expenses
Costs of Fund's operations and activities have been summarized on a functional basis in the statement of activities.

Estimated fair value of financial instruments
Financial instruments include cash and cash equivalents, marketable securities, accrued interest and dividends receivable, accounts payable, and unpaid awards. All financial instruments are reported at their estimated fair value. The carrying values of accrued interest and dividends receivable, accounts payable, and unpaid awards approximate fair values based upon the timing of future expected cash flows. The estimated fair value of marketable securities is determined based upon the latest quoted sales price for such securities as of the balance sheet date. The Fund's remaining assets and liabilities are not considered financial instruments.

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 the financial statements and the reported amounts of revenues and expenses during the reporting period. Actual results could differ from those estimates.

Market Risk
Market risk represents the risk of changes in value of a financial instrument, derivative or non-derivative, caused by fluctuations in interest rates, foreign exchange rates and equity prices. The Fund manages these risks by using derivative financial instruments in accordance with established policies and procedures.

2. Property and Equipment

The Fund's property and equipment consisted of the following:

	2002	2001
Building	$13,451	$13,451
Furniture and fixtures	1,735	1,717
Computer equipment	673	669
	15,859	15,837
Less: accumulated depreciation	(1,989)	(1,247)
	$13,870	$14,590

3. Federal Excise Taxes

The Fund is exempt from federal income taxes under Section 501(c)(3) of the Internal Revenue Code. However, since the Fund meets the definition of a private foundation under the Internal Revenue code, it is subject to federal excise tax on its annual net investment income. As the Fund had a net investment loss for the year ended August 31, 2002, no liability has been recorded. The federal excise tax receivable at August 31, 2001 represents an overpayment in fiscal 2000 due to the Fund qualifying at a 1% tax rate rather than the normal 2% tax rate.

Deferred federal excise taxes represent the tax liability on unrealized appreciation of marketable securities. At August 31, 2002, the Fund is in a net unrealized depreciation position, therefore, deferred federal excise taxes were not recorded.

4. Unpaid Awards

Unpaid awards as of August 31 are scheduled for payment as follows:

	2002	2001
Payable in less than one year	$32,555	$34,409
Payable in one to five years	40,404	47,852
	72,959	82,261
Unamortized discount	(2,019)	(3,373)
Total	$70,940	$78,888

The expected future liability to the Fund has been calculated based on discount rates ranging from 1.96% to 4.04%.

5. Marketable Securities

The cost and estimated market values of marketable securities at August 31 are as follows:

	2002		2001	
	Cost	Estimated Market Value	Cost	Estimated Market Value
U.S. and foreign governmental obligations	$74,419	$78,178	$110,968	$113,972
Corporate bonds	53,096	53,718	61,631	63,747
Common and preferred stocks	274,407	246,525	263,449	268,273
Foreign stocks and foreign equity funds	131,730	115,639	167,815	151,230
Option and forward foreign currency investments	83	93	6,148	6,077
Venture capital investments	13,834	12,283	11,369	11,230
Mutual fund	30,000	31,956	20,000	21,351
	$577,569	$538,392	$641,380	$635,880

6. Employee Benefit and Retirement Plans

The Fund provides medical insurance to all employees working at least thirty hours per week. Coverage extends to each employee's spouse and dependent children, if applicable. The expense for this employee benefit was $118 and $88 during fiscal 2002 and 2001, respectively.

The Fund has a defined-contribution retirement plan covering all employees working at least twenty hours per week. Under the terms of the plan, the Fund matches 50% of all employees' contributions up to 6% of the employee's annual compensation. Employees are 100% vested in employee and employer contributions immediately. The Fund also has a defined-contribution retirement plan funded solely through employer contributions. Under the terms of the plan, the Fund contributes 10% of the employee's annual compensation. This plan covers all employees and vesting in contributions is immediate. The expense for these retirement plans was $42 and $162 in fiscal 2002, and $40 and $148 in fiscal 2001, respectively.

7. Classification of Expenses

During the years ended August 31, expenses were classified as follows:

	2002		2001	
	Program Services	Management and General	Program Services	Management and General
Awards granted, net of cancellations and refunds of $7,833 and $6,221 in 2002 and 2001, respectively	$22,793	$ -	$42,655	$ -
Salaries and other employee expenses	-	2,236	-	2,171
Depreciation expense	-	743	-	729
Travel and entertainment	-	381	-	749
Maintenance and supplies	-	510	-	616
Honoraria	-	276	-	323
Professional fees	-	239	-	178
Printing and design costs	-	57	-	89
Miscellaneous	-	122	-	105
Total expenses	$22,793	$4,564	$42,655	$4,960

Schedule I:
Statement of Award Transactions

Year Ended August 31, 2002

(All dollar amounts presented in thousands)

Unpaid awards, beginning of year	$78,888
Add – Awards granted (Schedule II)	29,272
Less – Award payments made	(31,473)
Award cancellations (excluding refunds)	(7,101)
Net increase in unamortized discount	1,354
Unpaid awards, end of year	$70,940

Schedule II:
Statement of Awards Granted

Year Ended August 31, 2002

Schedule I information is included in the "Grants Index" beginning on the opposite page. The dollar amounts listed in the schedule reflect the actual dollar amounts (not rounded to thousands) approved and paid to awardees.

Program Summary

	Approved	Paid	Transferred/ Cancelled*
Basic Biomedical Sciences			
Career Awards in the Biomedical Sciences	$11,295,638	$9,626,284	$3,205,500
Career Awards Collaborative Grants	8,400	68,564	-
Hitchings-Elion Fellowships	1,203,110	833,485	1,075,839
Research Travel Grants		9,480	-
Life Sciences Research Fellowships	-	205,000	-
Obsetrics and Gynecology Research Fellowships	-	112,000	-
Other Grants	303,850	468,450	-
Total	$12,810,998	$11,323,263	$4,281,339
Infectious Diseases			
Investigators in Pathogenesis of Infectious Disease	$3,600,000	$360,000	$ -
New Initiatives in Malaria Research	369,003	1,010,000	300,000
New Investigator Awards in Molecular Parasitology	-	490,000	-
New Investigator Awards in Molecular Pathogenic Mycology	-	630,000	-
Scholar Awards in Molecular Parasitology	255,000	935,000	255,000
Scholar Awards in Molecular Pathogenic Mycology	-	865,000	-
Other Grants	1,483,466	1,124,007	1,000,000
Total	$5,707,469	$5,414,007	$1,555,000
Interfaces in Science			
Career Awards at the Scientific Interface	$4,196,000	$611,600	$40,000
Innovation Awards in Functional Genomics	185,149	675,583	75,000
Institutional Awards at the Scientific Interface	-	3,710,749	-
Other Grants	70,500	370,500	175,000
Total	$4,451,649	$5,368,432	$290,000
Translational Research			
Clinical Scientist Awards in Translational Research	$5,850,000	$5,625,000	$975,000
New Investigator Awards in the Pharmacological Sciences	-	1,050,000	-
New Investigator Awards in the Toxicological Sciences	-	805,000	-
Other Grants	88,600	318,600	-
Total	$5,938,600	$7,798,600	$975,000

	Approved	Paid	Transferred/ Cancelled*
Science Education			
Student Science Enrichment Program	$46,200	$812,751	$ -
Visiting Professorships in the Basic Medical Sciences	-	165,000	-
Visiting Professorships in the Microbiological Sciences	-	55,000	-
Other Grants	132,450	350,781	-
Total	$178,650	$1,383,532	$ -
Science and Philanthropy			
General	$108,700	$108,700	$ -
Communications	37,000	37,000	-
Science Policy	35,000	35,000	-
Special Award	4,000	4,000	-
Total	$184,700	$184,700	$ -
Totals	**$29,272,066**	**$31,472,534**	**$7,101,339**

Grand Totals†
- Approved: $22,170,727
- Paid: $31,472,534

* The "Transferred/Cancelled" totals reflect grants made to award recipients who changed institutions, modified the terms of their grant at their current institution, or both changed institutions and modified their grant. In these cases, BWF's policy has been to cancel the remaining portion of the original grant and, as necessary, approve a new grant. When the award recipient has changed institutions, the new grant is made to the new institution; when the award recipient has not moved but has modified the terms, the new grant is made to the current institution.

† To more accurately reflect the total amount that BWF approved in actual "new" dollars during this fiscal year, the "Transferred/Cancelled" total must be deducted from the "Approved" total.

Key to Grants Index—BWF makes all grants to nonprofit organizations. For most of the programs listed in the following sections, the name of the individual on whose behalf the grant is made is listed first, the title of the award recipient's project is listed second, and the name of the organization that received the money is listed third. For programs that may have coaward recipients, the award recipients and their organizations are listed first, followed by the project title. For grants made directly to organizations and not on behalf of an individual, the name of the organization is listed first, followed by the title of the project or a brief description of the activity being supported.

Totals
- Approved: $12,810,998
- Paid: $11,323,263
- Transferred/Cancelled: $4,281,339

Career Awards in the Biomedical Sciences

Career awards are postdoctoral-faculty bridging awards. During the fiscal year, some award recipients change institutions, modify the terms of their award at their current institution, or both change institutions and modify their award. In these cases, BWF's policy has been to cancel the remaining portion of the original award and, as necessary, approve a new award. When the award recipient has changed institutions, the new award is made to the new institution; when the award recipient has not moved but has modified the terms, the new award is made to the current institution. In the following descriptions, the name of the award recipient is listed first, the title of the project is listed second, the award recipient's current institution is listed third, and the amount approved or paid to the institution is listed fourth. For award recipients who either changed institutions or modified their award, the portion of the award paid to the original institution, as well as any portion that was transferred or cancelled, is listed last, in parentheses. For new award recipients still in the postdoctoral period, the portion of the award intended to cover a future faculty appointment is listed last, in parentheses.

Suzanne J. Admiraal, Ph.D.
Biosynthesis of hybrid natural products
Harvard Medical School
Approved $116,000 Paid $29,000
($384,000 approved for future faculty appointment)

Matthew L. Albert, M.D., Ph.D.
Tumor immunity versus tumor-mediated immunosuppression: characterizing the cellular and molecular mechanism of cross-priming and cross-tolerance
Rockefeller University
Paid $61,000

Ravi Allada, M.D.
Molecular and genetic analysis of the circadian rhythm gene *Clock* in *Drosophila*
Northwestern University
Paid $127,500

Matthew P. Anderson, M.D., Ph.D.
Role of T-type calcium channels in thalamic and hippocampal rhythmic activity
Massachusetts Institute of Technology
Paid $31,500

Oscar M. Aparicio, Ph.D.
Understanding the relationship of DNA replication to cell cycle control of cellular proliferation and chromosomal organization
University of Southern California
Paid $65,500

Vahe Bandarian, Ph.D.
Biosynthesis of deazapurine secondary metabolites
University of Michigan-Ann Arbor
Approved $116,000 Paid $29,000
($384,000 approved for future faculty appointment)

Jody L. Baron, M.D., Ph.D.
Role of the innate immune system in acute and chronic hepatitis B: studies in a novel transgenic mouse model of primary HBV infection
University of California-San Francisco School of Medicine
Paid $31,500

Greg J. Bashaw, Ph.D.
Molecular mechanisms of attractive and repulsive axon guidance at the midline of *Drosophila*
University of Pennsylvania Medical Center
Paid $193,000

Gregory J. Beitel, Ph.D.
Mechanisms that control and execute the cell movements and shape changes underlying metazoan morphogenesis
Northwestern University
Paid $67,650

Leonardo Belluscio, Ph.D.
Learning and memory in the mouse olfactory bulb
Duke University Medical Center
Paid $31,500

Guoqiang Bi, Ph.D.
Spatio-temporal specificity of synaptic plasticity at single synaptic contacts
University of Pittsburgh School of Medicine
Approved $18,600 Paid $142,600

David Bilder, Ph.D.
Genetic analysis of epithelial cell architecture
University of California-Berkeley
Paid $65,500

Mark Bix, Ph.D.
Effector CD4+ T-cell development: evidence for the stochastic generation and clonal distribution of a combinatorial cytokine repertoire
University of Washington School of Medicine
Paid $60,500

Cornelius F. Boerkoel, M.D., Ph.D.
A *Drosophila* model for dissection SMARCAL1 function
Baylor College of Medicine
Approved $116,000 Paid $29,000
($384,000 approved for future faculty appointment)

Azad Bonni, M.D., Ph.D.
Regulation of glial fate specification in the central nervous system
Harvard Medical School
Paid $65,500

Carrie B. Brachmann, Ph.D.
Using *Drosophila* as a tool for the study of apoptotic regulation
Washington University School of Medicine
Paid $61,000

Edward S. Brodkin, M.D.
Genetic analysis of anxiety-related behaviors in mice
University of Pennsylvania School of Medicine
Approved $357,500 Paid $60,500
($357,500 of original award to Princeton University was transferred/cancelled)

Chester W. Brown, M.D., Ph.D.
Understanding the reproductive roles of the activins using an activin beta B knock-in model
Baylor College of Medicine
Paid $127,500

Richard K. Bruick, Ph.D.
Investigation of hypoxia-sensing and signaling pathways
University of Texas Southwestern Medical Center-Dallas
Approved $500,000 Paid $29,000

Michael D. Bulger, Ph.D.
Relationship between organization and function at the mammalian beta-globin locus
University of Washington School of Medicine
Paid $31,500

Walter R. Burack, M.D., Ph.D.
Analysis of the immunological synapse: a membrane-associated machine
Washington University School of Medicine
Paid $31,500

Kathleen M. Caron, Ph.D.
Reproductive and cardiovascular effects of the adrenomedullin system
University of North Carolina-Chapel Hill School of Medicine
Paid $61,000

David C. Chan, M.D., Ph.D.
Structural and mechanistic studies of virus-mediated membrane fusion
California Institute of Technology
Approved $30,142 Paid $90,642

Thomas R. Clandinin, Ph.D.
Dissecting neuronal target selection in the *Drosophila* visual system
Stanford University School of Medicine
Approved $386,000 Paid $65,500
($63,000 of original award to the University of California-Los Angeles School of Medicine was paid; $386,000 of original award to the University of California-Los Angeles School of Medicine was transferred/cancelled)

John D. Crispino, Ph.D.
Functional characterization of hematopoietic transcription factor complexes
University of Chicago
Paid $127,500

David E. Cummings, M.D.
Studies of spermatogenesis and metabolism using mutant mice
University of Washington School of Medicine
Paid $60,500

Paul De Koninck, Ph.D.
Decoding rhythms in the nervous system
Laval University
Approved $17,555 Paid $145,055

Gregory C. DeAngelis, Ph.D.
Neural mechanisms underlying perceptual feature binding
Washington University School of Medicine
Paid $60,500

Abby F. Dernburg, Ph.D.
Chromosome architecture and the fidelity of meiotic segregation
University of California-Berkeley
Approved $11,459 Paid $127,500
($29,500 of original award to Stanford University
was transferred/cancelled)

Aaron DiAntonio, M.D., Ph.D.
Genetic analysis of synapse formation, growth, and plasticity
Washington University School of Medicine
Paid $60,500

Ricardo E. Dolmetsch, Ph.D.
Voltage-gated calcium channel signaling the nucleus
Harvard Medical School
Paid $61,000

Kelly S. Doran, Ph.D.
Penetration of the blood-brain barrier in GBS meningitis
University of California-San Diego
Paid $63,000

Charles G. Eberhart, M.D., Ph.D.
Analysis of medulloblastoma pathobiology and response
to novel therapies using murine transgenic models
Johns Hopkins University School of Medicine
Paid $29,500

Peter J. Espenshade, Ph.D.
Molecular mechanism of cholesterol homeostasis
in mammalian cells
University of Texas Southwestern Medical Center-Dallas
Paid $61,000

Miguel Estevez, M.D., Ph.D.
Investigation of a calcium channel related to migraine
and epilepsy in both an invertebrate and a mouse model
University of Pittsburgh Medical Center
Paid $61,000

Guowei Fang, Ph.D.
Mechanism of spindle assembly checkpoint control
Stanford University Medical Center
Paid $121,000

Kathryn M. Ferguson, Ph.D.
Structural basis for erbB receptor activation by epidermal
growth factor (EGF) agonists and neuregulin
University of Pennsylvania School of Medicine
Paid $61,000

Elizabeth A. Finch, Ph.D.
Postsynaptic calcium signaling by inositol trisphosphate
in neuronal dendrites
Emory University School of Medicine
Paid $127,500

Robert C. Flaumenhaft, M.D., Ph.D.
SNARE proteins in platelet alpha-granuale secretion
Harvard Medical School
Paid $65,500

Daved H. Fremont, Ph.D.
Structural studies of antigen presentation and T-cell activation
Washington University School of Medicine
Paid $60,500

Nicholas R. Gaiano, Ph.D.
Neural stem cells in the mammalian forebrain:
the roles of Notch and FGF signaling
New York University School of Medicine
Paid $29,500

Timothy P. Galitski, Ph.D.
Genetic networks
Institute for Systems Biology
Approved $386,000 Paid $131,000
($386,000 of original award to the Massachusetts Institute
of Technology was transferred/cancelled)

Erin C. Gaynor, Ph.D.
Molecular basis of colonization and invasion in the foodborne
enteric pathogen *Campylobacter jejuni*
Stanford University School of Medicine
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Jeffrey S. Glenn, M.D., Ph.D.
Prenylation and viral assembly
Stanford University School of Medicine
Paid $118,250

Joseph A. Gogos, M.D., Ph.D.
Genetic analysis of connectivity in the mammalian olfactory system
Columbia University College of Physicians and Surgeons
Paid $178,750

Joshua I. Gold, Ph.D.
Neural basis of perceptual-decision formation
University of Pennsylvania School of Medicine
Paid $65,500
($29,500 of original award to the University of Washington School of Medicine was paid)

Patrick A. Grant, Ph.D.
Analysis of histone acetyltransferase/transcriptional adaptor complexes in the regulation of gene expression
University of Virginia Health Sciences Center
Paid $131,000

Michael Graziano, Ph.D.
From eye to hand: sensory-motor integration in the primate brain
Princeton University
Paid $127,500

Matthias Gromeier, M.D.
Principles of polio neuropathies: exploiting poliovirus of brain cancer
Duke University Medical Center
Paid $65,500

Jay T. Groves, Ph.D.
Studies of cell recognition and signaling with micropatterned lipid membranes
University of California-Berkeley
Paid $193,000

Karen J. Guillemin, Ph.D.
Genetic and cellular basis of *Helicobacter pylori* associated malignancies
University of Oregon
Paid $127,500

Zhigang He, M.D., Ph.D.
Signaling mechanisms mediating the repulsive effects on developing and regenerating axons
Harvard Medical School
Paid $65,500

Victoria G. Herman, Ph.D.
Defining the molecular code for synaptic target selection
University of California-Los Angeles School of Medicine
Paid $61,000

Joel N. Hirschhorn, M.D., Ph.D.
Genetic analysis of complex endocrine disorders
Harvard Medical School
Paid $131,000
($29,500 of original postdoctoral award to Harvard Medical School Children's Hospital was transferred/cancelled)

Michael D. Hogarty, M.D.
*BIN*1: a *MYCN* interacting neuroblastoma suppressor
University of Pennsylvania School of Medicine
Paid $193,000

Lora V. Hooper, Ph.D.
Molecular analysis of commensal host-microbial interactions in the intestine
Washington University School of Medicine
Paid $31,500

Jennifer S. Hovis, Ph.D.
Understanding lipid and protein interactions at the molecular level in model cell membranes
Stanford University
Paid $29,500
($63,000 of original award to Stanford University was transferred/cancelled)

Xianxin Hua, M.D., Ph.D.
Identification and characterization of novel components in the TGF-_ signaling pathway
University of Pennsylvania Health System
Approved $24,642 Paid $142,892

Jeffry S. Isaacson, Ph.D.
Biophysical properties of presynaptic terminals in the central nervous system
University of California-San Diego School of Medicine
Paid $31,350

Akiko Iwasaki, Ph.D.
Defining the mechanism of immune induction and effector function in the female genital mucosa
Yale University School of Medicine
Paid $127,500

Raymond H. Jacobson, Ph.D.
TBP-related factor and selectivity factor I: probing TBP function in alternative contexts
University of Texas-Houston M.D. Anderson Cancer Center
Approved $314,500 Paid $178,750
($314,500 of original award to the University of California-Berkeley was transferred/cancelled)

Ursula H. Jakob, Ph.D.
Structural and functional characterization of new heat shock proteins
University of Michigan-Ann Arbor
Paid $193,000

James D. Jontes, Ph.D.
Role of protocadherins in neural development studied in living zebra fish embryos
Stanford University
Paid $61,000

David K.R. Karaolis, Ph.D.
Pathogenicity islands in the emergence of epidemic and pandemic cholera
University of Maryland-Baltimore School of Medicine
Paid $60,500

Laura J. Knoll, Ph.D.
Molecular genetic approaches to investigate developmental regulation in *Toxoplasma gondii*
University of Wisconsin-Madison
Approved $386,000 Paid $193,000
($386,000 of original award to Stanford University Medical Center was transferred/cancelled)

William R. Kobertz, Ph.D.
Molecular interactions of the lipid-exposed surfaces of integral membrane proteins
University of Massachusetts Medical School
Paid $29,500

Peter D. Kwong, Ph.D.
Atomic-level investigation of the structure and associated biology of the HIV-envelope protein, gp120
($357,500 of original award to the Columbia University College of Physicians and Surgeons was transferred/cancelled)

Bruce T. Lahn, Ph.D.
Systematic investigation of mammalian spermatogenesis
University of Chicago
Paid $65,500

Benhur Lee, M.D.
HIV-1 coreceptors and their role in HIV-associated hematopoietic dysfunction
University of California-Los Angeles
Approved $22,910 Paid $146,910

Brian C. Lewis, Ph.D.
Modeling tumor initiation, progression, and metastasis using tissue-specific somatic gene transfer
Weill Medical College of Cornell University
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Jeh-Ping Liu, Ph.D.
Molecular mechanisms in neural crest specification
University of Virginia Health System
Paid $115,500

Minmin Luo, Ph.D.
Integration of pheromonal signals and hormonal cues in mammalian reproduction
Duke University Medical School
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Hiten D. Madhani, M.D., Ph.D.
Specificity of signal transduction during dimorphic development of yeast
University of California-San Francisco
Paid $60,500

Mala S. Mahendroo, Ph.D.
Characterization of fecundity and parturition defects in mice deficient in steroid 5 alpha-reductase type 1
University of Texas Southwestern Medical Center-Dallas
Paid $118,250

Zachary F. Mainen, Ph.D.
Optical studies of synaptic plasticity mechanisms
Cold Spring Harbor Laboratory
Paid $60,500

Kelsey C. Martin, M.D., Ph.D.
Communication between the synapse and the nucleus during long-lasting synaptic plasticity
University of California-Los Angeles School of Medicine
Paid $60,500

Margaret E. McLaughlin, M.D.
Effects of heterotypic cell interactions and blood-borne signals on tumors of the nervous system
Massachusetts Institute of Technology
Approved $116,000 Paid $29,000
($384,000 approved for future faculty appointment)

Kelle H. Moley, M.D.
Glucose transport and apoptosis in blastocysts from diabetic mice
Washington University School of Medicine
Paid $121,000

James M. Olson, M.D., Ph.D.
NeuroD abrogation in neuroblastoma
University of Washington School of Medicine
Paid $57,750

Catherine L. Peichel, Ph.D.
Genetic and molecular basis of reproductive isolation of threespine sticklebacks
Stanford University School of Medicine
Approved $58,000
($442,000 approved for future faculty appointment)

Thomas T. Perkins, Ph.D.
Measurements of single DNA-based molecular motors
University of Colorado-Boulder
Approved $395,885 Paid $131,000
($386,000 of original award to Stanford University was transferred/cancelled)

Samuel J. Pleasure, M.D., Ph.D.
Molecular control of cell fate in the dentate gyrus
University of California-San Francisco School of Medicine
Paid $127,500

Matthew H. Porteus, M.D., Ph.D.
Regulation of gene targeting in vertebrate somatic cells
California Institute of Technology
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Salman T. Qureshi, M.D.
Genetic analysis of innate resistance to bacterial pathogens
Yale University School of Medicine
Paid $30,800

Jill Rafael, Ph.D.
Role of muscle proteins in synaptic structure and neuromuscular disease
Ohio State University College of Medicine and Public Health
Paid $65,500

Douglas N. Robinson, Ph.D.
Studies of the mechanisms of cytokinesis using *Dictyostelium*
Johns Hopkins University School of Medicine
Paid $193,000

Aimee K. Ryan, Ph.D.
Analysis of inductive events responsible for specification and differentiation of the anterior pituitary gland
McGill University
Paid $57,750

Bernardo L. Sabatini, M.D., Ph.D.
Role of localized biochemical signaling in the regulation of synaptic function and spine morphogenesis
Harvard Medical School
Paid $131,000

Stephen W. Santoro, Ph.D.
Directed evolution of natural and unnatural proteins and oligomers for gene manipulation, drug discovery, and biochemical investigation
Scripps Research Institute
Approved $58,000
($442,000 approved for future faculty appointment)

Bradley L. Schlaggar, M.D., Ph.D.
Development of cognition: fMRI studies
Washington University School of Medicine
Approved $500,000 Paid $29,000

Maria A. Schumacher, Ph.D.
Structural biology of cell growth, development, and regulation
Oregon Health & Science University
Paid $58,000

Kristin E. Scott, Ph.D.
Taste representation in *Drosophila* brain
Columbia University College of Physicians and Surgeons
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Nirao M. Shah, Ph.D.
Genetic analysis of neural circuits mediating sexually dimorphic behaviors in mammals
Columbia University College of Physicians and Surgeons
Paid $31,500

Krishna V. Shenoy, Ph.D.
Early reach plans in posterior parietal cortex
Stanford University
Approved $386,000 Paid $127,500
($386,000 of original award to the California Institute of Technology was transferred/cancelled)

Donald C. Sheppard, M.D.
Isolation and characterization of genes involved in morphogenesis and virulence of *Aspergillus fumigatus*
University of California-Los Angeles School of Medicine
Approved $116,000
($384,000 approved for future faculty appointment)

Elaine K. Sia, Ph.D.
Analysis of yeast mutants with altered simple repeat stability
University of Rochester
Approved $34,637 Paid $121,000

Upinder Singh, M.D.
Transcriptional control in *Entamoeba histolytica*
Stanford University School of Medicine
Paid $118,250

Douglas E. Smith, Ph.D.
Single molecular studies of viral DNA packaging
University of California-San Diego
Paid $193,000
($92,500 of original award to the University of California-Berkeley was transferred/cancelled)

Theodore S. Steiner, M.D.
Isolation and characterization of an interleukin 8 releasing protein from enteroaggregative *Escherichia coli*
University of British Columbia Faculty of Medicine
Paid $124,000

Xin Sun, Ph.D.
Understanding the endoderm in organogenesis and regeneration
University of California-San Francisco
Paid $29,500

Surachai Supattapone, M.D., D.Phil.
Structure and biology of a soluble prion
Dartmouth Medical School
Approved $20,308 Paid $118,250

Roger B. Sutton, Ph.D.
Biophysical and structural investigation of Ca^{+2} in neurotransmitter release
University of Texas Medical Branch-Galveston
Paid $131,000
($31,500 of original award to Stanford University was transferred/cancelled)

Susanne J. Szabo, Ph.D.
T-bet, a novel T-box transcription factor that directs T-helper cell type 1 lineage commitment
Harvard School of Public Health
Paid $31,500

Sarah A. Tishkoff, Ph.D.
Molecular sequence variation in G6PD and its role in malarial resistance
University of Maryland-College Park
Approved $3,500 Paid $121,750

Heidi A. Tissenbaum, Ph.D.
Genetic and molecular analysis of genes controlling longevity in *Caenorhabditis elegans*
University of Massachusetts Medical School
Paid $127,500

Stephen H. Tsang, M.D., Ph.D.
Unraveling genetic pathways leading to cell death in mice lacking the gamma subunit of the cGMP phosphodiesterase
University of California-Los Angeles School of Medicine
Paid $61,000

John B. Wallingford, Ph.D.
Molecular control of cell motility during vertebrate gastrulation
University of California-Berkeley
Approved $58,000
($442,000 approved for future faculty appointment)

Johannes Walter, Ph.D.
Characterization of eukaryotic replication initiation factors using a soluble, cell-free system
Harvard Medical School
Paid $60,500

Michael M. Wang, M.D., Ph.D.
Estrogen receptors and neuroprotection against excitotoxic injury
Johns Hopkins University School of Medicine
Paid $31,500

Anthony P. West, Ph.D.
Identification of the natural ligand of methuselah, a *Drosophila* GPCR associated with extended life span
California Institute of Technology
Paid $61,000

Carmen J. Williams, M.D., Ph.D.
Signal transduction mechanisms during mouse egg activation
University of Pennsylvania School of Medicine
Paid $118,250

Michael B. Yaffe, M.D., Ph.D.
Scaffolding and chaperone proteins in signal transduction: 14-3-3 regulation of mitosis and programmed cell death
Massachusetts Institute of Technology
Paid $124,000

Deborah L. Yelon, Ph.D.
Patterning during organogenesis: genetic analysis of cardiac chamber formation
New York University School of Medicine
Paid $127,500

Jennifer A. Zallen, Ph.D.
Molecular analysis of dynamic cell rearrangements in *Drosophila*
Princeton University
Approved $116,000
($384,000 approved for future faculty appointment)

Yanping Zhang, Ph.D.
ARF-MDM-p53 tumor suppression pathway
University of Texas M.D. Anderson Cancer Center
Paid $255,000

Karen M. Zito, Ph.D.
Regulation of synapse formation in the mammalian cortex
Cold Spring Harbor Laboratory
Approved $58,000 Paid $29,000
($442,000 approved for future faculty appointment)

Subtotals
Approved: **$11,295,638**
Paid: **$9,626,284**
Transferred/Cancelled: **$3,205,500**

Career Awards Collaborative Grants

Louis J. Muglia, M.D., Ph.D.
Glucocorticoid effects of T-cell development
Washington University School of Medicine
Paid $24,044

Matthew Redinbo, Ph.D.
Structural genomics: high-throughput methods and human nuclear receptors
University of North Carolina-Chapel Hill
Paid $19,520

Konstantin V. Severinov, Ph.D.
Two sessions for the 2003 FASEB summer conference on transcription in prokaryotes
Rutgers, the State University of New Jersey-New Brunswick
Approved $8,400

Upinder Singh, M.D.
Genomic approaches to investigating *Entamoeba histolytica* pathogenesis
Stanford University School of Medicine
Paid $25,000

Subtotals
Approved: **$8,400**
Paid: **$68,564**

Hitchings-Elion Fellowships

Shawn C. Ahmed, Ph.D.
Genetics of germline immortality in *Caenorhabditis elegans*
University of North Carolina-Chapel Hill
Approved $52,000 Paid $52,000
($49,000 of original award to the Medical Research Council was transferred/cancelled)

Catherine Baty, D.V.M., Ph.D.
Feline familial hypertrophic cardiomyopathy: a natural model of human familial hypertrophic cardiomyopathy
Medical University of South Carolina
Approved $49,000 Paid $24,500
($49,000 of original award to the University of Oxford was transferred/cancelled)

Michael W. Black, Ph.D.
Secretion-dependent regulation of ribosome synthesis in *Saccharomyces cerevisiae*
California Polytechnic State University
Approved $223,500 Paid $94,250
($223,500 of original award to the Medical Research Council was transferred/cancelled)
Medical Research Council
Approved $4,500

Tamara Caspary, Ph.D.
Identification and characterization of novel genes involved in mammalian sex determination
Memorial Sloan-Kettering Cancer Center
Paid $60,000

John W. R. Copeland, Ph.D.
Activation of SRF actin remodelling proteins
Imperial Cancer Research Fund
Paid $57,750

Aaron R. Dinner, Ph.D.
Molecular mechanism of free radical oxidative DNA damage
University of California-Berkeley
Approved $58,500 Paid $30,750
($228,125 of original award to the University of Oxford was transferred/cancelled)
University of Oxford
Approved $9,216 Paid $9,216
($228,125 approved for future faculty appointment)

Daniel Durocher, Ph.D.
Role of FHA domains during DNA damage signaling
University of Toronto
Approved $226,500 Paid $97,250
($14,714 of award to the University of Toronto was transferred/cancelled to cover expenses at former institution)
($288,000 of original award to the University of Cambridge was transferred/cancelled)
University of Cambridge
Approved $14,714 Paid $14,714

Francine Durocher, Ph.D.
Identifying common low penetrance genes and gene-environment interactions in breast cancer
Laval University
Approved $52,000 Paid $52,000

John T. Finn, Ph.D.
Cell-cycle control of cell number in the retina
University College London School of Medicine
Approved $2,569 Paid $2,569

Alan J. Herr, Ph.D.
Probing the pathway of RNA-mediated defense with viral suppressor genes
Sainsbury Laboratory
Paid $55,500

Steven L. Kazmirski, Ph.D.
Computational analysis of ATP-dependent motor proteins that are involved in the loading of DNA polymerase clamps onto DNA during DNA replication
Rockefeller University
Paid $27,750

Kenro Kusumi, Ph.D.
Notch pathway patterning of the mammalian brain and skeleton
University of Pennsylvania School of Medicine
Paid $77,500

Jonathan K. Pritchard, Ph.D.
Population structure and linkage disequilibrium in association mapping
University of Chicago
Approved $223,500 Paid $94,250
($223,500 of original award to the University of Oxford was transferred/cancelled)

Steven P. Smith, Ph.D.
Interactions of granulocyte-colony-stimulating factor with its receptor at the molecular level
Queen's University
Approved $52,000 Paid $52,000

Dean G. Tang, M.D., Ph.D.
Role of cell cycle components in timing the oligodendrocyte precursor cell differentiation and senescence
University of Texas M.D. Anderson Cancer Center
Paid $24,500

Joseph Terwilliger, Ph.D.
Mathematical analysis of complex disease
Columbia University
Approved $6,986 Paid $6,986

Subtotals
Approved: **$1,203,110**
Paid: **$833,485**
Transferred/Cancelled: **$1,075,839**

Research Travel Grants

Mark S. Kindy, Ph.D.
Identification of the serum amyloid A receptor: role in inflammation
University of Kentucky College of Medicine
Paid $9,480

Subtotal
Paid: **$9,480**

Life Sciences Research Fellowships

These fellowships were administered in partnership with the Life Sciences Research Foundation (LSRF). BWF awarded the primary grant to the LSRF, which distributes the funds to the individual awardees.

Ryan B. Case, Ph.D.
Biophysical analysis of 13S *Xenopus* condensin
University of California-Berkeley
Paid $41,000

Douglas J. Guarnieri, Ph.D.
Characterization of a *Drosophila* neuropeptide receptor involved in ethanol-induced behavior
University of California-San Francisco
Paid $41,000

Diane McFadden, Ph.D.
Characterization of *O*-acetylated carbohydrate epitopes on *Cryptococcus neoformans*
Albert Einstein College of Medicine
Paid $41,000

Scott T. R. Walsh, Ph.D.
Molecular recognition studies of human placental lactogen
University of Chicago
Paid $41,000

Robert T. Wheeler, Ph.D.
Creating a diversity of cell surface adhesin molecules in fungal pathogenesis
Massachusetts Institute of Technology
Paid $41,000

Subtotal Paid: **$205,000**

Reproductive Science
Obstetrics and Gynecology Research Fellowships

Angeles A. Alvarez, M.D.
Charles Hammond, M.D.
Regulation of angiogenesis in ovarian cancer and development of anti-angiogenesis therapy
Duke University Medical Center
Paid $51,000

Oliver Dorigo, M.D.
Development of a novel gene transfer system using gutless hybrid adeno-Epstein-Barr virus for prolonged transgene expression
University of California-Los Angeles School of Medicine
Paid $61,000

Subtotal Paid: **$112,000**

Other Grants

In addition to making competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted area.

Career Development of Postdoctoral Scientists

American Association for the Advancement of Science
Support for a panel discussion titled "Help for your academic job search"
Approved $3,000 Paid $3,000

American Society for Cell Biology
Support for the society's annual meeting
Approved $3,600 Paid $3,200

American Society of Primatologists
Support for the society's Young Investigator Award
Approved $10,000 Paid $10,000

Commission on Professionals in Science and Technology
Support for general activities
Approved $3,500 Paid $3,500

Duke University Medical Center
Support for a psychiatry and behavioral sciences convocation
Approved $750 Paid $750

Harvard Medical School
Support for a study of substance abuse, anabolic steroid use, and psychiatric disorders
Approved $7,000 Paid $7,000

Marine Biological Laboratory
Support for the course titled "Frontiers in Reproduction"
Paid $128,125

National Academy of Sciences
Support for a survey to determine postdoctoral working conditions
Approved $10,000 Paid $10,000

National Institute of Environmental Health Sciences
Support for a biomedical science fair
Approved $1,500 Paid $1,500

Society for Neuroscience
Support for postdoctoral travel awards for the society's annual meeting
Approved $10,000 Paid $10,000

Society for the Study of Reproduction
Support for a lecturer at the society's annual meeting
Approved $1,500 Paid $1,500

Society of Toxicology
Support for graduate travel awards for the society's annual meeting
Approved $5,000 Paid $5,000

University of California-San Francisco School of Medicine
Support for the study of the mechanism involved in vascular mimicry in ovarian cancer
Approved $240,000 Paid $160,000

University of California-San Francisco School of Medicine
Support for the Reproductive Scientist Development Program
Paid $80,000

University of North Carolina-Chapel Hill School of Medicine
Support for a symposium on grant writing, sponsored by the University of North Carolina Postdoctoral Association
Approved $2,500 Paid $2,500

University of Pennsylvania School of Medicine
Support for laboratory equipment, planning and evaluation, and operating the "Frontiers in Reproduction" course
Approved $5,500 Paid $42,375

Subtotals Approved: **$303,850**
Paid: **$468,450**

Totals
- Approved: $5,707,469
- Paid: $5,414,007
- Transferred/Cancelled: $1,555,000

Investigators in Pathogenesis of Infectious Disease

Barbara A. Burleigh, Ph.D.
Functional characterization of the role of the host cell fibrogenic response in *Trypanosoma cruzi* infection
Harvard School of Public Health
Approved $400,000 Paid $40,000

Zhijian J. Chen, Ph.D.
Role of TRAF5-regulated IKK activators in innate immunity
University of Texas Southwestern Medical Center-Dallas
Approved $400,000 Paid $40,000

Maurizio Del Poeta, M.D.
Role of inositol phosphoryl ceramide synthase 1 (IPC1) in fungal-host interaction
Medical University of South Carolina College of Medicine
Approved $400,000 Paid $40,000

Heidi Goodrich-Blair, Ph.D.
Pathogenesis of *Xenorhabdus nematophilus* in insects: a model for the innate immune response to bacterial pathogens
University of Wisconsin-Madison
Approved $400,000 Paid $40,000

David B. Haslam, M.D.
Mechanisms of Shiga toxin translocation and intoxication within host cells
Washington University School of Medicine
Approved $400,000 Paid $40,000

Margarethe J. Kuehn, Ph.D.
Toxin trafficking via vesicles
Duke University Medical Center
Approved $400,000 Paid $40,000

C. Erec Stebbins, Ph.D.
Structural studies of bacterial virulence factors
Rockefeller University
Approved $400,000 Paid $40,000

Ren Sun, Ph.D.
Identification of cellular factors that determine the fate of herpes virus infection: latency versus lytic replication
University of California-Los Angeles School of Medicine
Approved $400,000 Paid $40,000

Chloe L. Thio, M.D.
Identification of human genes associated with hepatitis B virus outcomes
Johns Hopkins University School of Medicine
Approved $400,000 Paid $40,000

Subtotals
- Approved: **$3,600,000**
- Paid: **$360,000**

New Initiatives in Malaria Research Awards

Russ B. Altman, M.D., Ph.D.
Knowledge base of biological function for malaria
Stanford University School of Medicine
Paid $100,000

Scott D. Bohle, Ph.D.
McGill University
Peter W. Stephens, Ph.D.
State University New York-Stony Brook
Interaction of the quinoline antimalarials and malaria pigment
Approved $269,003
($50,000 of original award to the University of Wyoming was paid; $200,000 of original award to the University of Wyoming was transferred/cancelled)

Jon C. Clardy, Ph.D.
Inhibitors of dihydroorotate dehydrogenase for malaria treatment
Cornell University
Paid $50,000

Fred E. Cohen, M.D., D.Phil.
University of California-San Francisco
Joseph L. Derisi, Ph.D.
University of California-San Francisco School of Medicine
Functional genomics approach to identification of new antimalarial drug targets
Paid $100,000

David A. Fidock, Ph.D.
William R. Jacobs, Ph.D.
Albert Einstein College of Medicine
Molecular genetic analysis of *Plasmodium falciparum*
Paid $50,000

Partho Ghosh, Ph.D.
Structural studies of *Plasmodium falciparum* histidine-rich protein 2
University of California-San Diego
Paid $25,000

Daniel E. Goldberg, M.D., Ph.D.
Washington University School of Medicine
Walter H. Lewis, Ph.D.
Washington University
Optimizing the search for new antimalarial therapeutics
Paid $100,000

Philippe Gros, Ph.D.
Mary M. Stevenson, Ph.D.
Genetic and functional dissection of susceptibility to malaria
McGill University Faculty of Medicine
Paid $50,000

Timothy A. J. Haystead, Ph.D.
Mining the malarial purine-binding proteome for novel drugs and their targets
Duke University Medical Center
Paid $100,000

Anthony A. James, Ph.D.
Genetic control of anopheline vectors
University of California-Irvine
Paid $50,000

Keith A. Joiner, M.D.
Mechanism of hemoglobin uptake in malaria
Yale University School of Medicine
Paid $100,000

Kami Kim, M.D.
Vern L. Schramm, Ph.D.
Genetic dissection of purine salvage pathways in *Plasmodium*
Albert Einstein College of Medicine
Paid $50,000

Michael A. Marletta, Ph.D.
Heme detoxification in *Plasmodium*
University of California-Berkeley
Approved $100,000 Paid $50,000
($100,000 of original award to the University of Michigan College of Pharmacy was transferred/cancelled)

James A. Martiney, Ph.D.
Kenneth S. Warren Laboratories
Paul D. Roepe, Ph.D.
Georgetown University
Single-cell photometric analysis of drug-resistant malaria
Paid $35,000

Stewart H. Shuman, M.D., Ph.D.
Targeting of mRNA cap formation for treatment of malaria
Sloan-Kettering Institute
Paid $50,000

Akhil B. Vaidya, Ph.D.
Plasma membrane proton pumps in malaria parasites
Drexel University College of Medicine
Paid $50,000

Subtotals
Approved: **$369,003**
Paid: **$1,010,000**
Transferred/Cancelled: **$300,000**

New Investigator Awards in Molecular Parasitology

Michael Cappello, M.D.
Molecular pathogenesis of hookworm anemia
Yale University School of Medicine
Paid $35,000

Vernon B. Carruthers, Ph.D.
Defining the proteome of toxoplasma secretory proteins
Johns Hopkins University Bloomberg School of Public Health
Paid $70,000

Daniel J. Eichinger, Ph.D.
Control of encystation-specific gene expression in *Entamoeba*
New York University School of Medicine
Paid $70,000

Theresa Gaasterland, Ph.D.
Comparative genome annotation of *Plasmodium falciparum*, *Leishmania major*, and *Trypanosoma brucei*
Rockefeller University
Paid $70,000

Silvia N. J. Moreno, Ph.D.
Pyrophosphate metabolism in *Toxoplasma gondii*
University of Illinois at Urbana-Champaign College of Veterinary Medicine
Paid $35,000

Barbara Papadopoulou, Ph.D.
Functional genomics of stage-specific gene expression in the kinetoplastid protozoan *Leishmania donovani*
Laval University Faculty of Medicine
Paid $70,000

Christian Tschudi, Ph.D.
Function of cis-splicing in trypanosome RNA
Yale University School of Medicine
Paid $70,000

Gary E. Ward, Ph.D.
Chemical genetic approach to the study of host cell invasion by *Toxoplasma gondii*
University of Vermont College of Medicine
Paid $70,000

Subtotal Paid: **$490,000**

New Investigator Awards in Molecular Pathogenic Mycology

J. Andrew Alspaugh, M.D.
Signal transduction and pathogenicity of *Cryptococcus neoformans*
Duke University Medical Center
Paid $70,000

Gary M. Cox, M.D.
Antisense repression in *Cryptococcus neoformans*
Duke University Medical Center
Paid $35,000

Tamara L. Doering, M.D., Ph.D.
Mechanisms of capsule biosynthesis in *Cryptococcus neoformans*
Washington University School of Medicine
Paid $70,000

Scott G. Filler, M.D.
Stimulation of endothelial cells in *Candida albicans*
University of California-Los Angeles School of Medicine
Paid $35,000

Ashraf S. Ibrahim, Ph.D.
Molecular genetics approach for studying the role of iron permease in the virulence of *Rhizopus oryzae*
University of California-Los Angeles School of Medicine
Paid $70,000

Patrick J. Keeling, Ph.D.
Early infection and adaptation to intracellular parasitism in *Microsporidia*
University of British Columbia
Paid $70,000

Jose L. Lopez-Ribot, Pharm.D., Ph.D.
Gene and protein expression profiling in *Candida albicans* biofilms
University of Texas Health Science Center-San Antonio
Paid $70,000

Neal F. Lue, M.D., Ph.D.
Functional analysis of telomerase components in *Candida albicans*
Weill Medical College of Cornell University
Paid $70,000

Anita Sil, M.D., Ph.D.
Genetic analysis of pathogenesis in *Histoplasma capsulatum*
University of California-San Francisco School of Medicine
Paid $35,000

Alan G. Smulian, M.B., B.Ch.
Role of MAP kinase Mkp1 in the regulation of cell wall synthesis in *Pneumocystis carinii*
University of Cincinnati College of Medicine
Paid $35,000

Jon Woods, M.D., Ph.D.
Antisense regulation of a protein kinase gene in *Histoplasma capsulatum*
University of Wisconsin Medical School
Paid $70,000

Subtotal Paid: **$630,000**

Scholar Awards in Molecular Parasitology

Alan A. Aderem, Ph.D.
Macrophage responses to *Leishmania* infection
University of Washington-Institute for Systems Biology
Paid $85,000

Norma W. Andrews, Ph.D.
Role of lysosome exocytosis in the cell invasion mechanism of *Trypanosoma cruzi*
Yale University School of Medicine
Paid $80,000

Paul J. Brindley, Ph.D.
Schistosome transgenesis
Tulane University School of Public Health and Tropical Medicine
Paid $85,000

Daniel E. Goldberg, M.D., Ph.D.
Hemoglobin metabolism in *Plasmodium falciparum*
Washington University School of Medicine
Paid $60,000

Patricia J. Johnson, Ph.D.
Investigation of potential chemotherapeutic targets and the pathogenesis of the human-infective parasite *Trichomonas vaginalis*
University of California-Los Angeles School of Medicine
Paid $60,000

Scott M. Landfear, Ph.D.
Biology of membrane transporters in *Leishmania* parasites
Oregon Health Sciences University School of Medicine
Paid $60,000

Marc Ouellette, Ph.D.
Functional genomics of drug resistance in *Leishmania*
Laval University Faculty of Medicine
Paid $85,000

Edward J. Pearce, Ph.D.
Role of the TGF-ß superfamily in host signaling to schistosomes
University of Pennsylvania School of Veterinary Medicine
Approved $255,000 Paid $42,500
($42,500 of original grant to the Cornell University College of Veterinary Medicine was paid; $255,000 of original award to the Cornell University College of Veterinary Medicine was transferred/cancelled)

Margaret A. Phillips, Ph.D.
Design of inhibitors for *Trypanosoma brucei* ornithine decarboxylase using a combination of structure-based approaches and combinatorial chemistry
University of Texas Southwestern Medical Center-Dallas
Paid $85,000

David S. Roos, Ph.D.
Exploring the function of the apicomplexan plastid
University of Pennsylvania
Paid $80,000

L. David Sibley, Ph.D.
Molecular pathogenesis in toxoplasmosis
Washington University School of Medicine
Paid $85,000

Samuel L. Stanley, M.D.
Pathways for amoebic induction of inflammation and programmed cell death
Washington University School of Medicine
Paid $85,000

Subtotals
Approved: **$255,000**
Paid: **$935,000**
Transferred/Cancelled: **$255,000**

Scholar Awards in Molecular Pathogenic Mycology

Martin Bard, Ph.D.
Characterization of new target sites for antifungal intervention in the *Candida albicans* ergosterol pathway
Indiana University-Purdue University at Indianapolis
Paid $85,000

Judith Berman, Ph.D.
Use of *Saccharomyces cerevisiae* to study molecular mechanisms of *Candida albicans* pathogenicity
University of Minnesota
Paid $60,000

Joseph Heitman, M.D., Ph.D.
Signal transduction pathways regulating virulence of *Cryptococcus neoformans*
Duke University Medical Center
Paid $80,000

Alexander D. Johnson, Ph.D.
Analysis of a mating-type-like locus in *Candida albicans*
University of California-San Francisco School of Medicine
Paid $40,000

Elizabeth J. Keath, Ph.D.
Novel molecular and DNA vaccine approaches to *Histoplasma capsulatum*
Saint Louis University
Paid $80,000

James W. Kronstad, Ph.D.
Temperature-regulated and infection-regulated gene expression in *Cryptococcus neoformans*
University of British Columbia
Paid $85,000

Stuart M. Levitz, M.D.
Use of molecular biology to identify *Cryptococcus neoformans* antigens that stimulate cell-mediated immunity
Boston University School of Medicine
Paid $80,000

Aaron P. Mitchell, Ph.D.
Analysis of the *Candida* CaRIM transduction pathway
Columbia University College of Physicians and Surgeons
Paid $60,000

Carol S. Newlon, Ph.D.
Analysis of chromosome structure and function in the pathogenic basidiomycete *Cryptococcus neoformans*
University of Medicine and Dentistry of New Jersey
Paid $85,000

Peter A. B. Orlean, Ph.D.
Glycolipid anchoring of protein and wall biogenesis in fungal pathogens
University of Illinois at Urbana-Champaign
Paid $40,000

Michael P. Snyder, Ph.D.
Analysis of morphogenic differentiation in *Candida albicans*
Yale University
Paid $85,000

Paula Sundstrom, Ph.D.
Global regulatory circuits and candidiasis
Ohio State University College of Medicine and Public Health
Paid $85,000

Subtotal { Paid: **$865,000**

Other Grants

In addition to making competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

General

American Association of Immunologists
Support for a symposium titled "Immunology Memory"
Approved $7,500 Paid $7,500

American Society for Microbiology
Support for a meeting titled "Immunity to Bacterial, Viral, and Protozoal Pathogens"
Approved $10,000 Paid $10,000

American Society of Tropical Medicine and Hygiene (ASTMH)
Support for a BWF-ASTMH Fellowship in Tropical Infectious Diseases
Approved $156,000 Paid $52,000

American Society of Tropical Medicine and Hygiene
Support for the society's annual meeting
Approved $20,000 Paid $20,000

American Type Culture Collection
Support for developing the CD-ROM that accompanied the *Nature* malaria genome issue
Approved $25,000 Paid $25,000

Birmingham-Southern College
Support for an annual lecture on infectious diseases, made on behalf of BWF Board Member, Gail Cassell, Ph.D.
Approved $4,000 Paid $4,000

CDC Foundation
Support for the International Conference on Emerging Infectious Diseases
Approved $2,500 Paid $2,500

Columbia University
Support for a meeting of *Candida albicans* genome annotators
Approved $5,000 Paid $5,000

Duke University
Support for the United States-United Kingdom Exchange Program reunion and review meeting
Paid $20,000

Duke University Medical Center
Support for the Duke/Oxford Pediatric Exchange Program for 2003
Approved $7,500 Paid $7,500

Foundation for Advanced Education in the Sciences
Support for the BWF/NIAID/Biology of Parasitic Infection lecture series
Approved $5,000 Paid $5,000

Gordon Research Conferences
Support for the conference titled "Biology of Host-Parasite Interactions"
Approved $5,000 Paid $5,000

Gordon Research Conferences
Support for the FASEB summer research conference titled "Microbial Toxins and Pathogenicity"
Approved $7,500 Paid $7,500

Gordon Research Conferences
Support for the conference titled "Cellular and Molecular Mycology"
Approved $1,000 Paid $1,000

Indiana University-Purdue University at Indianapolis
Support for the Midwest Microbial Pathogenesis Meeting
Approved $4,000 Paid $4,000

Institute for Genomic Research
Support for the Rodent Malaria Genomics Symposium
Approved $2,500 Paid $2,500

Institute for Genomic Research
Support for the *Plasmodium falciparum* genome annotation meeting
Approved $11,248 Paid $11,248

Johns Hopkins University Bloomberg School of Public Health
Support for the Wellcome Trust/BWF Infectious Diseases Initiative
Approved $501,324 Paid $162,519

Marine Biological Laboratory
Support for the Molecular Mycology: Current Approaches to Fungal Pathogenesis course
Approved $170,000

Marine Biological Laboratory
Support for the Biology of Parasitism course
Paid $150,000

National Academy of Sciences
Support for the Institute of Medicine's Forum on Emerging Infections
Approved $25,000 Paid $25,000

North Carolina State Museum of Natural Science
Support for "The Genomic Revolution" traveling exhibit
Approved $5,000 Paid $5,000

Stanford Genome Technology Center
Support for Eula Fung of Stanford University to attend the International Conference on *Cryptococcus* and *Cryptococcosis*
Approved $2,000 Paid $2,000

Wellcome Trust
Support for the Wellcome Trust/BWF Infectious Diseases Initiative ($1,000,000 of the original award was transferred/cancelled)

Yale University
Support for the Wellcome Trust/BWF Infectious Diseases Initiative 2000
Approved $506,394 Paid $171,504

Subtotals Approved: **$1,483,466**
Paid: **$705,771**
Transferred/Cancelled: **$1,000,000**

Molecular Parasitology

Monash University
Support for an integrated *Plasmodium* genome database
Paid $71,103

University of Pennsylvania
Support for an integrated *Plasmodium* genome database
Paid $262,133

Subtotal: Paid: **$333,236**

Pathogenic Mycology

Marine Biological Laboratory
Support for the Molecular Mycology: Current Approaches to Fungal Pathogenesis course
Paid $85,000

Subtotal Paid: **$85,000**

Totals { Approved: $4,451,649
Paid: $5,368,432
Transferred/Cancelled: $290,000

Career Awards at the Scientific Interface

Michael B. Elowitz, Ph.D.
In vivo modeling: a synthetic approach to regulatory networks
Rockefeller University
Approved $148,000 Paid $84,000
($390,000 approved for future faculty appointment)

Lisa J. Lapidus, Ph.D.
Dynamics of polypeptides from measurement of intramolecular contact formation
Stanford University
Approved $40,000
($390,000 of original award approved for future faculty appointment; $40,000 for the future faculty appointment was transferred/cancelled)

Patrick W. Nelson, Ph.D.
Theoretical study of HIV-1 pathogenesis: from primary infection, through latency, to effective drug therapy or progression to AIDS
University of Michigan-Ann Arbor
Approved $538,000 Paid $84,000

Todd E. Peterson, Ph.D.
Ultrahigh-resolution in vivo imaging
University of Arizona College of Medicine
Approved $148,000 Paid $84,000
($390,000 approved for future faculty appointment)

Jianghong Rao, Ph.D.
Imaging gene expression and protein phosphorylation in living organisms
University of California-Los Angeles
Approved $538,000 Paid $107,600

Ronald S. Rock Jr., Ph.D.
Exploring the protein folding energy landscape at the single molecule level
Stanford University School of Medicine
Approved $148,000 Paid $84,000
($390,000 approved for future faculty appointment)

Brent R. Stockwell, Ph.D.
Chemical profiling of cellular disease states
Massachusetts Institute of Technology
Approved $148,000 Paid $84,000
($390,000 approved for future faculty appointment)

Keith R. Weninger, Ph.D.
Single molecule study of the role of SNARE protein assisted membrane fusion in calcium-triggered neurotransmitter release
Stanford University
Approved $148,000 Paid $84,000
($390,000 approved for future faculty appointment)

Subtotals { **Approved: $4,196,000**
Paid: $611,600
Transferred/Cancelled: $40,000

Functional Genomics Innovation Awards

Listed by names, institutions, and research subjects. These special one-time awards were made in conjunction with the dedication of BWF's building in 2000. BWF also provides support for functional genomics through our other programs.

Christopher B. Burge, Ph.D.
Phillip A. Sharp, Ph.D.
Massachusetts Institute of Technology
Whole genome approaches to pre-mRNA splicing specificity and regulation
Paid $100,000

Wah Chiu, Ph.D.
Baylor College of Medicine
Gregor Eichele, Ph.D.
Max Planck Institute of Experimental Endocrinology
Spatial and temporal database of gene expression patterns of mouse brain
Paid $33,500

Frederick R. Cross, Ph.D.
Eric D. Siggia, Ph.D.
Rockefeller University
Computational and experimental analysis of promoters in the genome of budding yeast
Paid $50,000

Eugene Fiume, Ph.D.
University of Toronto
R. Mark Henkelman, Ph.D.
Hospital for Sick Children
Automated image analysis of genetically modified mice
Approved $185,149 Paid $50,000
($75,000 of original award to the University of Toronto was transferred/cancelled)

Terence T.L. Hwa, Ph.D.
University of California-San Diego
Gene expression profiles based on statistical significance of clustering analysis
Paid $83,750

Ian J. Jackson, Ph.D.
Western General Hospital
Monica J. Justice, Ph.D.
John S. Weber, Ph.D.
Baylor College of Medicine
Mutagenesis of central mouse chromosome 4: a paradigm for functional analysis of mammalian genomes
Paid $75,000

Leonid Kruglyak, Ph.D.
Elaine A. Ostrander, Ph.D.
University of Washington
Mapping cancer susceptibility genes in dogs by linkage disequilibrium
Paid $50,000

Sudhir Kumar, Ph.D.
Arizona State University
Computational genomic analysis to identify and dissect functionally important mutations in protein sequences
Paid $50,000

Gene E. Robinson, Ph.D.
University of Illinois at Urbana-Champaign
Sociogenomics: functional genomic analyses of social behavior with microarrays
Paid $133,333

Alan R. Templeton, Ph.D.
Washington University
Cladistic analyses of epistasis among candidate genes influencing common disease
Paid $50,000

Subtotals
Approved: **$185,149**
Paid: **$675,583**
Transferred/Cancelled: **$75,000**

Institutional Awards at the Scientific Interface

Listed by name of the training program, the institution or consortium conducting the program, and the researchers directing the program.

Cross-Disciplinary Training Program in Biophysical Dynamics
University of Chicago
Stephen J. Kron, M.D., Ph.D.
Norbert F. Scherer, Ph.D.
Paid $500,000

Graduate Program in Quantitative Biology
University of California-San Francisco School of Pharmacy
David A. Agard, Ph.D.
University of California-San Francisco School of Medicine
Ken A. Dill, Ph.D.
University of California-San Francisco School of Pharmacy
Paid $500,000

Interdisciplinary Graduate and Postdoctoral Training Program in Physics, Chemistry, and Biology
Rockefeller University
Albert Libchaber, Ph.D.
Thomas P. Sakmar, M.D.
Paid $136,250

Interdisciplinary Training Program in Brain Science
Brown University
John P. Donoghue, Ph.D.
David Mumford, Ph.D.
Paid $460,952

La Jolla Interfaces in Science Training Program
Consortium of the University of California-San Diego, the Scripps Research Institute, the Salk Institute of Biological Studies, and the San Diego Supercomputing Center; grant administered by the University of California-San Diego
Elizabeth D. Getzoff, Ph.D.
Scripps Research Institute
José N. Onuchic, Ph.D.
University of California-San Diego
Paid $138,546

Program in Computational Biology
Johns Hopkins University
Michael Paulaitis, Ph.D.
George D. Rose, Ph.D.
Johns Hopkins University School of Medicine
Paid $500,000

Program in Computational Molecular Biology
California Institute of Technology
Scott E. Fraser, Ph.D.
Michael L. Roukes, Ph.D.
Paid $125,000

Program in Mathematical and Computational Neuroscience
Boston University
Howard B. Eichenbaum, Ph.D.
Nancy J. Kopell, Ph.D.
Paid $350,000

Program in Mathematics and Molecular Biology
Consortium of 17 laboratories and 12 institutions nationwide; grant administered by Florida State University
Wilma K. Olson, Ph.D.
Rutgers, the State University of New Jersey-New Brunswick
DeWitt L. Sumners, Ph.D.
Florida State University
Paid $500,000

Training Program in Biological Dynamics
Princeton University
John J. Hopfield, Ph.D.
Simon A. Levin, Ph.D.
Paid $500,000

Subtotal { Paid: **$3,710,748**

Other Grants

In addition to making competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Interfaces in Science

American Physical Society
Support for a conference titled "Opportunities in Biology for Physicists"
Approved $10,000 Paid $10,000

American Physiological Society
Support for a conference titled "Physiological Genomics of Cardiovascular Disease: From Technology to Physiology"
Approved $5,000 Paid $5,000

Biophysical Society
Support for a postdoctoral career development session at the society's annual meeting
Approved $5,000 Paid $5,000

Canadian Genetic Diseases Network
Support for the Canadian Bioinformatics Workshop series
Approved $15,000 Paid $15,000

Florida State University
Support for the meeting titled "Modeling across the Scales," which brought together trainees and mentors from BWF's 10 Interfaces institutional training programs
Paid $300,000

Marine Biological Laboratory
Support for course titled "Modeling of Biological Systems: An Interdisciplinary Course"
($175,000 of original award was transferred/cancelled)

Michigan Radio
Support for general activities; made in lieu of an honorarium for Jonathan Alger, speaker at Interfaces meeting held in Santa Fe, New Mexico
Approved $500 Paid $500

Rutgers, the State University of New Jersey-New Brunswick
Support for a Center for Discrete Mathematics and Theoretical Computer Science summer tutorial and a fall workshop focusing on computational and mathematical epidemiology
Approved $35,000 Paid $35,000

Subtotals { Approved: **$70,500**
Paid: **$370,500**
Transferred/Cancelled: **$175,000**

Science and Philanthropy
Ad Hoc Grants

Totals { Approved: $184,700
Paid: $184,700

Communications/Science Writing

American Association for the Advancement of Science
Support for the Mass Media Science
and Engineering Fellows Program
Approved $12,000 Paid $12,000

Council for the Advancement of Science Writing
Support for the New Horizons in Science Briefing
and Traveling Fellowship Program
Approved $25,000 Paid $25,000

Subtotals { **Approved: $37,000**
Paid: $37,000

General Philanthropy

Council on Foundations
Support for general activities
Approved $39,600 Paid $39,600

Fogarty International Center
Support for the center's 35th anniversary symposium
Approved $5,000 Paid $5,000

Foundation Center
Support for general activities
Approved $5,000 Paid $5,000

Friends of the National Library of Medicine
Support for general activities
Approved $2,500 Paid $2,500

Grantmakers in Health
Support for general activities
Approved $5,000 Paid $5,000

Institute of Medicine (IOM)
Support for the institute's Dissemination Fund,
in honor of Ken Shine, Ph.D., president of IOM
Approved $10,000 Paid $10,000

North Carolina Biotechnology Center
Support for the symposium titled "Honoring 15 Years of Vision,
Trust, and Friendship," held in honor of Charles Hamner, Ph.D.
Approved $10,000 Paid $10,000

North Carolina Center for Nonprofits
Support for general activities
Approved $600 Paid $600

North Carolina Community Foundation
Support for the North Carolina Network of Grantmakers
Approved $1,000 Paid $1,000

Sigma Xi, The Scientific Research Society
Support for the forum titled "Changing the Face of Science
and Engineering"
Approved $10,000 Paid $10,000

Triangle Community Foundation
Support for the Stephen D. and Sandra L. Corman
Donor-Advised Fund, made on behalf of BWF board
member, Stephen D. Corman
Approved $20,000 Paid $20,000

Subtotals { **Approved: $108,700**
Paid: $108,700

Science Policy

Life Sciences Research Office
Support for a study to document the trends of scientists conducting integrative science and to determine if the supply of such scientists will meet future demand
Approved $10,000 Paid $10,000

Research!America
Support for the 435 Project, which advocates for increased funding for medical research
Approved $25,000 Paid $25,000

Subtotals Approved: **$35,000**
Paid: **$35,000**

Special Award

Association for Women in Science
Support for the 30th Anniversary Leadership Conference
Approved $2,500 Paid $2,500

Nantucket Conservation Foundation
Support for general activities; made in lieu of an honorarium for Curt Livingston, a member of BWF's Investment Committee
Approved $1,500 Paid $1,500

Subtotals Approved: **$4,000**
Paid: **$4,000**

Totals { Approved: $178,650
Paid: $1,383,532

Student Science Enrichment Program

American Chemical Society, North Carolina Local Section
Summer Educational Experience for the Disadvantaged
Paid $59,900

Campbell University School of Pharmacy
Harnett Central Middle School Science and Technology Enrichment Program
Paid $39,250

Catawba Science Center
Science Technology Enrichment Program
Paid $36,140

Duke University
Design to Learn
Paid $23,532

Duke University
Techtronics: Hands-on Exploration of Technology in Everyday Life
Paid $60,000

Duke University Nicholas School of the Environment and Earth Sciences
Connecting Coastal Communities
Paid $28,053

Durham Public Schools
Bridging Education Science and Technology High School Molecular Research Preparation Course
Approved $26,200 Paid $26,200

Johnson C. Smith University
Intensive Summer Science Camp
Paid $58,897

Lenoir-Rhyne College
Carolina Institute for the Multicultural Approach to Science
Paid $59,996

North Carolina State University
Science and Mathematics Colloquies at the Science House
Paid $57,644

North Carolina State University
Performing Inquiry-Based Exploration: An Example in Using Agricultural Waste and Wastepaper to Produce New Products
Paid $22,200

Pines of Carolina Girl Scout Council
Healthy START-UP: Science and Technology around Research Triangle Park
Paid $59,400

Roanoke Rapids City Schools
Summer Science Explorations in the Roanoke Valley
Approved $20,000 Paid $20,000

Shaw University
Mentoring and Encouraging the Science Skills of Youth
Paid $60,000

Shodor Education Foundation
Stimulating Understanding of Computational Science through Collaboration, Experiment, and Discovery
Paid $59,931

Swain County Schools
Students Involved and Experiencing Nature, Careers in Science, and Environmental Awareness
Paid $26,673

University of North Carolina-Chapel Hill School of Medicine
Scientific Enrichment Opportunities for High School Students
Paid $59,910

Warren Wilson College
Environmental Science Camp
Paid $48,750

Wilmington Children's Museum
Middle School Docents Program
Paid $6,275

Subtotals Approved: **$46,200**
Paid: **$812,751**

Visiting Professorships in the Basic Medical Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of BWF lectures cited if given in fiscal year 2002. BWF's visiting professorships were discontinued following the 2001 award series.

Baylor College of Medicine
Richard A. Crowther, Ph.D.
Medical Research Council (United Kingdom)
Investigating virus structure by electron microscopy: past, present, and future
Paid $5,000

Case Western Reserve University School of Medicine
Susan S. Taylor, Ph.D.
University of California-San Diego
Structure and dynamics of cAMP-dependent protein kinase
Paid $5,000

Central Caribbean University School of Medicine
Anatoli Lopatin, Ph.D.
University of Michigan-Ann Arbor
Polyamines, inward rectifier potassium channels, and cardiac excitability
Paid $5,000

Dalhousie University Faculty of Medicine
Victor Ling, Ph.D.
University of British Columbia Faculty of Medicine
Promise of genomic science in cancer research
Paid $5,000

East Carolina University School of Medicine
David A. Williams, M.D.
Indiana University School of Medicine
RAC and ROLL: the roles of GTPases in blood cell formation and function in mouse and man
Paid $5,000

Harvard Medical School
Mitchell Kronenberg, Ph.D.
La Jolla Institute of Allergy and Immunology Influence of TL, a nonclassical class I molecule, on the mucosal immune system
Paid $5,000

Iowa State University
Helmut Sies, M.D., Ph.D.
University of Dusseldorf (Germany)
Oxidative stress
Paid $5,000

McGill University Faculty of Medicine
Gerard Karsenty, M.D., Ph.D.
Baylor College of Medicine
Genetic analysis of biomineralization
Paid $5,000

Medical College of Wisconsin
Donald A. Fischman, M.D.
Weill Medical College of Cornell University
Cell lineages in the embryonic heart: implications for myocardial and coronary artery development
Paid $5,000

Medical University of South Carolina College of Medicine
Aravinda Chakravarti, Ph.D.
Johns Hopkins University School of Medicine
Genomic variation in human complex diseases
Paid $5,000

Memorial University of Newfoundland Faculty of Medicine
Stephen W. Scherer, Ph.D.
Hospital for Sick Children in Toronto
Human Genome Project: Resources and Reagents for Clinical Studies
Paid $5,000

Morehouse School of Medicine
Alan A. Jackson, M.B., B.Chir., M.D.
University of Southampton (United Kingdom)
Anticipating demands: developing people for a healthy society
Paid $5,000

New York University School of Medicine
Jose M.C. Ribeiro, M.D., Ph.D.
National Institute of Allergy and Infectious Diseases
Drugs from bugs: novel pharmacologically active molecules and novel vaccine targets from saliva of blood-sucking insects and ticks
Paid $5,000

North Dakota State University College of Pharmacy
Maret G. Traber, Ph.D.
Oregon State University
Antioxidants and health with emphasis on the role of vitamin E
Paid $5,000

Oregon State University College of Pharmacy
Frances M. Ashcroft, Ph.D., Sc.D.
University Laboratory of Physiology (United Kingdom)
ATP-sensitive potassium channels and insulin secretion in health and disease
Paid $5,000

Purdue University School of Pharmacy and Pharmacal Sciences
William A. Catterall, Ph.D.
University of Washington School of Medicine
Structure, function, and molecular pharmacology of voltage-gated sodium channels
Paid $5,000

Rutgers, the State University of New Jersey-New Brunswick
Eric Westhof, Ph.D.
University Louis Pasteur (France)
Chemical recognition of aminoglycoside antibiotics by ribosomal RNA fragments
Paid $5,000

Saint Francis Xavier University
John W. Hanrahan, Ph.D.
McGill University
Chloride channels in health and disease
Paid $5,000

Saint Louis University School of Medicine
Ronald C. Conaway, Ph.D.
Joan W. Conaway, Ph.D.
Oklahoma Medical Research Foundation
Elongin BC-based ubiquitin ligases transcriptional regulation
Paid $5,000

Texas A&M University College of Veterinary Medicine
Elaine A. Ostrander, Ph.D.
Fred Hutchinson Cancer Research Center
Genetic mapping and analysis of human cancer susceptibility genes
Paid $5,000

University of California-Los Angeles School of Medicine
Michael A. Farrell, M.B., B.Chir.
Royal College of Surgeons (Republic of Ireland)
Bovine spongiform encephalopathy and new variant Creutzfeldt Jakob disease: clinical, neuropathologic, and epidemiologic considerations of a modern public health crisis
Paid $5,000

University of Colorado-Boulder
Xiao-dong Wang, Ph.D.
University of Texas Southwestern Medical Center-Dallas
Expanding role of mitochondria in apoptosis
Paid $5,000

University of Georgia
Charles J. Billington, M.D.
Minneapolis Veterans Affairs Medical Center
Challenge of obesity: what can we do?
Paid $5,000

University of Miami School of Medicine
Irving L. Weissman, M.D.
Stanford University School of Medicine
Biology of stem and progenitor cells
Paid $5,000

University of Michigan-Dearborn
Ralph M. Garruto, Ph.D.
State University of New York-Binghamton
Search for an understanding of the human condition: kuru, cannibalism, and mad cows
Paid $5,000

University of Minnesota-Duluth School of Medicine
Dean P. Jones, Ph.D.
Emory University School of Medicine
Nutrition, aging, and disease: mitochondrial redox control
Paid $5,000

University of North Carolina-Chapel Hill School of Public Health
Barbara B. Kahn, M.D.
Harvard Medical School
The adipocyte-secreted proteins, leptin and adiponectin, regulate fatty acid metabolism through stimulation of the AMP-activated protein kinase
Paid $5,000

University of Texas Medical Branch-Galveston School of Medicine
Jan-Ake Gustafsson, M.D., Ph.D.
Karolinska Institute (Sweden)
A new paradigm in estrogen signaling provided by the dynamic interplay between ERalpha and ERbeta
Paid $5,000

University of Washington School of Medicine
Leslie A. Leinwand, Ph.D.
University of Colorado-Boulder
Molecular pathways of cardiac and skeletal muscle adaptation
Paid $5,000

University of Western Ontario Faculty of Medicine and Dentistry
John E. Walker, D.Phil.
Medical Research Council (United Kingdom)
Rotary mechanism of ATP synthase
Paid $5,000

University of Wisconsin Medical School
Arturo Casadevall, M.D., Ph.D.
Albert Einstein College of Medicine
Mechanisms of antibody-mediated protection against intracellular fungal and bacterial pathogens
Paid $5,000

Washington State University College of Pharmacy
Lawrence A. Loeb, M.D., Ph.D.
University of Washington School of Medicine
Single greatest killer: tobacco
Paid $5,000

Wright State University School of Medicine
Debra I. Diz, Ph.D.
Wake Forest University School of Medicine
Aldosterone blockade: new insights into cardiovascular protection
Paid $5,000

Subtotal Paid: **$165,000**

Visiting Professorships in the Microbiological Sciences

Listed by host institution, visiting professor, and professor's affiliation. Titles of BWF lectures cited if given in fiscal year 2002. BWF's visiting professorships were discontinued following the 2001 award series.

Davidson College
Raul J. Cano, Ph.D.
California Polytechnic State University
Digging for pathogens: what can ancient DNA teach us about current human diseases?
Paid $5,000

Florida International University
Nicholas Cohen, Ph.D.
University of Rochester School of Medicine and Dentistry
Paid $5,000

Goucher College
Lynn Margulis, Ph.D.
University of Massachusetts-Amherst
From Microcosm to Gaia
Paid $5,000

Louisiana State University
Bonnie L. Bassler, Ph.D.
Princeton University
How bacteria talk to each other: regulation of gene expression by quorum sensing
Paid $5,000

Morehouse School of Medicine
Anthony S. Fauci, M.D.
National Institute of Allergy and Infectious Diseases
AIDS consideration for the 21st century
Paid $5,000

North Carolina Central University
Stuart M. Brown, Ph.D.
New York University Medical Center
Medical genomics
Paid $5,000

Oakland University
Timothy J. Donohue, Ph.D.
University of Wisconsin-Madison
From photons to physiology: deciphering metabolic and regulatory diversity within the purple photosynthetic bacterium *Rhodobacter sphaeroides*
Paid $5,000

University of Guam
William Fenical, Ph.D.
University of California-San Diego
Assessing marine microbial diversity as a new drug discovery resource
Paid $5,000

University of Guelph
Geoffrey M. Gadd, Ph.D.
University of Dundee (United Kingdom)
Microbial influence on metal mobility
Paid $5,000

University of Texas-El Paso
Joseph O. Falkinham III, Ph.D.
Virginia Polytechnic Institute and State University
Pathogens in the environment
Paid $5,000

Wayne State University School of Medicine
Randall K. Holmes, M.D., Ph.D.
University of Colorado Health Sciences Center
Diptheria: an intoxicating tale of medicine, public health, and molecular biology
Paid $5,000

Subtotal Paid: **$55,000**

Other Grants

In addition to making competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the general environment for research in the targeted areas.

Crestline Elementary School
Support for science education activities, made on behalf of BWF Board Member, Gail Cassell, Ph.D.
Approved $1,000 Paid $1,000

Durham Public Education Network
Support for the 2002 Celebration of Education
Approved $150 Paid $150

Georgia Institute of Technology
Support for the scholarship fund for outstanding chemistry students, made on behalf of past BWF Board Member, Jerry Whitten, Ph.D.
Approved $4,000 Paid $4,000

Grantmakers for Education
Support for general activities
Approved $3,000 Paid $3,000

National Association of Academies of Science
Support for a session at the American Association for the Advancement of Science annual meeting to provide high school students an opportunity to interact with scientists
Approved $2,500 Paid $2,500

North Carolina Association for Biomedical Research
Support for general activities
Approved $10,000 Paid $10,000

North Carolina School of Science and Mathematics
Support for general activities, made on behalf of past BWF Board Member, Jerry Whitten, Ph.D.
Approved $1,000 Paid $1,000

North Carolina Science Olympiad
Support for general activities
Approved $2,000 Paid $2,000

North Carolina Society of Hispanic Professionals
Support for the society's annual summit
Approved $1,000 Paid $1,000

North Carolina State University
Support for a series of conferences for representatives from university science departments to discuss K-12 outreach
Paid $90,431

North Carolina State University
Support for the North Carolina Science Leadership Institute
Approved $10,000 Paid $10,000

Public School Forum of North Carolina
Support for an international study program for educational policymakers
Paid $47,900

Public School Forum of North Carolina
Support for the Institute for Educational Policymakers
Paid $75,000

Shodor Education Foundation
Support for the Student Science Enrichment Program Web site
Approved $15,000 Paid $15,000

Shodor Education Foundation
Support for high school students and for teachers from underrepresented schools to attend the National Computational Science Institute
Approved $54,800 Paid $54,800

Teach for America
Support for the Mathematics and Science Initiative for teachers in eastern North Carolina
Approved $8,000 Paid $8,000

University of North Carolina-Chapel Hill
Support for convening a group of experts to help develop the Center for Functional Nanostructures
Paid $5,000

University of North Carolina-Greensboro
Support for planning the Health Science Academy in Pitt County
Approved $20,000 Paid $20,000

Subtotals Approved: **$132,450**
Paid: **$350,781**

Totals { Approved: $5,938,600
Paid: $7,798,600
Transferred/Cancelled: $975,000

Clinical Scientist Awards in Translational Research

During the fiscal year, some award recipients change institutions or modify the terms of their award at their current institution, or both. In these cases, BWF's policy is to cancel the remaining portion of the original award and, as necessary, approve a new award. When the award recipient has changed institutions, the new award is made to the new institution; when the award recipient has not moved but has modified the terms, the new award is made to the current institution. In the following descriptions, the name of the award recipient is listed first, the title of the project is listed second, the award recipient's current institution is listed third, and the amount approved or paid to the institution is listed fourth. For award recipients who either changed institutions or modified their awards, the portion of the award paid to the original institution, as well as any portion that was transferred or cancelled, is listed last, in parentheses.

Sunil K. Ahuja, M.D.
HIV-1 AIDS pathogenesis: bridging the gap between host genotype and HIV transmission/disease phenotype
University of Texas Health Science Center-San Antonio
Paid $150,000

David M. Altshuler, M.D., Ph.D.
Genomic approaches to the genetics of type 2 diabetes and response to antidiabetic medication
Massachusetts General Hospital
Approved $750,000 Paid $75,000

Cameron S. Carter, M.D.
Multimodal brain imaging and the pharmacotherapy of cognitive disability in schizophrenia
University of Pittsburgh School of Medicine
Paid $150,000

Judy H. Cho, M.D.
Characterization of expression patterns in monocyte-derived cells in inflammatory bowel disease
University of Chicago Pritzker School of Medicine
Approved $750,000 Paid $75,000

Gilbert Chu, M.D., Ph.D.
Cancer treatment by genome-wide transcription scanning
Stanford University Medical Center
Paid $150,000

Robert B. Darnell, M.D., Ph.D.
Detection and activation of tumor-specific killer cells in animal models and cancer patients
Rockefeller University
Paid $150,000

Robert W. Doms, M.D., Ph.D.
Chemokine receptors as new targets for HIV-1 therapeutics
University of Pennsylvania School of Medicine
Paid $150,000

Jeffrey A. Drebin, M.D., Ph.D.
Targeted suppression of B-catenin in colorectal cancer
Washington University School of Medicine
Paid $150,000

Brian J. Druker, M.D.
Mechanism-based therapy for chronic myelogenous leukemia
Oregon Health & Science University
Paid $150,000

Erol Fikrig, M.D.
Borrelia gene expression and lyme arthritis
Yale University School of Medicine
Paid $150,000

Barry A. Finette, M.D., Ph.D.
Mechanisms of malignant transformation in humans
University of Vermont College of Medicine
Approved $750,000 Paid $75,000

Glenn I. Fishman, M.D.
Gap junction channels as novel antiarrhythmic targets
New York University School of Medicine
Approved $600,000 Paid $75,000
($75,000 of original award to the Mount Sinai School of Medicine was paid; $600,000 of original award to Mount Sinai School of Medicine was transferred/cancelled)

Thomas F. Gajewski, M.D., Ph.D.
Development of a second-generation melanoma vaccine
University of Chicago Pritzker School of Medicine
Paid $150,000

Lisa M. Guay-Woodford, M.D.
Genetic modifiers in recessive polycystic kidney disease: implications for pathogenesis and therapeutics
University of Alabama-Birmingham School of Medicine
Paid $150,000

Eva Guinan, M.D.
Extending the donor pool by inducing alloantigen specific T-cell anergy ex vivo for human hematopoietic stem cell transplantation
Harvard Medical School
Paid $150,000

Barbara L. Hempstead, M.D., Ph.D.
Growth factor regulation of coronary angiogenesis
Weill Medical College of Cornell University
Paid $150,000

Marshall S. Horwitz, M.D., Ph.D.
Therapeutic inhibition of aberrant protease activity in inherited neutropenias
University of Washington School of Medicine
Paid $150,000

Thomas J. Hudson, M.D.
Genomic approaches to identify genes predisposing to asthma
McGill University Faculty of Medicine
Approved $750,000 Paid $75,000

Daniel C. Javitt, M.D., Ph.D.
NMDA-based treatment development for schizophrenia
New York University School of Medicine
Paid $150,000

Jonathan D. Licht, M.D.
Targeting aberrant repression as a therapeutic strategy in hematological malignancy
Mount Sinai School of Medicine
Approved $750,000 Paid $75,000

Alex E. MacKenzie, M.D., Ph.D.
Cytoprotective NAIP and XIAP genes: identification of activation pathways and inducing agents
University of Ottawa Faculty of Medicine
Paid $150,000

Joseph M. McCune, M.D., Ph.D.
Regulation of human thymic function in vivo
University of California-San Francisco School of Medicine
Paid $150,000

Margaret J. McElrath, M.D., Ph.D.
Induction of cellular immunity in HIV-1 exposed seronegative individuals
University of Washington School of Medicine
Paid $150,000

Elizabeth M. McNally, M.D., Ph.D.
Microvascular spasm in the progression of cardiomyopathy
University of Chicago
Paid $150,000

Hector D. Molina, M.D.
Mechanisms of complement-induced abnormalities in fetomaternal tolerance
Washington University School of Medicine
Approved $750,000 Paid $75,000

Jason D. Morrow, M.D.
Isoprostanes as markers and mediators of oxidant stress in humans
Vanderbilt University Medical Center
Paid $150,000

Anthony J. Muslin, M.D.
Signaling mechanisms in cardiovascular disease
Washington University School of Medicine
Paid $150,000

Mark R. Philips, M.D.
Endomembrane trafficking of Ras: novel molecular targets for anticancer agents
New York University School of Medicine
Paid $150,000

Steven A. Porcelli, M.D.
Defining the protective human CD8+ T-cell response against *Mycobacterium tuberculosis*
Albert Einstein College of Medicine
Paid $150,000

Daniel J. Rader, M.D.
Novel therapeutic approach to atherosclerosis through modulation of HDL metabolism
University of Pennsylvania School of Medicine
Paid $150,000

W. Edward Robinson Jr., M.D., Ph.D.
Structure-function analyses of clinically relevant HIV integrases
University of California-Irvine College of Medicine
Paid $150,000

Don C. Rockey, M.D.
Cellular and molecular basis of portal hypertension: an endothelialopathy in cirrhosis
Duke University Medical Center
Paid $150,000

Howard A. Rockman, M.D.
Novel molecular therapeutic strategies in heart failure: role of beta-adrenergic receptor desensitization
Duke University Medical Center
Paid $150,000

Antony Rosen, M.B., Ch.B.
Altered structure and clearance of autoantigens during apoptosis: implications for autoimmunity
Johns Hopkins University School of Medicine
Paid $150,000

Marc E. Rothenberg, M.D., Ph.D.
Experimental analysis of eosinophil-associated gastrointestinal inflammation
University of Cincinnati College of Medicine
Paid $150,000

David T. Scadden, M.D.
Developing control mechanism-based stem cell therapies
Massachusetts General Hospital
Approved $750,000 Paid $75,000

Christian W. Schindler, M.D., Ph.D.
Intervention of IL-5 signaling: a therapeutic paradigm for asthma
Columbia University College of Physicians and Surgeons
Paid $150,000

Ann Marie Schmidt, M.D.
Novel therapeutic strategy for the prevention and treatment of diabetic complications: antagonism of receptor for advanced glycation end products (RAGE)
Columbia University College of Physicians and Surgeons
Paid $150,000

Joyce M. Slingerland, M.D., Ph.D.
Resistance to tamoxifen: a consequence of altered $p27^{Kip1}$ regulation during breast cancer progression
University of Toronto Faculty of Medicine
Paid $150,000

Dennis J. Templeton, M.D., Ph.D.
Stress signaling inhibitors potentiate genotoxin induced apoptosis in a human colon tumor model
Case Western Reserve University
($375,000 of original award to Case Western Reserve University was transferred/cancelled)

Matthew L. Warman, M.D.
Delineating the proteins and pathways that maintain human joints and their potential for treating heritable and acquired forms of arthritis
Case Western Reserve University School of Medicine
Paid $150,000

Mark J. Yeager, M.D., Ph.D.
Structure and function of cardiac gap junction membrane channels
Scripps Research Institute
Paid $150,000

Subtotals
Approved: **$5,850,000**
Paid: **$5,625,000**
Transferred/Cancelled: **$975,000**

New Investigator Awards in the Pharmacological Sciences

Lee S. Bardwell, Ph.D.
Novel roles for protein-protein interactions in mitogen-activated protein kinase signaling
University of California-Irvine
Paid $35,000

Peter J. Belshaw, Ph.D.
Combinatorial synthesis of nonribosomal peptide-based electrophilic libraries
University of Wisconsin-Madison
Paid $70,000

Anton M. Bennett, Ph.D.
p21Ras signaling by protein tyrosine dephosphorylation
Yale University School of Medicine
Paid $70,000

Graeme W. Davis, Ph.D.
Molecular and genetic analysis of synaptic homeostasis
University of California-San Francisco School of Medicine
Paid $35,000

Pehr A. B. Harbury, Ph.D.
DNA display: in vitro evolution of small molecules
Stanford University School of Medicine
Paid $70,000

Neil L. Kelleher, Ph.D.
Genome-proteome correlations in respiratory pathogens: an experimental approach for identification of new pharmacological targets
University of Illinois at Urbana-Champaign
Paid $70,000

Calvin J. Kuo, M.D., Ph.D.
Physiologic and pathologic roles of vascular endothelial growth factor
Stanford University School of Medicine
Paid $70,000

Andres V. Maricq, M.D., Ph.D.
Dominant activation of neurons: a genetic approach to uncover mechanisms of neuronal signaling and control of behavior
University of Utah
Paid $35,000

Carla Mattos, Ph.D.
Surface features of the Ral GTPase obtained from the multiple solvent crystal structures and from its complex with RalBP1 and calmodulin
North Carolina State University
Paid $70,000

Ram Sasisekharan, Ph.D.
Heparin-like glycosaminoglycans as a target for therapeutic intervention
Massachusetts Institute of Technology
Paid $35,000

David P. Siderovski, Ph.D.
GoLoco motif-derived peptides as selective G-protein "perturbagens"
University of North Carolina-Chapel Hill School of Medicine
Paid $70,000

Scott K. Silverman, Ph.D.
Phototriggered folding approaches to RNA structural motifs and RNA-protein interactions
University of Illinois at Urbana-Champaign
Paid $70,000

Erik J. Sontheimer, Ph.D.
Reversible control of RNA structure with small biarsenical ligands
Northwestern University
Paid $70,000

Natalie C. Strynadka, Ph.D.
Antibiotic discovery targeting essential proteins on the bacterial outer membrane
University of British Columbia Faculty of Medicine
Paid $35,000

Joseph Tsien, Ph.D.
Novel pharmacogenetic approach to neuronal signaling
Princeton University
Paid $70,000

Lu-Yang Wang, Ph.D.
Regulation of synaptic strength by subtype-specific coupling between Ca^{2+} channels and metatropic receptors
University of Toronto Faculty of Medicine
Paid $70,000

Beverly R. Wendland, Ph.D.
New pathways to the cell interior: dominant negative and positive effectors of endocytosis
Johns Hopkins University
Paid $35,000

Hongtao Yu, Ph.D.
Molecular investigation of transitions and checkpoints in mitosis
University of Texas Southwestern Medical Center-Dallas
Paid $70,000

Subtotal { **Paid: $1,050,000**

New Investigator Awards in the Toxicological Sciences

Raffi V. Aroian, Ph.D.
Bacillus thuringiensis toxicity and resistance in nematodes
University of California-San Diego
Paid $70,000

Karlene A. Cimprich, Ph.D.
Exploring DNA damage checkpoints using a cell-free system
Stanford University School of Medicine
Paid $35,000

Virginia W. Cornish, Ph.D.
In vivo screening for enzymatic activity
Columbia University
Paid $70,000

Mohanish P. Deshmukh, Ph.D.
Caspase activation during apoptosis: a novel mechanism of regulation in neurons
University of North Carolina-Chapel Hill School of Medicine
Paid $70,000

Bevin P. Engelward, Sc.D.
Fluorescent detection of loss heterozygosity in mammals
Massachusetts Institute of Technology
Paid $70,000

James M. Ford, M.D.
Transcriptional regulation of damage-inducible DNA repair genes
Stanford University School of Medicine
Paid $70,000

Su Guo, Ph.D.
Mechanism of action of neurotoxins that induce parkinsonism: a molecular genetic study in zebra fish
University of California-San Francisco School of Pharmacy
Paid $70,000

Carla M. Koehler, Ph.D.
Mitochondrial biogenesis in health and disease: assembly of the mitochondrial inner membrane
University of California-Los Angeles
Paid $70,000

Fang Liu, Ph.D.
Role of transforming growth factor-beta-inducible gene regulation in tumorigenesis
Rutgers, the State University of New Jersey College of Pharmacy
Paid $35,000

Anna K. Mapp, Ph.D.
Small molecules for reprogramming gene expression
University of Michigan College of Pharmacy
Paid $70,000

Thomas W. Muir, Ph.D.
Structure-activity analysis of the autoinducing peptides from *Staphylococcus aureus* responsible for virulence
Rockefeller University
Paid $35,000

Tomas A. Prolla, Ph.D.
Genetic characterization of the DNA mismatch repair system in induced mutagenesis
University of Wisconsin-Madison Medical School
Paid $35,000

Terry L. Sheppard, Ph.D.
Chemical toxicology of oxidative DNA damage lesions
Northwestern University
Paid $70,000

Zhengui Xia, Ph.D.
Mechanisms of arsenite neurotoxicity
University of Washington School of Public Health and Community Medicine
Paid $35,000

Subtotal Paid: **$805,000**

Other Grants

In addition to making competitive awards, BWF makes noncompetitive grants for activities that are closely related to our major focus areas. These grants are intended to enhance the environment for research in the targeted areas.

Scholar Awards in Experimental Therapeutics

This program was superceded by the Clinical Scientist Awards in Translational Research.

Jonathan D. Gitlin, M.D.
Mechanisms of cellular copper homeostasis
Washington University School of Medicine
Paid $60,000

Daniel L. Kaufman, Ph.D.
Biopharmaceuticals for the prevention of insulin-dependent diabetes mellitus
University of California-Los Angeles School of Medicine
Paid $60,000

Subtotal Paid: **$120,000**

Scholar Awards in Toxicology

This program was superceded by the New Investigator Awards in the Pharmacological or Toxicological Sciences. The latter program was then discontinued in 2001.

Titia de Lange, Ph.D.
Cell-based assays for telomerase toxicity
Rockefeller University
Paid $60,000

Subtotal Paid: **$60,000**

Translational Research

American Federation for Medical Research
Support for Trainee Travel Awards to the annual meeting
Approved $7,500 Paid $7,500

American Society for Clinical Investigation/Association of American Physicians
Support for the organizations' joint meeting
Approved $2,500 Paid $2,500

American Society for Clinical Nutrition
Support for the National Clinical Nutrition Internship Program
Approved $12,500 Paid $12,500

Clinical Research Alliance
Support for the organization's annual meeting
Approved $50,000 Paid $50,000

Institute of Medicine
Support for the clinical research focus groups of clinical research trainees
Approved $1,100 Paid $1,100

National Academy of Sciences
Support for the Clinical Research Roundtable
Paid $50,000

National Research Council
Support for the workshop titled "Achieving XXcellence in Science: The Role of Professional Societies in Advancing Women's Careers in Science and Clinical Research"
Approved $5,000 Paid $5,000

Weill Medical College of Cornell University
Support for the international symposium titled "Management of Ambiguous Genitalia in the Newborn," made on behalf of Jean Wilson, Ph.D., a member of the BWF Board of Directors
Approved $10,000 Paid $10,000

Subtotals Approved: **$88,600**
Paid: **$138,600**

Information for Applicants

The Burroughs Wellcome Fund makes approximately 90 percent of our grants through competitive award programs, which support investigators in targeted areas of basic scientific research that have relevance to human health.

Most of BWF's award programs are open only to citizens or permanent residents of the United States and Canada. (Programs with different requirements are noted in the descriptions that follow.) Awards are made with the advice of our advisory committees, which comprise scientists and educators selected for their expertise in the program areas. Program application deadlines for the 2003 award series are listed in the "Program Application Deadlines" section on page 73.

Most grants are made only to degree-granting institutions on behalf of individual researchers, who must be nominated by their institution. Institutions receiving grants must be tax-exempt 501(c)(3) organizations. Government agencies, such as the National Institutes of Health and the Centers for Disease Control and Prevention, generally are not eligible for grants.

Throughout the following program descriptions, references to M.D. and Ph.D. degrees include all types of medical and scientific doctoral degrees.

BWF believes that diversity within the scientific community enhances the well-being of the research enterprise; therefore, we encourage applications from women and from members of underrepresented minority groups.

BWF does not support activities that are primarily clinical in nature (such as disease diagnosis and treatment) or primarily related to health care and health care policy. We generally do not provide support for research projects or other activities outside our competitive programs, nor do we generally support endowments, development campaigns, ordinary operating expenses, capital facilities and equipment, or publications.

To obtain the most up-to-date information about our award programs, visit our Web site at www.bwfund.org

Burroughs Wellcome Fund

t 919.991.5100
f 919.991.5160

www.bwfund.org

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Research Triangle Park, NC 27709-3901

Shipping Address:
21 T. W. Alexander Drive
Research Triangle Park, NC 27709

Basic Biomedical Sciences

Career Awards in the Biomedical Sciences
These awards are made in honor of Gertrude B. Elion, D.Sc., and George H. Hitchings, Ph.D., who shared the 1988 Nobel Prize in Physiology or Medicine and were long associated with the Burroughs Wellcome Fund. The awards are intended to foster the development and productivity of biomedical researchers who are early in their careers and to help them make the critical transition to becoming independent investigators. The grants provide $500,000 over five years to bridge advanced postdoctoral training and the first three years of faculty service. Recipients may spend part of the grant period at institutions in the United Kingdom. BWF expects to award up to 20 of these grants annually. Approximately half of the awards will go to researchers with a Ph.D. degree and half to those with an M.D. or M.D.-Ph.D. degree. Candidates must have completed at least 12 months but not more than 48 months of postdoctoral research training by the application deadline. For candidates with M.D. degrees, postdoctoral training excludes clinically oriented residencies that do not contain a major research component. Researchers who hold a faculty appointment as an assistant professor or the equivalent, or who know they will hold such an appointment within a year of the application deadline, are not eligible.

Infectious Diseases

Investigators in Pathogenesis of Infectious Disease
These awards provide new opportunities for accomplished investigators at the assistant professor level to study pathogenesis, with a focus on the intersection of human and pathogen biology. The program is intended to shed light on the overarching issues of how human hosts handle infectious challenge. These five-year grants, which provide $80,000 per year, are intended to give recipients the freedom and flexibility to pursue new avenues of inquiry and higher-risk research projects that hold potential for advancing significantly the biochemical, pharmacological, immunological, and molecular biological understanding of how infectious agents and the human body interact. BWF is particularly interested in work focused on the host, as well as host-pathogen studies originating in viral, bacterial, fungal, or parasite systems. Studies in these areas may have their root in the pathogen, but the focus of the work should be on the effects on the host at the cellular and/or systemic levels. Excellent animal models of human disease are within the scope of the program. Candidates must have an established record of independent research and hold a tenure-track position as an assistant professor or equivalent at a degree-granting institution in the United States or Canada. Up to eight of these grants will be awarded.

Interfaces in Science

Career Awards at the Scientific Interface
These awards are intended to foster the early career development of researchers with backgrounds in the physical/computational sciences whose work addresses biological questions and who are dedicated to pursuing a career in academic research. Candidates are expected to draw from their training in a scientific field other than biology to propose innovative approaches to answer important questions in the biological sciences. The grants provide up to $500,000 over five years to support up to two years of advanced postdoctoral training and the first three years of a faculty appointment. BWF expects to award up to eight of these grants in 2003. Candidates must have a Ph.D. degree in physics, chemistry (physical, theoretical, or computational), mathematics, computer science, statistics, or engineering. Exceptions will be made only if the candidate can demonstrate significant expertise in one of these areas, evidenced by publications or advanced course work. In addition to being open to U.S. and Canadian citizens and permanent residents, this program is open to temporary residents whose lawful immigration status has been granted and will extend for the duration of the award.

Institutional Awards at the Scientific Interface
These grants, which are made to degree-granting institutions, are intended to encourage the interdisciplinary training of graduate and postdoctoral students from the physical, chemical, and computational sciences so they can better apply their unique knowledge and talents to biological problems. BWF has made grants in this program in 1996, 1998, and 2000. We expect to commit up to $10 million for these grants each year they are offered, and the grants will provide from $150,000 to $500,000 per year for up to five years. Emphasis will be placed on supporting new programs or existing programs that will change graduate and postdoctoral training in a meaningful way, as opposed to programs seeking more funding for activities already under way. Specific guidelines may change for future awards, which will not be made until at least 2004.

Translational Research

Clinical Scientist Awards in Translational Research
These awards are intended to foster the development and productivity of established independent physician-scientists who will strengthen translational research, the two-way transfer between work at the laboratory bench and clinical medicine. The grants provide $750,000 over five years ($150,000 per year). BWF expects to award up to eight of these grants annually. We are interested particularly in supporting investigators who will bring novel ideas and new approaches to translational research and who will mentor the next generation of physician-scientists. Proposed activities may draw on the many recent advances in the basic biomedical sciences—including such fields as biochemistry, cell biology, genetics, immunology, molecular biology, and pharmacology—that provide a wealth of opportunities for studying and alleviating human disease. Candidates generally must be affiliated with a medical school; candidates at other types of degree-granting institutions (including schools of veterinary medicine, public health, and pharmacy) will be considered only if they can demonstrate a plan for coordinating with institutions that provide the patient connection essential for translational research. Candidates must have an M.D. or M.D.-Ph.D. degree and hold an appointment or joint appointment in a subspecialty of clinical medicine. In exceptional circumstances, non-M.D. candidates will be considered if their work is likely to contribute significantly to the clinical enterprise; these candidates should hold an appointment or joint appointment in a clinical department. Candidates must be tenure-track investigators at the late assistant professor level or the associate professor level, or hold an equivalent tenure-track position, at the time of application. Candidates must present evidence of already having established an independent research career, as this is not a "new investigator" award. Individuals holding the rank of professor are ineligible.

Science Education

Student Science Enrichment Program
These awards are limited to nonprofit organizations in BWF's home state of North Carolina. BWF provides around $1 million annually for this program, and grants provide up to $60,000 per year for three years. The program's goals include improving students' competence in science, nurturing their enthusiasm for science, and interesting them in pursuing careers in research or other science-related areas. The awards are intended to support projects that provide creative science enrichment activities for students in the sixth through twelfth grades who have shown exceptional skills and interest in science, as well as those who may not have had an opportunity to demonstrate conventional "giftedness" in science but are perceived to have high potential. The projects must enable students to participate in hands-on scientific activities and pursue inquiry-based avenues of exploration—an educational approach that has proven to be an effective way to increase students' understanding and appreciation of the scientific process. Project activities must take place outside of the usual school environment, such as after school, on weekends, or during vacation periods. Projects may be conducted all year, during the school year, or during the summer. Eligible organizations include colleges and universities, community groups, museums and zoos, public and private schools, scientific groups, and others that can provide experiential activities for middle school and high school students. We encourage partnerships—for example, between scientific groups and school systems or between universities and community groups. Industries may participate in collaboration with nonprofit organizations that assume the lead role.

Science and Philanthropy

BWF makes noncompetitive grants for activities that fall outside of our competitive award programs but are closely related to our targeted areas, such as career development of scientists or the pathogenesis of infectious disease. We place special priority on working with non-profit organizations, including government agencies, to leverage financial support for our targeted areas of research, and on encouraging other foundations to support biomedical research. Proposals should be submitted to BWF in the form of a letter, which should be no more than five pages. Applicants should describe the focus of the activity, the expected outcomes, and the qualifications of the organization or individuals involved; provide certification of the sponsor's Internal Revenue Service tax-exempt status; and give the total budget for the activity, including any financial support obtained or promised. Proposals are given careful preliminary review, and those deemed appropriate are presented for consideration by BWF's Board of Directors.

Program Application Deadlines

2004 Award Series

Basic Biomedical Sciences

Career Awards in the Biomedical Sciences — October 1, 2003

Infectious Diseases

Investigators in Pathogenesis of Infectious Disease — November 1, 2004

This program will not be offered in 2003-04
but will be offered again in 2004-05.

Interfaces in Science

Career Awards at the Scientific Interface — May 1, 2004

Institutional Awards at the Scientific Interface — See note below*

This program will not be offered in 2003-04
but will be offered again in 2004-05.

Translational Research

Clinical Scientist Awards in Translational Research — September 1, 2004

This program will not be offered in 2003-04
but will be offered again in 2004-05.

Science Education

Student Science Enrichment Program — April 10, 2003

Science and Philanthropy — Received all year

** These institutional awards are offered periodically, alternating with Career Awards at the Scientific Interface.*

Advisory Committees

The Burroughs Wellcome Fund uses advisory committees for each competitive award program to review grant applications and make recommendations to BWF's Board of Directors, which makes the final decisions. We select members of these committees for their scientific and educational expertise in the program areas. In addition, BWF uses a financial advisory committee to help in developing and reviewing the Fund's investment policies. This committee is appointed by and reports to the Board of Directors.

Career Awards in the Biomedical Sciences

Pamela J. Bjorkman, Ph.D.
Howard Hughes Medical Institute
California Institute of Technology

William Chin, M.D.
Eli Lilly and Company

Patricia K. Donahoe, M.D.
Massachusetts General Hospital
Harvard Medical School

Elaine Fuchs, Ph.D.
Rockefeller University

Phil Gold, M.D., Ph.D.
Montreal General Hospital
McGill University Faculty of Medicine

Margaret K. Hostetter, M.D.
Yale University School of Medicine

Thomas M. Jessell, Ph.D.
Columbia University

Lawrence C. Katz, Ph.D.
Howard Hughes Medical Institute
Duke University Medical Center

Stanley J. Korsmeyer, M.D.
Howard Hughes Medical Institute
Dana-Farber Cancer Institute
Harvard Medical School

George M. Langford, Ph.D.
Dartmouth College

Martin M. Matzuk, M.D., Ph.D.
Baylor College of Medicine

J. Anthony Movshon, Ph.D.
New York University

Suzanne R. Pfeffer, Ph.D. (Cochair)
Stanford University School of Medicine

John F. Sheridan, Ph.D.
Ohio State University

Jerome F. Strauss III, M.D., Ph.D. (Cochair)
University of Pennsylvania Health System

Ian A. Wilson, D.Phil.
Scripps Research Institute

James M. Wilson, M.D., Ph.D.
Institute for Human Gene Therapy
University of Pennsylvania Health System

Christopher Wylie, Ph.D.
University of Cincinnati College of Medicine

Investigators in Pathogenesis of Infectious Disease

Arturo Casadevall, M.D., Ph.D.
Albert Einstein College of Medicine

Mary K. Estes, Ph.D.
Baylor College of Medicine

Diane E. Griffin, M.D., Ph.D.
Johns Hopkins University Bloomberg School of Public Health

Stephen L. Hajduk, Ph.D.
University of Alabama-Birmingham School of Medicine

Philippa Marrack, Ph.D.
Howard Hughes Medical Institute
National Jewish Medical and Research Center

David G. Russell, Ph.D.
Cornell University College of Veterinary Medicine

Magdalene So, Ph.D.
Oregon Health Sciences University

P. Frederick Sparling, M.D. (Chair)
University of North Carolina-Chapel Hill School of Medicine

Interfaces in Science

Laurence F. Abbott, Ph.D.
Brandeis University

Robert H. Austin, Ph.D.
Princeton University

Carlos Bustamante, Ph.D.
Howard Hughes Medical Institute
University of California-Berkeley

Susan N. Coppersmith, Ph.D.
University of Wisconsin-Madison

Jeffrey I. Gordon, M.D. (Chair)
Washington University School of Medicine

Douglas A. Lauffenburger, Ph.D.
Massachusetts Institute of Technology

Michael C. Reed, Ph.D.
Duke University

Susan S. Taylor, Ph.D.
Howard Hughes Medical Institute
University of California-San Diego School of Medicine

Clinical Scientist Awards in Translational Research

Martin J. Blaser, M.D. (Cochair)
New York University Medical Center

Bruce A. Chabner, M.D.
Massachusetts General Hospital

Susan George, M.D.
University of Toronto Faculty of Medicine

John W. Griffin, M.D.
Johns Hopkins University School of Medicine

Alan Krensky, M.D.
Stanford University Medical Center

John E. Niederhuber, M.D.
University of Wisconsin Medical School

Jennifer M. Puck, M.D. (Cochair)
National Human Genome Research Institute
National Institutes of Health

Marlene Rabinovitch, M.D.
University of Toronto Faculty of Medicine
University of Toronto Hospital for Sick Children

Judith L. Swain, M.D.
Stanford University Medical Center

Craig B. Thompson, M.D.
Leonard and Madlyn Abramson Family Cancer
Research Institute
University of Pennsylvania Medical Center

Michael J. Welsh, M.D.
Howard Hughes Medical Institute
University of Iowa College of Medicine

Wayne M. Yokoyama, M.D.
Howard Hughes Medical Institute
Washington University School of Medicine

New Investigator Awards in the Pharmacological or Toxicological Sciences

This program is being discontinued after the 2001 award series; however the advisory committees will continue to monitor awardees' progress.

Pharmacological Sciences Subcommittee

Lorraine J. Gudas, Ph.D.
Weill Medical College of Cornell University

T. Kendall Harden, Ph.D.
University of North Carolina-Chapel Hill School of Medicine

Lee E. Limbird, Ph.D. (Chair)
Vanderbilt University Medical Center

Victor Ling, Ph.D.
British Columbia Cancer Research Centre

Palmer Taylor, Ph.D.
University of California-San Diego School of Medicine

Jeffrey M. Trent, Ph.D.
National Human Genome Research Institute
National Institutes of Health

Toxicological Sciences Subcommittee

Barbara F. Hales, Ph.D.
McGill University Faculty of Medicine

Philip Hanawalt, Ph.D.
Stanford University

Victor A. Levin, M.D.
University of Texas M. D. Anderson Cancer Center

Baldomero M. Olivera, Ph.D.
University of Utah

Stephen H. Safe, D.Phil.
Texas A&M University College of Veterinary Medicine

Thomas J. Slaga, Ph.D. (Chair)
AMC Cancer Research Center

Student Science Enrichment Program

Luciano Corazza, Ph.D.
University of California-San Diego

G. Thomas Houlihan, Ph.D.
Council of Chief State School Officers

Samuel Houston, Ed.D.
Edgate.com

Marian Johnson-Thompson, Ph.D.
National Institute of Environmental Health Sciences

Shirley M. Malcom, Ph.D. (Chair)
American Association for the Advancement of Science

Sally G. Shuler
Smithsonian Institution

Liz Woolard
W. G. Enloe High School

Investment Committee

The committee is composed of four members from outside BWF and two members from BWF's Board of Directors. The board's chair, BWF's president, and BWF's vice president for finance also serve on the committee as nonvoting members.

Stephen D. Corman (Chair)
BWF Board of Directors

Michael Even
Citigroup

Ronald Frashure
Acadian Asset Management

Albert James Hudspeth
BWF Board of Directors

W. Curtis Livingston
Western Asset Management

Walter Niemasik
Snyder Capital Management

Philip R. Tracy
BWF Board of Directors

Board of Directors

Enriqueta C. Bond, Ph.D.

President
Burroughs Wellcome Fund

Gail H. Cassell, Ph.D.

Vice President, Infectious Diseases
Drug Discovery Research
and Clinical Investigation
Eli Lilly and Company,
Lilly Research Laboratories

Stephen D. Corman

Founder and former Chair
and Chief Executive Officer
PharmaLink Inc.

Marye Anne Fox, Ph.D.

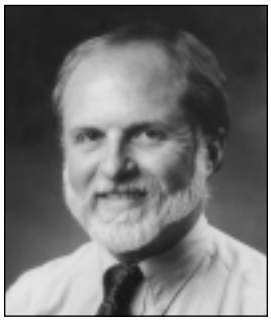
Chancellor
North Carolina State University

Henry G. Friesen, M.D.

Distinguished Professor Emeritus,
Senior Fellow
Center for the Advancement of Medicine
University of Manitoba
Chair of the Board,
Genome of Canada

Phil Gold, M.D., Ph.D.

Douglas G. Cameron Professor of Medicine
McGill University
Professor, Departments of Physiology
and Oncology
Montreal General Hospital



Albert James Hudspeth, M.D., Ph.D.

Investigator,
Howard Hughes Medical Institute
F. M. Kirby Professor and Head,
Laboratory of Sensory Neuroscience
Rockefeller University

I. George Miller, M.D.

John F. Enders Professor of Pediatric Infectious Diseases
Professor of Epidemiology and Molecular Biophysics and Biochemistry
Yale University School of Medicine

Mary-Lou Pardue, Ph.D.

Boris Magasanik Professor of Biology
Massachusetts Institute of Technology

James F. Strauss, II, M.D., Ph.D.

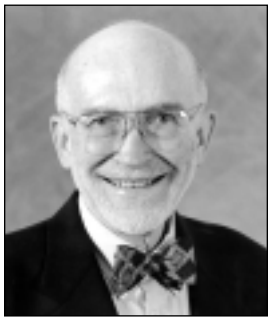
Luigi Mastroianni Jr. Professor of Obstetrics and Gynecology
University of Pennsylvania Medical Center
Director, Center for Research on Reproduction and Women's Health
Hospital of the University of Pennsylvania

Judith Swain, M.D.

Arthur L. Bloomfield Professor of Medicine
and Chair, Department of Medicine
Stanford University Medical Center

Philip R. Tracy

Of Counsel
Smith, Anderson, Blount, Dorsett, Mitchell & Jernigan, L.L.P.



Jean D. Wilson, M.D.

Charles Cameron Sprague Distinguished Professor of Biomedical Science
University of Texas Southwestern Medical Center-Dallas

Executive

LEFT TO RIGHT:
Enriqueta C. Bond, Ph.D., President
Scott G. Schoedler, Vice President, Finance

Administration, Finance, Meetings, and Technology

SITTING, LEFT TO RIGHT:
Jennifer Caraballo, Accountant
Kenneth P. Browndorf, Senior Asset and Accounting Manager
Martie H. Gregory, Senior Manager, Facility and Administrative Services
Judy McConnell, Librarian/Secretary

STANDING, LEFT TO RIGHT:
Wendell E. Jones, Technology Coordinator
Betsy Stewart, Secretary
Sam Caraballo, Systems and Web Engineer
Glenda H. Oxendine, Document/Web Specialist
Brent Epps, Administrative Support
Catherine L. Voron, Meeting Professional
Barbara J. Evans, Administrative Meeting Assistant

Programs and Communications

SITTING, LEFT TO RIGHT:
Jean A. Kramarik, Program Associate
D. Carr Agyapong, Senior Program and Communications Officer
Mirinda J. Kossoff, Communications Officer
Nancy S. Sung, Ph.D., Program Officer

STANDING, LEFT TO RIGHT:
Rolly L. Simpson Jr., Program Associate
Victoria P. McGovern, Ph.D., Program Officer
Debra A. Vought, Program Associate
Debra J. Holmes, Administrative Program Assistant
Melanie B. Scott, Program and Database Specialist
Martin Ionescu-Pioggia, Ph.D., Senior Program Officer

Contact Information for Major Programs

Staff e-mail addresses and focus areas

Basic biomedical sciences
Martin Ionescu-Pioggia, Ph.D., mionescu@bwfund.org
Senior program officer

Rolly L. Simpson Jr., rsimpson@bwfund.org
Program associate

Infectious diseases
Victoria P. McGovern, Ph.D., vmcgovern@bwfund.org
Program officer

Jean A. Kramarik, jkramarik@bwfund.org
Program associate

Interfaces in science; translational research
Nancy S. Sung, Ph.D., nsung@bwfund.org
Program officer

Debra A. Vought, dvought@bwfund.org
Program associate

Science education
D. Carr Agyapong, cagyapong@bwfund.org
Senior program and communications officer

Melanie B. Scott, mscott@bwfund.org
Program and database specialist

To obtain information about programs

Burroughs Wellcome Fund
The most up-to-date information about our programs, including complete application information, can be found on our Web site at www.bwfund.org

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f 919.991.5160

www.bwfund.org

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