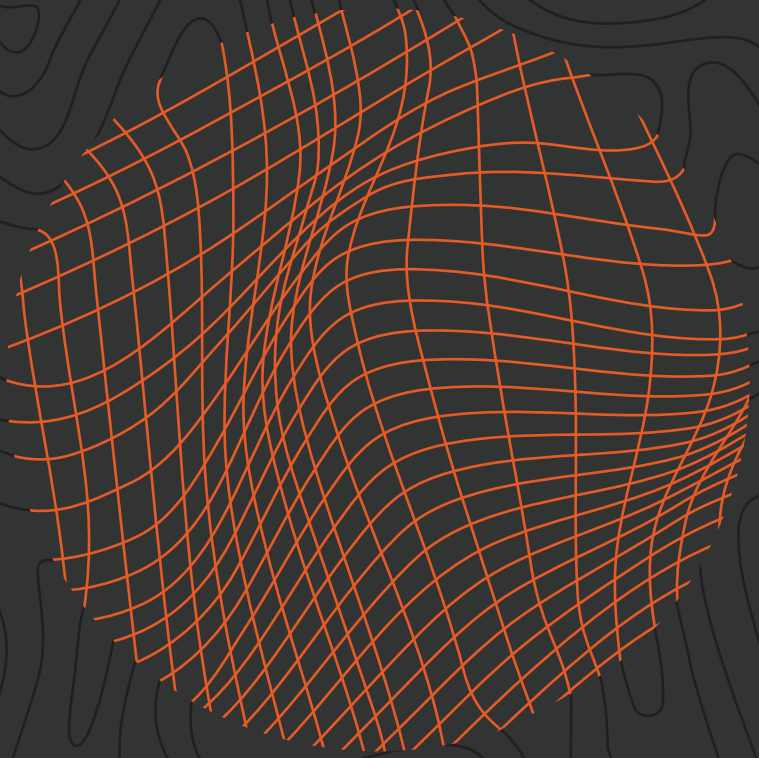

# Creating a Vision

2019 ANNUAL REPORT

BURROUGHS
WELLCOME
FUND

# Creating a Vision

2019 ANNUAL REPORT

## Contents




**Burroughs Wellcome Fund**
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# Investing in Biomedical Research and Career Development

## More than 60 years of Investing in Scientists and Biomedical Science

Founded in 1955, 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, BWF seeks to accomplish two primary goals—to help scientists early in their careers develop as independent investigators, and to advance fields in the biomedical sciences that are undervalued or in need of particular encouragement.

BWF's primary approach is to target individual researchers at degree-granting institutions in the United States and Canada, providing financial support through our competitive, peer-reviewed award programs. In complement to our support of academic research, we also make grants to nonprofit organizations whose missions improve the overall environment for scientific activities and careers.

Above all, BWF establishes relationships and invests in the person. We prioritize the researcher's individual development—designing awards that enhance opportunities for training, collaboration, and idea-sharing. We then facilitate networks, gatherings, and conversations to further provide awardees with a diverse community of expertise, mentorship, and inspiration.

BWF believes that a diverse scientific workforce is essential to the process and advancement of research innovation, academic discovery, and public service.

Our investment in the person ensures that each award has life beyond any single grant—that creative, original, and unique solutions to biomedical problems will continue to rise throughout an investigator's career—and in turn, confer good health and strength for all humankind.

> BWF believes that a diverse scientific workforce is essential to the process and advancement of research innovation, academic discovery, and public service.

> Starting in 2020, we will undergo a strategic terrain mapping exercise in which we look at our funding program areas and determine whether or not they are having the impact that we desire.

## President's Message

It is with the greatest enthusiasm and appreciation that I begin my tenure as president and CEO of the Burroughs Wellcome Fund. The Fund has an extraordinary reputation and aura of prestige that has been fostered by the very successful efforts of the past presidents, Drs. Enriqueta Bond and John Burris, the staff, Board of Directors, and Advisory Committee members.

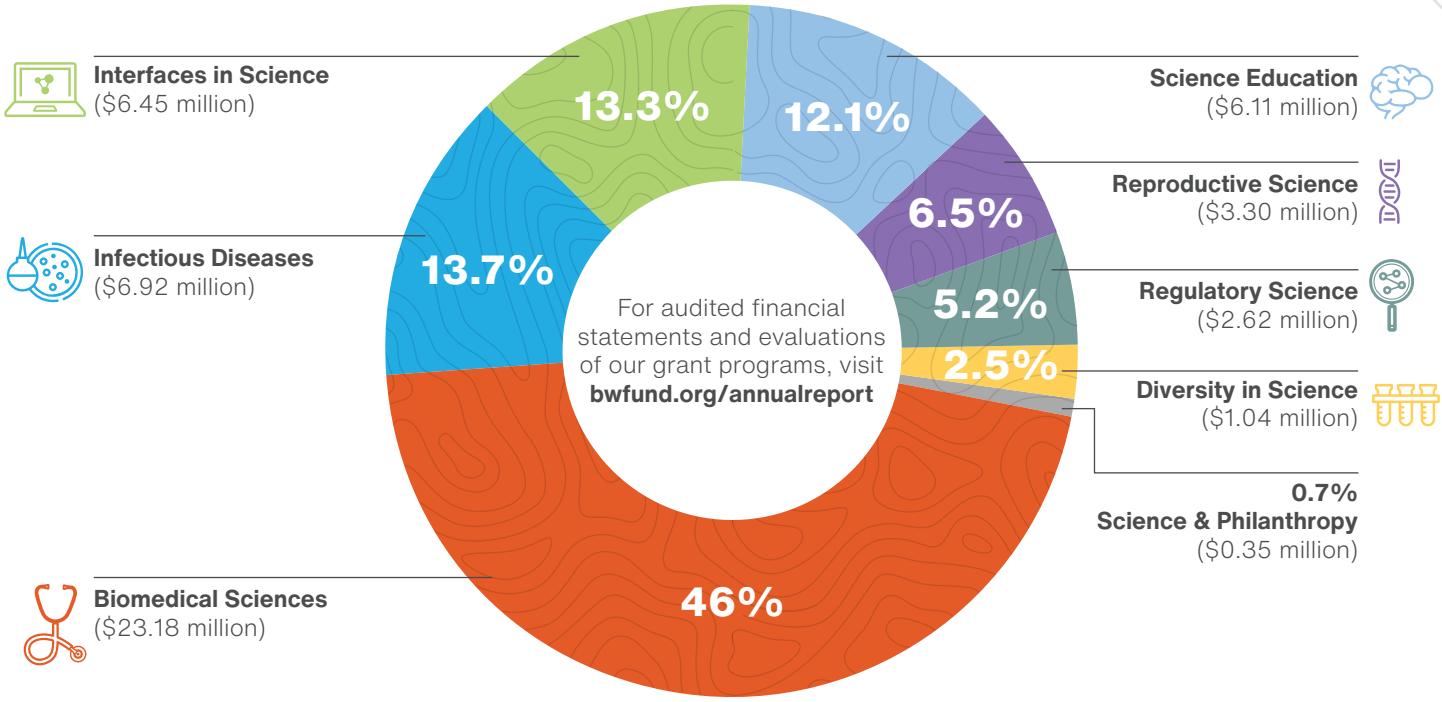
I now have the privilege and mandate of asking what is next for us as a foundation? This question enables us to think innovatively and critically about assessing our approach to grantmaking. It allows us to determine how we can have the greatest impact on biomedicine and society as a whole with the resources available to us.

In 2020, we will initiate a strategic terrain mapping exercise in which we evaluate our funding program areas and determine whether or not they are having the impact that we desire. Are we funding the best science and research? Are we recognizing the best educational programs? We hope to support talented programs, not just the best known ones, because talent is everywhere and comes in many different forms.

In addition to our philanthropic support, we will continue to build on the community created by our awardees and staff. We will provide opportunities to help create and develop networks among others in biomedical research and STEM education so they may influence and inspire each other.

Moreover, I have a vision of the Burroughs Wellcome Fund

## BWF awarded more than $50 million in grants during fiscal year 2019




headquarters in Research Triangle Park becoming a hub of intellectual activity for regional and national areas of interest. We hope to host more events and gatherings to discuss the important scientific topics of our time. We have an opportunity to engage in creative and constructive dialogue. This dialogue is the bridge connecting science to broader social issues.

To help keep you informed, we will undertake a stronger social media presence to allow you to better connect with the Fund's work and engage with our many collaborations. A recent example is our partnership with the National Academies of Science to address the connection between human health and climate change. This convening may well instigate new funding areas at the Fund.

In the article following this letter, we provide an overview of our programmatic funding and pose several questions that we ask you to consider. Please share your feedback and thoughts with us as we undergo our strategic planning efforts. Reach out to us let us know what your ideas and concerns and help us become the best foundation that we can possibly be not just now but for the future and for the future of our society.

Thank you.

**Louis J. Muglia, MD, PhD**
President and CEO
Burroughs Wellcome Fund

# Burroughs Wellcome Fund Programs

## PAST, PRESENT AND FUTURE

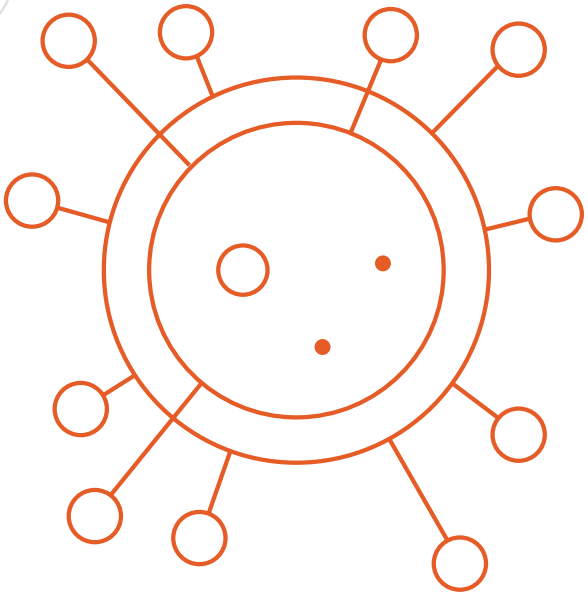
**The potential of biomedical research to advance human well-being has never been greater.** More than treating disease, disease prevention strategies and efforts to enhance human accomplishment and longevity have gained greater centrality. The National Institutes of Health in the United States has promoted this culture beginning in the Vietnam war era, and they remain the primary support system for most academically oriented institutions. In this manuscript, we will highlight how a non-profit, non-governmental organization, the Burroughs Wellcome Fund, has thought about optimizing its impact given the resources it has available to invest, in the past, and what efforts are currently underway to continue this disproportionately high impact given the scale of the funding it controls in comparison to other funders, by prioritizing its targets.

## Biomedical Research, Broadly

Since becoming an independent foundation in the mid-1990s, the Burroughs Wellcome Fund has distinguished itself as a funder by focusing on the human capital of the research enterprise, in particular, the individual researcher. Such a focus began with the Career Awards in the Biomedical Sciences (1995-2006), which served as a bridging award for postdocs focused on basic biomedical questions and provided risk funding into the early years of independent research. Aided by a distinguished Board of Directors and Advisory Committee, the prestige associated acquiring these awards inspired many early stage investigators to apply. The success of this approach contributed to the NIH instituting the K99/R00 awards which addressed a similar demographic. As a consequence, the Fund reconfigured the CABS award into the Career Awards for Medical Scientists (CAMS) award to further enhance its ongoing impact.

The Career Award for Medical Scientists (CAMS) focused on the transition of physician-scientists from postdocs/fellows into an independent research position. This program hoped to address the shortage of physicians entering the research workforce. To date, the program has funded 148 physician-scientists to go on to become independent researchers.

In spite of the successes of the CAMS program, it became apparent to the Board (and a large number of people) that we were not training enough physician-scientists, especially MD's-only. In 2017 the Fund's Board of Directors approved a $25 million initiative aimed at encouraging medical schools to offer research-training programs to MD-only students. Ten programs were funded with the goal of keeping this group closely networked to share best practices in the hopes of inspiring other medical schools to offer similar programs. This mechanism tests divergent strategies to achieve the enhancement of the MD physician-scientist pool given constraints in clinical training requirement, physician debt, and protected research time during training.



The Investigators in the Pathogenesis of Infectious Disease program has funded 177 assistant professors with **$500,000 grants** throughout the years.

## Infectious Disease

Throughout the years of the Fund's association with the pharmaceutical company, the organization offered scholar programs in various fields of infectious disease. As an independent foundation in the mid-90s, the Fund decided to switch gears and focus on the infectious disease researcher at the assistant professor level. Funding at this level provides flexible risk capital for the investigator to explore novel approaches that have come to light during their independent research career. The program, Investigators in the Pathogenesis of Infectious Disease (PATH), is especially looking for the connection between the host and pathogen. Throughout the years the Fund has funded 177 assistant professors with $500,000 grants.

The infectious disease program has also tried to build networks throughout the field, exploring areas to facilitate collaborations. Nearly two decades ago, the Fund provided support around the Eukaryotic Pathogen Genomics Database (EuPathDB.org), which is a collection of resources for analyzing large-scale datasets associated with microbial pathogens.

Pathogenesis has also been actively involved in a variety of meetings and funding for other efforts in areas such as mycology and malaria. The Fund provided significant funding for sequencing the Plasmodium falciparum genome, which was published in Nature in 2002.

Since 1999, BWF has supported a program of the American Society of Tropical Medicine and Hygiene that sends junior M.D.'s to conduct research in areas of the world where tropical diseases are prevalent. As of 2019, 53 fellows have been funded.

## Scientific Interfaces

By the mid-1990's, the Burroughs Wellcome Fund identified the interface of biology and the physical and quantitative sciences as an area in need of funding. It quickly became apparent that there was little formal training for individuals with a quantitative or physical science background interested in tackling biomedical questions. So rather than follow its pattern of funding individual investigators directly, the Fund created a program (Institutional Awards at the Scientific Interface – IASI) that funded 10 institutions from 1996-2000, which supported 367 trainees.

The Career Awards at the Scientific Interface program began in 2001, and a total of 167 awards have been granted for an investment of **$81.4 million**.

The success of the IASI program led to the creation of the Career Awards at the Scientific Interface (CASI) program that was modeled closely on BWF's Career Awards in the Biomedical Sciences (CABS) program. CASI is distinguished by the requirement that applicants have doctoral level training or evidence of significant expertise in a computational, theoretical, or physical science discipline outside of biology. The CASI program began in 2001, and a total of 167 awards have been granted for an investment of $81.4 million.

Importantly, this institutional program and CASI have been one of the few private sources of funding for foreign nationals—a vital source of biomedical intellectual capital in North America. Following the success of funding foreign nationals in this program, the other career awards programs at the Fund opened their application process to such individuals.

## Reproductive Sciences

A core goal of the Fund is to provide funding for important, yet undervalued and underfunded areas. Reproductive sciences are seen as one of these areas. BWF has provided longstanding support for the Frontiers in Reproduction course at the Marine Biological Laboratories (MBL) in Woods Hole, MA and the Reproductive Scientist Development (RSDP) award program.

Recognizing a particular need for more research into understanding the mechanisms of preterm birth, the Fund established its Preterm Birth Initiative. The program currently funds six awards of $500,000. Since its full inception in 2011 (in 2009 10 planning grants were made) 31 grants have been made for an investment of more than $15 million dollars. Meeting collaborations with the March of Dimes have also been a core part of support for Preterm Birth, although they have recently evolved to smaller, interactive across disciplines meetings supported exclusively by the BWF. Adverse pregnancy outcomes of other types, such as growth restriction, stillbirth, and preeclampsia will be considered as well.

## Regulatory Sciences

The Fund identified regulatory science as an underfunded field in 2012. The program created focuses on support for academic researchers developing new methodologies or innovative approaches in regulatory science that will ultimately inform the regulatory decisions the FDA and others make. This field too relies on the interdisciplinary talents of researchers.

Following the approach for preterm birth, the Innovation in Regulatory Science Awards funds five research proposals at $500,000. Since the first funding cycle in 2013, the Fund has provided 32 grants for an approximately $16 million investment. This program is distinguished by a requirement that the applicant show clearly how the research is intended to impact regulations.

## Career Guidance

Throughout its history the Fund has provided guidance to biomedical scientists regarding career choices. In particular we have tried to help young scientists as they begin their careers. This has ranged from sponsorship of numerous meetings (e.g. GREAT, ABRACAMS, SACNES) as well as early support for postdoctoral associations in the US and Canada. In recent years we have run a more formal program entitled Career Guidance for Trainees (CGT). Our CGT awardees, who receive grants of up to $50,000, have been recognized for their novel contributions to providing information and guidance to young scientists. We also provided early support for the AAAS myIDP program.

Since its inception in 1996, the Student STEM Enrichment Program has reached all 100 of North Carolina's counties and granted almost **$40 million**.

## Education

The Fund has focused its science and math education efforts in North Carolina and in grades K-12. The longest running of the programs is SSEP (Student STEM Enrichment Program). This program emphasizes informal science education outside of the classroom. Since its inception in 1996 the program has reached all 100 of North Carolina's counties and granted almost $40 million.

Other science education programs are CASMT – Career Awards for Science and Math Teachers -which runs on alternate years and funds five outstanding teachers at $175,000/5 years. It is based on the same idea as a Career Excellence Award (e.g. MERIT) the NIH provides – choose the best and most promising investigators and give them a substantial grant for multiple years. It remains, to the best of our knowledge, the largest financial award for K-12 teachers in the US.

PRISM – Promoting Innovations in Science and Mathematics Program, is another of our alternate year programs. It is focused on providing small grants to teachers to get equipment and supplies and, if needed, some professional development to use those materials. The application process is simple, and it has as a goal to encourage a large number of teachers to apply and be funded to provide the confidence and expertise that will enable them to submit more and larger grants.

Other programs in education include our support of implementation of Singapore Math in several schools. For the schools that implemented and continued the curriculum the results have been positive. There has been some wider adoption in schools outside of those funded by the BWF, but there has not been the hoped-for broad implementation. The assessment of what works and doesn't is ongoing, though, and will be valuable for others who may choose to try this approach that has been so successful in Singapore.

## Science, Math, and Technology Education Center

The Science, Math, and Technology Education Center (SMT) under the leadership of Dr. Sam Houston is an independent organization, but because the BWF provides most of its funding, it is often viewed as an extension of the Fund. The Center is seen as a neutral broker for education in the state and individuals and groups from a wide variety of community to political entities come to the Center to help run programs or collaborate in seeking grant funding. The most recent program that has involved the direct support of the Fund is an effort to get hands-on science kits to the largest number of students possible.

SMT recognized that a major barrier to kit implementation is the lack of funds to refurbish kits, thus many were abandoned after their first use. By establishing two refurbishment centers with the support and collaboration of the various school districts involved, the barrier to refurbishment has been removed and now, in the areas served, all the students have a chance to do hands-on science using well-vetted kits that are constantly being renewed. The SMT Center has led this effort and has worked hard to make the process sustainable, requiring that school districts help provide part of the funding and establishing an escrow account for future funding.

## Diversity in Science

The Fund has long recognized that the scientific community does not reflect the diversity of the US population. To try to encourage more underrepresented minorities and women to participate in science, the

The Fund has long recognized that the scientific community does not reflect the diversity of the US population. The Post-doctoral Enrichment Program is a three-year grant, with **16 awards** made per year, and is open only to members of underrepresented groups.

Fund has encouraged applications by participation in the many minority meetings, as well as in meetings that focus on women's participation. With regards to women, the Fund does make awards in proportion to the women applying (about 35-40%) which is a number quite close to the awarding of NIH RO1's and perhaps even slightly higher.

Although awards are made to underrepresented minorities in proportion to the application rates, these numbers are extremely small. To increase this number, the Fund has worked to increase the number of underrepresented minorities in the applicant pool. The post-doctoral enrichment program (PDEP) is a direct outgrowth of this effort. This three-year grant, with 16 awards made per year, is open only to members of underrepresented groups. We have averaged around 80 applications per year and helped create a strong cadre of well-qualified individuals who are already moving on to academic positions as well as to other BWF awards.

We are working to replicate this success with underrepresented minority graduate students in North Carolina and have now run a graduate enrichment program (GDEP) for two cycles. We have been pleased to get an increasing number of students applying and several of them are already qualified to be applicants for PDEP.

## Other Programs

Starting in 2008 the Fund supported 10 awards of $2.5 million each to institutions for a program unifying population and laboratory-based sciences (PUP). It was an effort to encourage population scientists to tackle biomedical questions (and vice versa). The program has had some successes, and some of the awardees are still spending out their grants. A review of the program will be undertaken in the next several years to establish if it had a positive impact and encouraged long- term efforts in this area.

The Fund has long been interested in trying to increase the quantitative in the biological sciences. We have had numerous Board meetings devoted to how we might encourage more individuals to gain more training in this area and bring the quantitative skills to tackle "big data". The Fund decided to create such an institutional program in the most recent terrain mapping exercise, but the physician-scientist initiative was viewed as a more pressing area where the Fund could make a difference. A small program Quantitative Institutional Program (QUIP) was created and 3 schools were funded to develop curriculum that would better prepare students for what will certainly be a need for a more quantitative approach to biology in the future.

## The Next Five Years at BWF

As we enter 2020, BWF is initiating its regular "terrain mapping exercise" to both evaluate existing programs for continuing research and education investment, as well as to imagine new areas emerging for substantial impact. Data and ideas gathered from the program officers and associates, advisory committees and the Board of Directors will be assembled and considered, and ultimately approved by the Board of Directors. Questions regarding current programs to be considered for ongoing resource allocation include:

1. **Did the program attract the interest and applications desired?**
2. **Was the quality of the applications at the high level expected by BWF?**
3. **What impact did the award have on the recipient? This metric can often be difficult to assess, especially as a differentiator from those that did not receive the award. Career advancement, high impact publications, health impact, diversity development, success in acquisition of ongoing research support are all components of the evaluation.**
4. **Is there a strong sense the program should continue to exist? This view could be shaped by not achieving the above points, but also by whether or not the problem has been "solved" or more commonly, such as with the CABS awards, other funders are now significantly represented in this space.**

**One New Adventure: Climate Change and Human Health**

BWF in collaboration with the National Academies of Sciences plans to embark upon scoping activities around the many consequences of climate change for human well-being. This effort will be initiated with a two-day meeting of experts to explore and articulate emerging issues that could provide critical new approaches to mitigating this critical concern. The areas of discussion will include:

1. **Disease transmission in changing climates:** How is vector function, geographic range, and frequency of exposure being modified?
2. **Extreme weather conditions and a consequence of climate change:**

> As we enter 2020, BWF is initiating its regular "terrain mapping exercise" to both evaluate existing programs for continuing research and education investment, as well as to imagine new areas emerging for substantial impact.

weather-related disasters, hurricanes, extreme heat or cold, flooding, air quality will all have consequences acutely and chronically for human health.

3. **Social dynamics and climate change:** How will climate change consequences differentially impact those in poverty, different geographies, and mentally or physically disadvantaged groups?
4. **Climate change effect on nutrition:** crop quality, nutrient content, crop production.

As an initial pilot investment, the Fund will contribute $200,000 to encourage and promote activities building upon this meeting at the National Academies. We anticipate this will allow up to eight scoping projects that the Academies will develop collaboratively with research communities. These scoping projects will serve as a platform for BWF, as well as the Academies, to consider next steps in the vast climate change area as to which themes or approaches seem most relevant and aligned with BWF priorities.

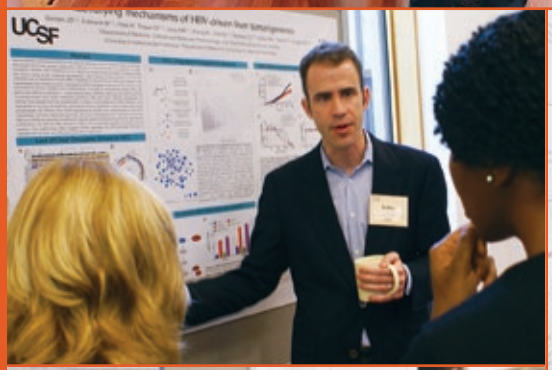
We, at BWF, provide this framework to not only to provide our history and perspective, but also to utilize to seek your ideas as a scientific community for our incorporation in terrain mapping and program implementation in our next phase. Please send your comments to: news@bwfund.org

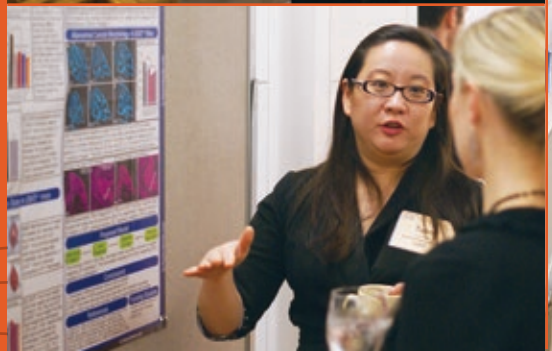
**John Burris, PhD**
President, BWF 2008 - 2019

**Louis Muglia, MD, PhD**
President, BWF 2020 -

# Annual Networking Meeting

Each year the Burroughs Wellcome Fund gathers the recent cohort of grant recipients at the Fund's headquarters in Research Triangle Park, NC. This provides an opportunity for introduction to the Fund's staff and to peers and colleagues across scientific disciplines. The Fund invites past awardees to share their experience and discuss the scientific career path.



## FISCAL YEAR 2019

# Major Competitive Grant Awardees

### Career Award at the Scientific Interface

**Steven Mark Banik, PhD**
Stanford University

**Jennifer Ann Noelani Brophy, PhD**
Stanford University

**Fei Chen, PhD**
Massachusetts Institute of Technology

**Víctor García-López, PhD**
Rice University

**Livnat Jerby, PhD**
Massachusetts Institute of Technology

**Christina K. Kim, PhD**
Stanford University

**Joseph William Larkin, PhD**
University of California-San Diego

**Jeffrey E. Markowitz, PhD**
Harvard Medical School

**Sergey D. Stavisky, PhD**
Stanford University

**Jeffrey Robert Tithof, PhD**
University of Rochester

**Mark Wagner, PhD**
Stanford University

### Career Awards for Medical Scientists

**Jonathan R Brestoff, MD, PhD**
Washington University

**Gaurav Das Gaiha, DPhil, MD**
Harvard Medical School

**Karuna Ganesh, MD, PhD**
Memorial Sloan-Kettering Cancer Center

**Wei Gu, MD, PhD**
University of California-San Francisco

**Marie A Guerraty, MD, PhD**
University of Pennsylvania

**Rodney Infante, MD, PhD**
University of Texas Southwestern Medical Center-Dallas

**Michael George Kattah, MD, PhD**
University of California-San Francisco

**Corey Keller, MD, PhD**
Stanford University

**Robert M Samstein, MD, PhD**
Memorial Sloan-Kettering

**Ashley Steed, MD, PhD**
Washington University

**Santosha A. Vardhana, MD, PhD**
Memorial Sloan-Kettering Cancer Center

**Andrew Sean Venteicher, MD, PhD**
University of Pittsburgh

**Doris Du Wang, MD, PhD**
University of California-San Francisco

### Career Guidance for Trainees

**American Society for Pharmacology and Experimental Therapeutics**

**Boston University**

**Clemson University**

**Iowa State University**

**Ohio State University**

**Western University**

**Vanderbilt University**

### Investigators in the Pathogenesis of Infectious Disease

**Theresa Alenghat, DVM., PhD**
University of Cincinnati

**Francis Alonzo, PhD**
Loyola University-Chicago

**Isaac M. Chiu, PhD**
Harvard Medical School

**Jun R. Huh, PhD**
Harvard Medical School

**Ivaylo Ivanov, PhD**
Columbia University

**Leigh Knodler, PhD**
Washington State University

**Kristin N. Parent, PhD**
Michigan State University

**John W. Schoggins, PhD**
University of Texas Southwestern Medical Center-Dallas

**Kimberley D. Seed, PhD**
University of California-Berkeley

**Randy Stockbridge, PhD**
University of Michigan-Ann Arbor

**Ellen Yeh, MD, PhD**
Stanford University

### Postdoctoral Enrichment Program

**Osama M Ahmed, PhD**
Princeton University

**Cierra A Birch, PhD**
University of California-San Diego

**Korey Brownstein, PhD**
University of Chicago

**Alex J Guseman, PhD**
University of Pittsburgh

**Nadia Herrera, PhD**
University of California-San Francisco

**Barbara Juarez, PhD**
University of Washington

**Andrew Kekupa'a Knutson, PhD**
University of Hawaii

**Laramie Denise Lemon, PhD**
Emory University

**David Rafael Martinez, PhD**
University of North Carolina-Chapel Hill

**Michaelle Ntala Mayalu, PhD**
California Institute of Technology

**Aaron Lavel Moye, PhD**
Harvard University

**Diane LaVern-Lygette Nelson, PhD**
Carnegie Mellon University

**Nancy Padilla Coreano, PhD**
Massachusetts Institute of Technology

**Brittany Louise Taylor, PhD**
University of Pennsylvania

### Physician Scientist Institutional Award

**Texas A&M University**

**University of California-Los Angeles**

**University of Chicago**

**Washington University**

**Weill Cornell Medicine Physician-Scientist Academia**

### Student STEM Enrichment Program

**Aurora Fossil Museum**

**Communities In Schools of Cape Fear**

**Duke University**

**McClintock Partners In Education (McPIE)**

**North Carolina State University**

**UNC Institute for the Environment**

**Wake County Public School System**

**Western Carolina University**

# Biomedical Sciences

## CAREER DEVELOPMENT OF BIOMEDICAL SCIENTISTS

**The biomedical sciences provide a firm foundation for improving human health.** But to advance biomedical science, we have to close gaps in research and the development of biomedical research talents.

The Burroughs Wellcome Fund is committed to fostering the development of the next generation of academic research scientists. Through our Biomedical Sciences portfolio, we identify and invest in talent pathways and career development elements that best benefit the current needs of the biomedical research landscape.

Our major focus in this area is the Career Awards for Medical Scientists (CAMS). Since 2007, the CAMS program has addressed the on-going need to increase and sustain the number of physician-scientists within the ranks of biomedical researchers, and to build synergy between basic research and clinical practice. BWF believes that physician-scientists bring unique perspectives to solving biomedical problems, given their dual experience in clinical training and hypothesis-based research. As such, the CAMS program was designed to help medical doctors transition into research careers, as they complete postdoctoral fellowship training and early years of faculty service.

In 2017, the Physician Scientist Institutional Award was created to tap an overlooked pool of potential research scientists. The program was developed to seek novel and creative ideas to attract, train, and provide support for MDs to launch a research career.

## Career Awards for Medical Scientists

Physician-scientists offer unique perspectives that bridge real-world practice with the lab bench: their synergy of clinical training and research thinking can bring new insights to solving biomedical challenges. We need to increase the number of physician-scientists, keep them in research, and sustain their presence among research communities and institutional leadership.

The Burroughs Wellcome Fund wants to help more physician-scientists become established in academic careers.

CAMS is tailored for physician-scientists who are still in a mentored, non-faculty position such as a residency, fellowship, or postdoc. The award provides $700,000 in funding over five years for a physician-scientist to bridge the final years of their advanced postdoctoral or fellowship training, and their early years of faculty service and independent research.

Our hope is to steer more physician-scientists towards tenure-track academic appointment in basic biomedical, disease-oriented, or translational research, with at least 75-percent protected time for research activities. We also seek out applicants whose specialties align with emerging

gaps in biomedical science, such as the interface of neuroscience and the practice of psychiatry.

## Physician Scientist Institutional Award

To advance biomedical sciences, we have to narrow the gaps in developing biomedical research talents. Increasing and sustaining physician-scientists in biomedical research careers will ensure the continued contributions of these unique talents and strengthen our overall prospects for improving human health.

In 2017, the Fund established the Physician Scientist Institutional Award. Over two cycles, the Fund has provided 10 grants for an investment of $25 million to institutions that have created programs with the intent to increase opportunities for physicians interested in a research career.

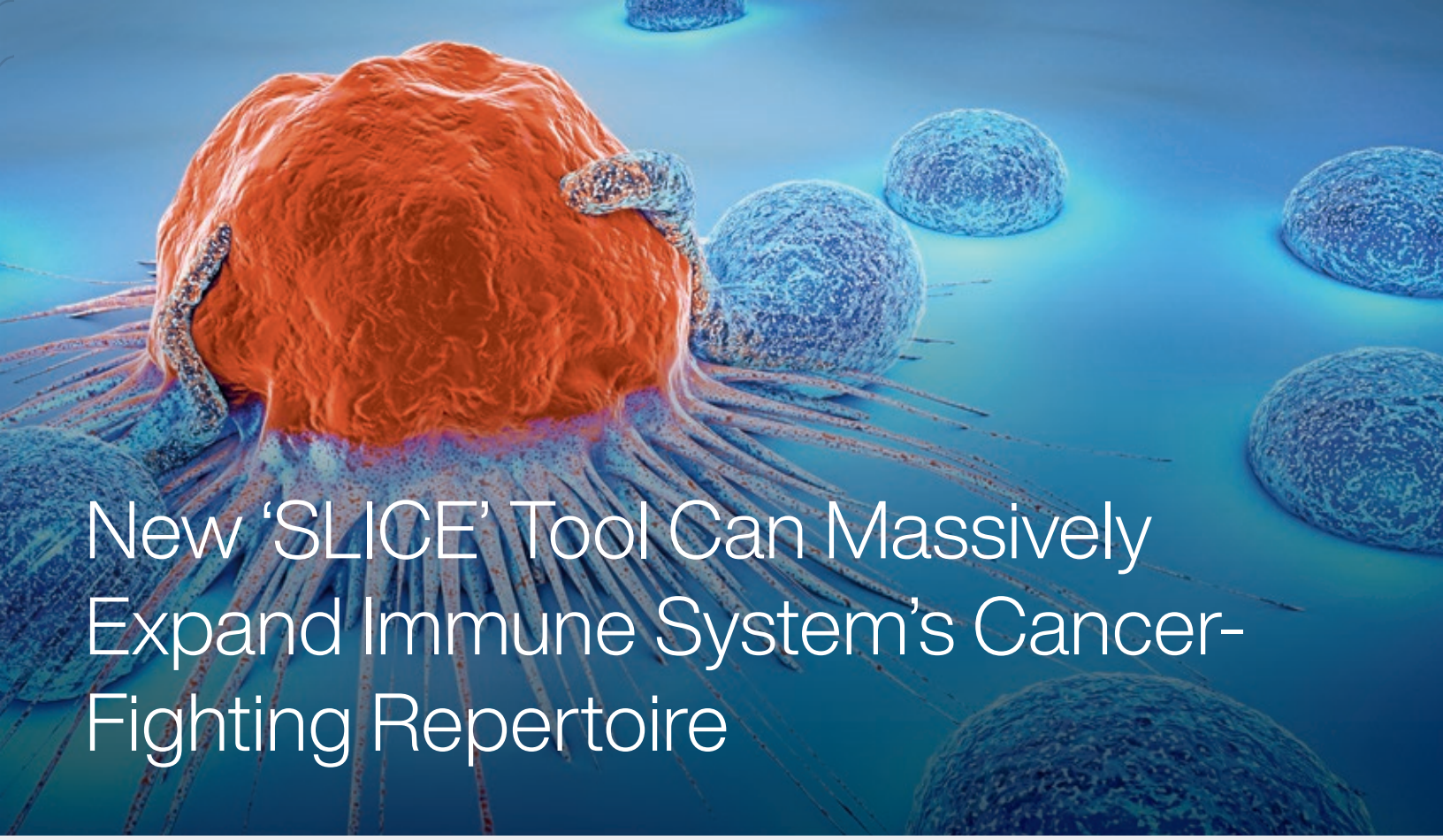
The Fund also created the Physician-Scientist Resource Center (bwfphysicianscientist.org) as a means to curate important information pertaining to physician-scientists.

## Collaborative Research Travel Grant (CRTG)

The Burroughs Wellcome Fund understands that science is a process best shared. But often in biomedical research, prospective colleagues or cutting-edge equipment are located at distant institutions, and funding limitations may preclude these exploratory, enriching visits.

BWF helps researchers make those trips. Our Collaborative Research Travel Grants (CRTG) provide up to $15,000 for domestic or international travel for one year—helping investigators and postdoctoral trainees to visit labs at other institutions to learn new research techniques, or to begin or continue research collaboration.

CRTG funds can be applied towards airfare, accommodations, meals, ground transportation, and other travel expenses—as well as lab supplies and other materials required for the visit. Researchers can make multiple visits to one collaborator or visit multiple collaborators. Those with doctorate-level training in the physical, mathematical, or engineering sciences are especially encouraged to apply. ///



# New 'SLICE' Tool Can Massively Expand Immune System's Cancer-Fighting Repertoire

## THE NEW CRISPR-BASED SYSTEM WILL OPEN THE DOOR TO NEXT-GENERATION TARGETED IMMUNOTHERAPIES

**By Jason Alvarez**

Immunotherapy can cure some cancers that until fairly recently were considered fatal. In addition to developing drugs that boost the immune system's cancer-fighting abilities, scientists are becoming expert at manipulating a patient's own immune cells, turning them into cancer-killing armies. But cancers have tricks to evade attack, so scientists are racing to outmaneuver cancer and boost the effectiveness of immune cell therapies.

Today's scientists are skilled immune system engineers, but they're working off of an incomplete blueprint: while they know a great deal about how to reprogram immune cell pathways, they often can't determine precisely which circuits they should rewire in order to fabricate a more potent immune system.

Now, UC San Francisco researchers have devised a CRISPR-based system called SLICE, which will allow scientists to rapidly assess the function of each and every gene in "primary" immune cells—those drawn directly from patients. The new method, described in the Nov. 15 issue of Cell, provides researchers with a powerful tool that will guide their decision-making when determining how best to engineer immune cells to fight cancer and a host of other diseases.

"SLICE allows us to perform genome-wide screens in which we mutate every gene in the genome to see which genes have the biggest effect on the cellular behavior we're interested in," explained Alex Marson, MD, PhD, associate professor of microbiology and immunology at UCSF and co-senior author of the new study. "We change one gene at a time in each cell and see which change causes the cell to do what we want it to do. SLICE is the discovery engine that will point us towards pathways that we can reprogram to generate the most effective next-generation cell therapies."

*continued >*

Alex Marson, MD, PhD, co-senior author of the study.

## Discovery Engine for Future Immune Cell Therapies

As a proof of principle, the researchers tested whether they could use SLICE to identify genes that make T cells—a common type of immune cell —replicate more effectively. This is especially important for cancer immunotherapy, which employs artificially stimulated and engineered T cells to kill cancer. So far, these therapies have only been effective against certain malignancies, but scientists believe that identifying genes that promote T cell proliferation can make cancer immunotherapy available to a wider range of patients.

Using SLICE, the researchers were able to identify genes that promote T cell replication, and others that suppress it. Though some of these genes had been previously characterized using other discovery methods, many were entirely new, demonstrating that SLICE could reveal key regulators of proliferation that other methods failed to capture.

After identifying these genes, the researchers obtained primary T cells from multiple human donors and deleted the genes that had been found to inhibit replication. When these CRISPR-modified T cells were cultured in the presence of cancer, they exhibited a markedly improved cancer-killing capacity, demonstrating that scientists could edit genes identified by SLICE and turn ordinary T cells into a potent potential therapy.

## Outsmarting Cancer's Defenses

But cancer has tricks of its own. Cancer immunotherapy often fails because tumors thrive in so-called microenvironments that are teeming with compounds that suppress immune activity and prevent T cells from realizing their full cancer-killing potential.

"T cells seem to become 'suppressed' in tumor microenvironments," said UCSF Health oncologist Julia Carnevale, MD, a Damon Runyon Cancer Foundation fellow and co-first author of the new study. "We wanted to know if SLICE could help us find a way to help T cells overcome this suppression."

The researchers showed that SLICE can indeed be employed to invigorate suppressed T cells. Utilizing SLICE, the researchers identified genes targeted by adenosine, an immunosuppressor found in tumor microenvironments, and found that deleting these genes allowed T cells to proliferate, even in the presence of adenosine.

"SLICE functions as a flexible platform that allows scientists to model the interaction between immune cells and the tumor microenvironment. We've shown that SLICE can help researchers identify genes that allow immune cells to escape the immunosuppressive forces they encounter in these microenvironments," said Alan Ashworth, PhD, the E. Dixon Heise Distinguished Professor in Oncology at UCSF, president of the UCSF Helen Diller Family Comprehensive Cancer Center, and co-senior author of the new study.

> SLICE functions as a flexible platform that allows scientists to model the interaction between immune cells and the tumor microenvironment.
>
> ALAN ASHWORTH, PHD

## Discovery Engine for Future Immune Cell Therapies

SLICE builds on a recent discovery from the Marson lab. In July 2018, researchers in Marson's lab reported in *Nature* that they could deliver CRISPR-based gene-editing constructs into immune cells using electroporation, a technique in which cells are literally shocked into absorbing molecules from outside the cell. SLICE takes a hybrid approach, incorporating the best aspects of the Marson lab's electroporation method alongside more conventional methods that employ viruses to deliver components of the CRISPR system. Once SLICE identifies genomic targets, the electroporation-based CRISPR method could be used to re-engineer those targets and reprogram immune cells, thus boosting their therapeutic capacity.

SLICE also represents a major advance over the current crop of tools that scientists use to study gene function. Though the existing methods—including RNA interference (RNAi) and a handful of CRISPR-based approaches—have yielded important insights, their use is limited to cell lines that often fail to capture the real-life biology that researchers are most interested in. Furthermore, SLICE could be used to interrogate regions of the genome that don't code for proteins—a major advance over RNAi, which was limited to coding regions of the genome.

But most importantly, the potential applications for SLICE are not limited to what's described in the new paper, said Marson, who serves as scientific director of biomedicine at the UC Berkeley-UCSF Innovative Genomics Institute, and is also affiliated with the Parker Institute for Cancer Immunotherapy, which funded the new study.

"Given the flexibility of this approach," Marson said, "SLICE may one day help scientists to create personalized immune cells with novel disease-fighting properties."///

Alex Marson holds a Career Award for Medical Scientists from the Burroughs Wellcome Fund. Additional authors on the paper include Eric Shifrut, PhD, Victoria Tobin, Theodore L. Roth, Jonathan M. Woo, Christina Bui, P. Jonathan Li, and Morgan Diolaiti, PhD.

# Career Guidance

## PROVIDING PROFESSIONAL GUIDANCE FOR BIOMEDICAL RESEARCHERS

**The Burroughs Wellcome Fund primarily invests in trainees and early-career investigators** who have tremendous potential to become leaders and innovators in the biomedical sciences. However, we realize that the skills scientists need to transform from employment to professional success are not always taught at the lab bench.

Graduate programs classically provide PhD trainees with deep knowledge, hands-on experience, and the ability to ask meaningful questions and find answers to them. But for many employers, the most desirable job candidates also have experience managing projects and people; the capacity to think independently, with initiative and entrepreneurialism; and advanced practice in communicating clearly about complex ideas.

Yet, emphasis on this comprehensive mentoring approach may fall short in some research training environments. At the same time, students, postdocs, and mid-life career-changers often report frustrations in attempting to translate their full skill set to tasks within and beyond the academic realm.

The Burroughs Wellcome Fund invests in pilot projects that demonstrate practical approaches to prepare scientists for career transitions, through our Career Guidance for Trainees (CGT) award. We want to assess approaches that help trainees acquire and hone the skills expected of knowledgeable workers and institutional leaders. We also want to help scientists find their optimal path within the research landscape—whether as principal investigators, in non-tenure track positions, in industrial careers, or in scientific careers away from the bench.

## Career Guidance for Trainees

To give research professionals the professional guidance they deserve, the Burroughs Wellcome Fund conducts the CGT award.

The program provides one-year grants up to $50,000 for academic institutions, professional societies, and other nonprofit organizations to demonstrate affordable projects that help individual scientists assess their personal growth and effectively pursue career paths.

BWF aims to advance innovative proposals that have the potential to be deployed on a larger scale. An idea should augment the basic “PhD-level” skills already offered by institutions—by helping research trainees discover and match their skills and interests with potential employers, or by providing them the tools to critically assess their vocational strengths with professional options.///

# Diversity in Science

## ENRICHING BIOMEDICAL RESEARCH WITH NEW VOICES AND FACES

**The Burroughs Wellcome Fund believes that racial, ethnic, and cultural diversity is essential** to the process and advancement of scientific innovation, academic discourse, and public service. In 2012, we launched the Diversity in Science program with the specific goal of supporting underrepresented minority trainees in biomedical research.

Molding a diverse research community begins with mentoring diverse talents. To address this foundational issue, BWF has created the Postdoctoral Enrichment Program (PDEP) to support early career scientists and engineers of Latino, Native-American, Pacific Island, and African-American descent. The grant provides postdoc-mentor pairs in the United States and Canada with funding to enhance research productivity and career counseling resources—to help early-career scientists develop as independent investigators.

The Burroughs Wellcome Fund makes personal investments in biomedical research and careers. Enriching biomedical and medical research with new voices and faces is simply fundamental to the BWF ethos of supporting researchers who hold promise for creative, original, and unique solutions to biomedical problems.

## Postdoctoral Enrichment Program

BWF created the PDEP to support early career scientists and engineers of Latino, Native-American, Pacific Island, and African-American descent, through training and mentoring support. PDEP awards a total of $60,000 over three years to postdoc-mentor pairs in biomedical or medical research, who are citizens of the United States or Canada, and hosted at a degree-granting institution in the United States or Canada.

Funding through PDEP supports participation in the following activities:

**Opportunities for the PDEP postdoctoral fellow** to enhance their research productivity. Examples include travel and attendance to workshops, courses, and trainings in new techniques; or meetings and events that launch new collaborations and knowledge transfer.

**Opportunities for the PDEP mentor** to develop and provide mentoring resources at their home institution, to increase the research productivity and long-term career success of the postdoctoral fellow. Examples include career guidance discussions, research management trainings, or professional development in grant writing, communication, and other skills demanded of future principal investigators.

**Opportunities for the PDEP mentor** to attend an annual meeting of PDEP mentors hosted by the Burroughs Wellcome Fund.

**Opportunities for the PDEP postdoc-mentor pair** to participate in a national peer network of underrepresented minority postdoctoral scholars to foster inter-institutional collaboration and greater community engagement. ///

# An Interview with Rossie Clark-Cotton

## FINDING A COMMUNITY THROUGH THE FUND'S GRADUATE DIVERSITY ENRICHMENT PROGRAM

**Interview by Russ Campbell**

Rossie Clark Cotton is a fifth-year PhD student in cell biology at Duke University in Durham, N.C and a 2016 Howard Hughes Medical Institute Gilliam Fellow. She studies how yeast cells track chemical signals. In 2017, she applied for and received the Burroughs Wellcome Fund's Graduate Diversity Enrichment Program grant. The Fund was piloting the program to focus on underrepresented minority PhD biomedical students in North Carolina. After taking a year off, the Fund is running the program again. In this brief chat Ms. Clark-Cotton describes the benefits of the awards and how her persistence paid off when it came to other fellowship opportunities.

**What was the biggest benefit of the Graduate Diversity Enrichment Program award?**

I might be unusual in that the biggest benefit for me was actually not the money but the networking opportunities. I have an HHMI Gilliam fellowship that I was able to use for travel, so the award would have been valuable for that but it wasn't something I needed. I primarily used the funding for microscopy, for exploratory experiments.

Like I said, the networking opportunities were the most valuable. I had the opportunity to meet with other grant recipients, beginning at the Burroughs Wellcome Fund new awardee networking event. I was able to expand my network and meet other underrepresented minorities in science. I received more exposure than I would have received otherwise.

Then, when BWF organized the Graduate Diversity Enrichment Network (GDEN), I was asked to be a student representative. I had the opportunity to gather with faculty, staff, and administrators from different institutions serving diverse populations. It's important to have student advocates at the table to provide insight on the student experience and perspective.

When GDEN convened a group of students here at Duke for a regional Graduate Diversity Enrichment Networking event in March to talk about funding opportunities through the Burroughs Wellcome Fund, I was asked to participate. I met Dr. George Langford [former BWF Board of Directors member] and that was very nice. I was the only graduate student who was on the panel so that was a really nice learning opportunity.

**What advice would you give students looking to apply for grants?**

One thing is that you don't lose anything by applying.

When I was a first year graduate student, I applied for a fellowship and I didn't get it. In large part it was because I didn't ask anyone to help me and I didn't know anything about the process. I had only been in graduate school for a few months and I didn't know how to write a good scientific proposal. I submitted it and

Rossie Clark Cotton

I didn't get it. I emailed them and asked if they could send me the comments on my review. I noticed that the reviewers didn't agree on everything.

One of them thought that I did a good job of describing how I would further the mission of the fellowship and one of them thought I had not done a good job of that at all. I realized that a great deal of success with those kinds of applications is the luck of the draw.

I realized it did not say something bad about me. It was a very selective fellowship and something like 96 percent of the applicants did not get funded. I didn't really feel bad about it once I realized the odds.

I figured out how not to internalize the rejection and I started thinking about it a little more practically. I used the reviews to see what sort of information that would help me in another application. I found out how to write a statement that would appeal broadly to reviewers. Some might be looking for a personal story, some might be looking for leadership efforts, and some might be looking for involvement in established organizations or programs. I started thinking about ways to capture all those particular elements that any individual reviewer might be attentive to and looking for in a statement. You never really know who's going to be looking for what.

**So you are suggesting that prospective applicants should ask for help and write broadly appealing statements...**

Yes. For the second fellowship application I wrote, I was established in a lab by then and I asked my advisor for help and he gave me a lot of really valuable feedback. I realized that as an incoming graduate student it's hard to know what a person who is going to read these applications is looking for. I needed somebody with a background in reading these things to help me understand what makes a compelling application.

Getting someone to help with the scientific piece and getting help with the personal statement is invaluable because I think almost every application will ask for some variation on that.

I discovered that the people who can give you the best feedback on the science aren't necessarily the same as the people who give you the best feedback on the personal statement.

I found a resource office at Duke that gave me good feedback on how to make my personal statement better and how to really frame myself as someone who would contribute to the mission of the organization sponsoring the fellowship.

My bottom line response is that it's useful to apply to fellowships. Don't worry if you get rejected because you can learn a lot from the process and that information will help you with future application submissions. If you do get it, it's great. ///

# Infectious Diseases

## ANSWERING PERSISTING QUESTIONS ON THE MECHANISMS AND NATURE OF HUMAN PATHOGENS

**Investigations into infectious diseases have been in the Burroughs Wellcome bloodline** for more than a century, ever since Henry Wellcome established his first tropical disease laboratory in the Sudan in 1902. Today, we still need new answers to fundamental questions on human infectious diseases.

The Burroughs Wellcome Fund began supporting an Infectious Disease programs in 1981, when it began funding modern molecular approaches to understanding what have been called the great neglected diseases—malaria, the pathogenic fungi, and human parasites—that affect people in countries around the world. Then, as more institutions focused their attention to the prevention and treatment aspects of these diseases, BWF shifted its aim towards the research questions and angles still in dire need of investigation.

Since 2000, we have directed our resources through our Investigators in the Pathogenesis of Infectious Disease (PATH) award. PATH encourages seasoned investigators at the assistant professor level to explore how specific pathogens—be they of bacterial, viral, fungal, eukaryotic, or other physiologies—interact with the human body to damage human health.

## Investigators in the Pathogenesis of Infectious Disease

How do human hosts handle infectious challenge? How can we shed light on the interplay between human and microbial biology, and explain how human health can be damaged by these encounters?

To answer these persisting questions, we need to be daring in our investigations into the mechanisms and nature of human pathogens.

Through our highly competitive PATH award, the Burroughs Wellcome Fund provides $500,000 over a period of five years for investigators at the assistant professor level to study pathogenesis.

PATH seeks investigators still early in their careers, who want to apply their own expertise to daring, multidisciplinary approaches blending the biochemical, pharmacological, immunological, and molecular.

We encourage proposals explaining how specific pathogens—be they of bacterial, viral, fungal, eukaryotic, or other physiologies—interact with the human body to damage human health. What affects the outcomes of these encounters? How do colonization, infection, commensalism, and other relationships play out at levels, from molecular interactions to systemic ones?

BWF wants to give these accomplished investigators the freedom and flexibility to pursue daring avenues of inquiry and higher-risk research projects—and advance their careers as innovators in infectious disease research. ///

# PATH Awardees Join Forces to Fight War on Flu

**By Marla Broadfoot**

When the Burroughs Wellcome Fund created the Investigators in the Pathogenesis of Infectious Disease (PATH) award nearly two decades ago, one of its defining principles was to move past the metaphor of "war" against infectious diseases. No longer did it make sense to limit thinking around the relationship between host and microbe as a battle between us and them. Microbes could be our allies as well as our adversaries, and wiping them out could do more harm than good.

But with a pair of recent publications from PATH awardees, the war is back on. The two publications provide startingly detail of an evolutionary arms race taking place between the flu virus and the human immune system.

"These results were both surprising and satisfying in that they show that evolution isn't something that just happens in the drawers of the history museum or a classroom textbook," said Victoria McGovern, the senior program officer overseeing the PATH program. "It's something that's rapidly affecting the natural history of our interactions with flu and probably all kinds of other microbes."

The findings were the culmination of a years-long collaboration between the University of Washington's Jesse Bloom and the University of Pennsylvania's Scott Hensley. They suggest that only by joining forces can scientists hope to outsmart one of the smartest viruses on the planet.

## Crossing Paths

The two met early in their careers, when Bloom was still a postdoc under David Baltimore and Hensley was starting his own lab. At first, they connected over shared interests: Hensley studied how the human immune system recognizes flu, while Bloom was interested in how the virus evolves to escape that immunity. After they were granted PATH awards—Bloom in 2015 and Hensley in 2016—their paths began to cross even more. At one point, they began discussing ways to get members of their labs to interact with each other.

"One thing that Seattle has that Philadelphia doesn't is lots of outdoor things to do," joked Bloom. After some

Scott Hensley

Jesse Bloom

searching, a graduate student in his lab found a ski lodge perched on the crest of Snoqualmie Pass, right outside Seattle, that was affordable during the off-season.

As PATH investigators, Bloom and Hensley each had access to $1,000 a year to invite other awardees to give a seminar at their home institution. Rather than use the money for a single speaker's travel, they decided to pool their resources and fly Hensley's entire lab to Seattle.

"This has been a creative and unexpected use of this funding mechanism," said McGovern. "Since the whole purpose of these funds is to get scientists out there and talking to each other, we think there is probably nothing better than including grad students and postdocs. They're the ones who are the closest to the cutting edge on any given day."

## S'mores and Science

For two days, about thirty undergrads, technicians, graduate students, and postdocs bunked in the looming and light-filled lodge. Before their labs even arrived, Bloom and Hensley were already conspiring on ways to get them to collaborate. They created teams with members from each of their labs to handle meal prep in the lodge's commercial scale kitchens. The teams began emailing each other weeks before the retreat to plan the meals and buy ingredients.

"It was a cool idea because it basically made the labs get together and solve a problem, how to cook the meal for 30 people," said Hensley.

The retreat was structured to provide plenty of time for science and plenty of time for socialization. Each day started with a series of informal 15-minute science talks given by the members of each lab. Those talks were followed by various indoor and outdoor activities, including games in the basement and hiking in the nearby wilderness. One afternoon the entire group hiked a section of the Pacific Crest Trail, posing for pictures near rocky outcroppings and pools of blue-green water.

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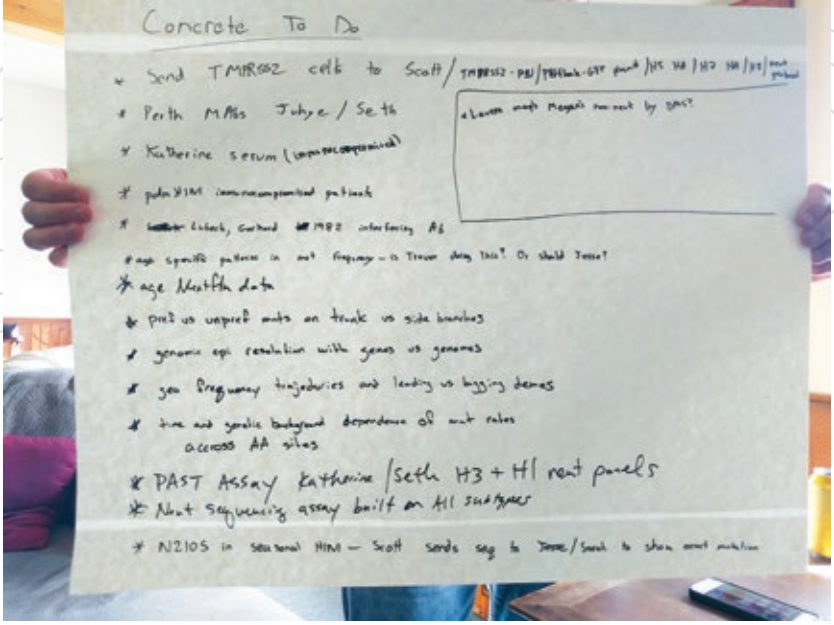


After much bonding and brainstorming, the scientists jotted down bits of their shared ideas on a giant sheet of butcher paper.

"Just like with conferences, some of the best stuff came from informal talks over beer or hiking," said Hensley.

After much bonding and brainstorming, the scientists jotted down bits of their shared ideas on a giant sheet of butcher paper. Many of those ideas turned into experiments, and now papers.

"One of the lessons that I took away from that butcher paper is that you can write things down and make plans, but the key thing is that there's people who are on the ground doing this work that talk to each other and believe they are worthwhile ideas to actually pursue," said Bloom.

## A Ground War

After the retreat, graduate students Juhye Lee from Bloom's lab and Seth Zost from Hensley's lab pursued several of those worthwhile ideas. The first question they tackled was a longstanding one in the field of viral immunology. The flu virus has an amazing ability to mutate, making tiny tweaks to its structure to evade the immune system's defenses. However, the human immune system is amazing too. It can make a slew of antibodies that target many different parts of the flu virus, and it seems unlikely that a single mutation could escape them all. Why, then, do millions of people succumb to the flu every flu season?

Lee used a new technique, called deep mutational scanning, to map how mutations to the virus affected its recognition by antibodies circulating in the serum of 16 different study volunteers. They were surprised to find that though the human immune system can potentially make an astronomical number of antibodies, for many people, the actual immune response is very narrowly focused on a specific part of the virus.

"I think that's incredible," said Bloom. "We found that different people's immunity is focused in different ways, meaning that they may be more protected or more susceptible to whatever strain is circulating. It also means that as the virus is evolving, there may be new mutations that are strongly favored while the virus is replicating in one person, but that are no longer favored when the virus jumps to another person. It presents a lot of interesting evolutionary implications."

## The year of the rabbit

The findings jibed with Hensley's previous research, which suggested that each of us harbor different types of antibodies because we have

> Just like with conferences, some of the best stuff came from informal talks over beer or hiking.
>
> SCOTT HENSLEY

encountered different types of flu viruses in our lives. “I was born in the late seventies, and my immune system was probably primed or educated with viruses from the late seventies and early eighties,” said Hensley. “I have a different sort of immune repertoire compared to someone who was born in the 90s, because their immune system was exposed to different viruses.”

Hensley said the impact of immune history is so strong that it might be possible to one day predict people’s susceptibility to the flu simply by asking their birthday, like a Chinese horoscope for infectious diseases.

With more research, such knowledge could be used for more than just a parlor trick. It could be parlayed into population models that predict how the flu virus will evolve and circulate throughout the population, making it possible to more accurately pick which flu vaccine strains to produce for the next flu season.

Because the flu virus changes so rapidly, new batches of the flu vaccine have to be formulated and administered every year. Having a universal flu vaccine, like we have for the measles or the mumps, could save a lot of headaches and a lot of lives. But to create a universal vaccine, researchers would need to target a region of the virus that doesn’t change from season to season. Not surprisingly, that idea was discussed during the joint lab retreat.

Again, Zost and Lee joined forces, this time combining Zost’s curation of human sera with Lee’s computational techniques to map exactly where antibodies latch onto flu viruses. They identified one antibody, from one individual, that targeted a conserved region of the virus. As a result, the antibody was effective against several strains of the flu.

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> Successful collaborations like this one make it easier to get new ones going, because people see it's a productive route to work together.
>
> JESSE BLOOM

"The real trick is figuring out why that person developed that type of immunity," said Hensley. "If we could figure that out, then we could start thinking about developing new vaccines that are harder for the flu virus to defeat."

## The next retreat

Lee and Zost, who are first authors of their respective papers, have now graduated. But other collaborations continue between the Bloom and Hensley labs, with more exciting results in the offing. "Successful collaborations like this one make it easier to get new ones going, because people see it's a productive route to work together," said Bloom.

They hope to do another joint retreat next year, perhaps hosting one every two to three years.

McGovern said that as more people have grown to appreciate the value of collaboration, other PATH awardees have begun holding their own joint retreats.

"I think collaboration has always been important, because of its ability to play one axis against another, like biochemistry and genetics, or in this case, computational biology and immunology," said McGovern. "That's always been true, but it is especially true now because the problems we are bigger than any one scientist or discipline." ///


**Citations:**

Lee JM, Eguia R, Zost SJ, Choudhary S, Wilson PC, Bedford T, Stevens-Ayers T, Boeckh M, Hurt A, Seema Lakdawala SS, Hensley SE, and Bloom JD. Mapping person-to-person variation in viral mutations that escape polyclonal serum targeting influenza hemagglutinin. *doi:* **https://doi.org/10.1101/670497**

Zost SJ, Lee J, Gumina ME, Parkhouse K, Henry C, Wilson PC, Bloom JD, and Hensley SE. Identification of antibodies targeting the H3N2 hemagglutinin receptor binding site following vaccination of humans. *doi:* **https://doi.org/10.1101/675272**


within-host

# Interfaces in Science

## INVESTING IN CROSS-TRAINED RESEARCHERS TO MAKE TRANSDISCIPLINARY BREAKTHROUGHS

**The biological sciences are changing.** Advances in genomics, quantitative structural biology, modeling of complex systems, and nanotechnology have opened up new realms of research especially for ambitious investigators with backgrounds in physics, mathematics, computer science, and engineering who want to explore these new frontiers of biology. The promise of an exciting research career at this scientific interface is undeniable.

In recognition of the vital role such cross-trained researchers will play in furthering biomedical science, the Burroughs Wellcome Fund is making major investments in early-career researchers with undergraduate and graduate training in the physical, chemical, or computational sciences.

BWF has formed the Career Awards at the Scientific Interface (CASI) award to catalyze the future careers of these creative, transdisciplinary talents. We believe that their unique perspective and expertise—and their career potential as faculty members and institutional leaders—will spark the exploration of toolkits, lenses, and machinery previously unimaginable in biomedical research.

From cell theory to DNA, great leaps in the biological sciences have always resulted from advances in how researchers detect, visualize, and manipulate the mechanisms of life.

We now stand at a new frontier where great changes in biological sciences await again. We are investing in cross-trained researchers who can navigate this interface of sciences—so they can make transdisciplinary breakthroughs for the benefit of human health.

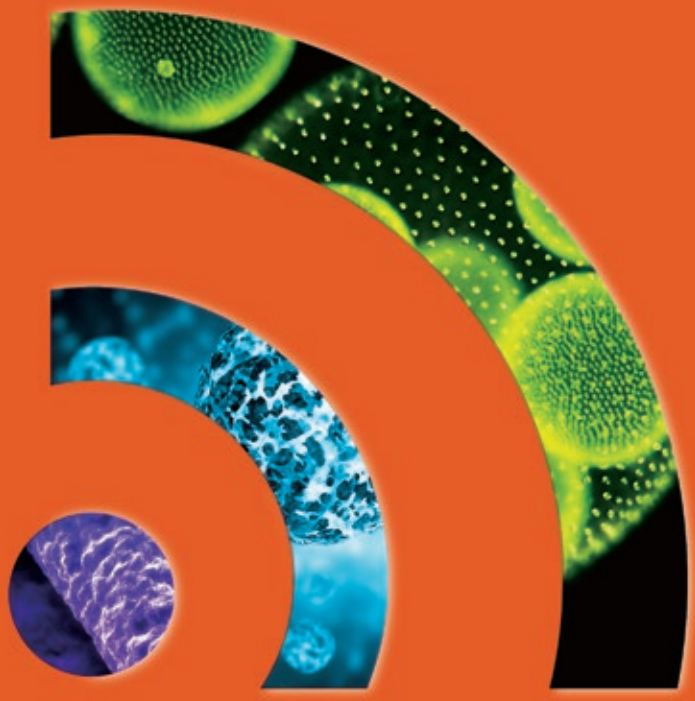
## Career Awards at the Scientific Interface

Possibilities at the interface of biological, physical, computational, and engineering sciences have never been more exciting. Biomedical researchers are now blending technologies and inspirations transcending varied disciplines—giving us toolkits, lenses, and machinery previously unimaginable, and with the potential to advance human health.

The Burroughs Wellcome Fund wants to cultivate investigators who are pushing the frontiers of these exciting possibilities. To do so, we have formed the CASI program as a career catalyst for creative, cross-trained researchers in biomedicine and biophysics.

CASI grants are open to researchers in the U.S. and Canada. The program provides $500,000 over five years—as well as job placement mentoring and professional networking resources—to help early-career researchers bridge their advanced postdoctoral training with their first three years of faculty service.

Through CASI, the Fund hopes to encourage scientists and engineers whose pre-doctoral work in chemical, physical, mathematical, and computational fields now prepares them to make grand leaps as postdoctoral and faculty researchers in biomedicine. Past awardees have explored programming paradigms for controlling robotic human limbs; imaging techniques to resolve intercellular dynamics or neural circuit function; biomagnetic matrices for stem cell cultures; chemical and evolutionary bases of circadian rhythms; spatiotemporal controls of embryonic tissue arrangement; and many other scientific interfaces. ///



# FOCUS on Science

## EXCERPT FROM FOCUS IN SOUND #21: INTERVIEW WITH ARIANA ANDERSON

**Interview by Ernie Hood**

**Ariana, in your capacity as PI and Director of the Laboratory of Computational Neuropsychology, you've led several other important projects over the last few years. I'd like to hear about all of them, starting with your research related to the placebo effect. That's a fascinating area that has been crying out for elucidation, and I understand your research is designed to also aid the drug development process. Tell us more...**

The placebo response is one of the biggest problems in developing new drugs, and the reason for this is that when drug trials are instituted, everyone gets a pill but they don't know what it is. So that means the placebo response is actually operating within people receiving a medication. So you have this very powerful effect that is trying to compete with the effects of an active drug, and it's also very noisy. So it's hard for us to tell whether a change is due to a drug or the placebo effect within people, and it's hard to discriminate between active and inactive medications because of that.

What we are trying to do is we are trying to use multiple measurements to assess and identify and control the effects of the placebo. Now we are doing this in a few ways. The first way we're doing it is we're using brain imaging. We are looking at drug studies of people who have received medication, before and after. The medication they might have received might be an active medication or it might be a sham one, and we are trying to identify whether or not there are these brain changes that are specific to receiving a placebo pill, and whether or not there's what changes look like they happen just because someone is getting treated in general. If we can measure these different components of the placebo

> What we are trying to do is use electronic medical records to automatically calculate risk of diabetes. So clinicians can know whether or not that person needs to be screened using all of the available information.
>
> ARIANA ANDERSON, PHD

response, then we can identify whether or not these placebo components are affecting the drug outcome. And that's what we are trying to do in our brain imaging research.

**You've also had great success in using electronic medical records and data mining to create new detection algorithms for diabetes screening. How does that work?**

Normally diabetes risk assessment only looks at a few different pieces of information to identify whether or not people might be high risk. So these may be things like age, it might be your BMI; it might be your gender and perhaps ethnicity. However, we know that there is a wealth of information that's collected when you go to the doctor. We have, for example, how long you've been a patient, how many medications you're taking, what other diagnoses you might already have, whether or not you have hypertension—this variety of information that we believe can help better assess and better predict whether or not someone is likely to have diabetes. Now this is an important problem because one in four people with diabetes don't know that they have it, and oftentimes they don't figure out they have it until they have some horrible complication of it. For example, someone might have just blurry eyes and tingling skin, and they will completely ignore it. Then they might go to the doctor later because they have a sore on their foot that doesn't heal, and they'll figure out that they have some form of gangrene, because it's a complication of diabetes. So oftentimes, people with diabetes don't find out they have it until they have some major complication or require hospitalization. One of the most expensive parts of diabetes isn't actually treating the disease; it's treating the complications that come from it, especially when it's not managed. And you can't manage disease that you don't know that you have.

What we are trying to do is trying to use electronic medical records to automatically calculate risk of diabetes. So clinicians can know whether or not that person needs to be screened using all of the available information. Now our past worked showed that people who are at risk for diabetes have different features in electronic medical records that go far beyond the basic information. So for example, if you have a history of high blood pressure, that is a risk factor. But then there's also a bunch of other risk factors that you would expect. So for example, if you have bacterial infections, that might be another risk factor for diabetes that we didn't know about before, that we could use to increase your risk of needing a diabetes screening. Now what we're actually doing with this project, since we published our first paper, is we're trying to extend this to major psychiatric disorders. So for example, people with schizophrenia are more likely to have diabetes, based on both genetic risk and the medications they are taking. So what we're trying to do with our medical records here at UCLA and throughout the UC system, is we are creating new screening algorithms for diabetes that are intended for people with psychiatric disorders. These people are the ones who are at the highest risk for psychiatric disorders from many different factors,

*continued >*

Ariana Anderson, PhD, Director of the Laboratory of Computational Neuropsychology in the Medical Psychology-Neuropsychology Division, UCLA

but also they are the people who are most likely to not have reliable contact with the medical community other than seeing a psychiatrist. So we're making a tool that psychiatrists can use to automatically assess whether or not the person needs to be screened for diabetes, given that they're on a variety of medications for mood, and given that they probably have genetic likelihood of already having it.

**Well Ariana, it's so interesting that your work in computational neuropsychology seems to focus on being able to detect and predict various conditions early on. Another example is your work on early prediction of cognitive decline in Alzheimer's disease, vascular dementia, and other neurocognitive disorders. Fill us in on how you've been developing that aspect, which is what actually helped you get the NIA grant I mentioned...**

When people think of dementia, they often think of Alzheimer's disease. However, there is vascular dementia, which is the second-leading cause of memory impairment in older adults. Now vascular dementia can mean that you have risk factors for strokes, but it also means that there are problems with your vascular system, your vascular compliance, that leads to you basically being a bit slower in processing and responding to information. So what we are doing is we are using functional MRI to look at the hemodynamic response—how did your blood flow respond when you, for example, are thinking of something, when you're seeing an image of something? And we're finding out that the pattern of this response can predict whether or not you're having memory issues above and beyond,

> When people think of dementia, they often think of Alzheimer's disease. However, there is vascular dementia, which is the second-leading cause of memory impairment in older adults.
>
> ARIANA ANDERSON, PHD

for example, how many years you went to school, or your age or ethnicity or socioeconomic status. So these actual patterns you see in vascular responses may indicate that you're having already some sort of cognitive problems that are caused not by, for example, the typical plaques and tangles, but just caused by vascular issues. So vascular health can determine cognitive ability early on. It's an early marker for cognitive problems.

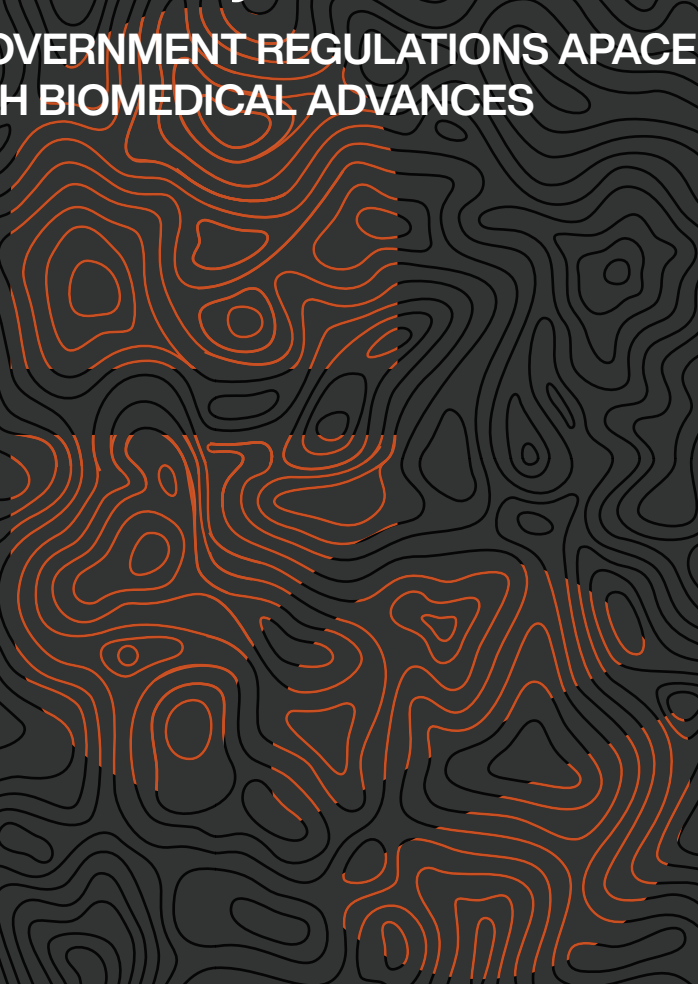
**Tell us about your project related to prison violence...**

At UCLA, we are also interested in the social outcomes. So for example, many people who have mental health issues might end up in the prison system. We're interested in finding out how we can look at different interventions, and whether or not they might be effective, for example, for reducing violence in prison and for reducing recidivism. So I work closely with an organization called BetaGov. It's a collaboration between NYU and UCLA where we're looking at how to do these real-time interventions. How do you implement these trials to judge whether or not these interventions that are being implemented in prisons actually are effective in reducing violence and helping outcomes in reducing stress among prison staff, for example. ///

To listen to the full interview, visit FOCUS in Sound on iTunes at **https://podcasts.apple.com/us/podcast/focus-in-sound/id835115630**

# Regulatory Science

## KEEPING GOVERNMENT REGULATIONS APACE WITH BIOMEDICAL ADVANCES



**The U.S. Food and Drug Administration** defines "regulatory science" as the science of developing new tools, standards, and approaches to assess the safety, efficacy, quality, and performance of FDA-regulated products.

But regulatory science itself is an underserved area of research. National policies and regulations on new biomedical therapies should be supported by state-of-the-science data—yet given the pace of innovation and fiscal realities, agencies often lack the resources to fully address each and every emerging regulatory question.

Academic researchers can help agencies meet this demand. Recognizing the need and the opportunity, the Burroughs Wellcome Fund has made Regulatory Science among its major initiatives for funding.

Our Innovation in Regulatory Science Award (IRSA) specifically funds academic investigators to assess the safety and efficacy of new therapies. We seek investigators who can leverage their multidisciplinary expertise and institutional resources towards new methodologies or approaches for vetting novel therapies—and produce timely knowledge and evidence that can directly assist U.S. and Canadian agencies in making regulatory decisions.

Regulations in biomedical therapies exist to balance public benefit with informed risk, and the demand for informed policymaking is as limitless as the frontier of medical therapies. To advance biomedical science and its promise for public good, the Burroughs Wellcome Fund will continue its encouragement of regulatory science—keeping government regulations apace with biomedical advances.

## Innovations in Regulatory Science Award

Regulations in biomedical therapies exist to balance public benefit with informed risk. Appropriately, these national policies and regulations should be supported by state-of-the-art science data and evidence.

But given the pace of innovation and fiscal realities, agencies often lack the resources to fully address each and every emerging regulatory question.

To help the Food and Drug Administration (FDA) and other U.S. and Canadian agencies close this gap, the Burroughs Wellcome Fund created the IRSA.

IRSA offers investigators up to $500,000 over five years to develop innovative and implementable solutions to regulatory questions. Applications are open to U.S. and Canadian citizens or permanent residents who have a faculty or adjunct faculty appointment at a North American degree-granting institution.

Applicants must explain how their research will have direct implications for regulatory policy—including the strategy and timeline for an agency to receive and consider the findings in their regulatory decision-making, as well as any potential pitfalls and the major validation steps required.

Beyond this, the possibilities are as limitless as the frontier of medical therapies. We invite collaborations and talents spanning mathematics, computer science, applied physics, medicine, engineering, toxicology, epidemiology, and systems pharmacology, and any other field spanning biomedical, biophysical, and biostatistical disciplines. ///

# Keeping Genetic Engineering Localized

## RESEARCHERS ARE DEVELOPING A SO-CALLED "DAISY-CHAIN" GENE-DRIVE SYSTEM THAT PROVIDES CONTROLS FOR GENETIC ENGINEERING OF CERTAIN POPULATIONS

**By Helen Knight | MIT Media Lab**

Genetic engineering tools that spread genes within a target species have the potential to humanely control harmful pests as well as eradicate parasitic diseases such as malaria.

The tools, known as gene drives, ensure that engineered organisms transmit desired genetic variants to their offspring. These variants could ensure, for example, that the organisms only produce male offspring, or sterile females.

In this way, gene drives could be used to exterminate insects such as mosquitoes that carry pathogens, and that can spread malaria, dengue, and the Zika virus. Gene drives could also be used to control invasive species such as rodents that can threaten the survival of native animals.

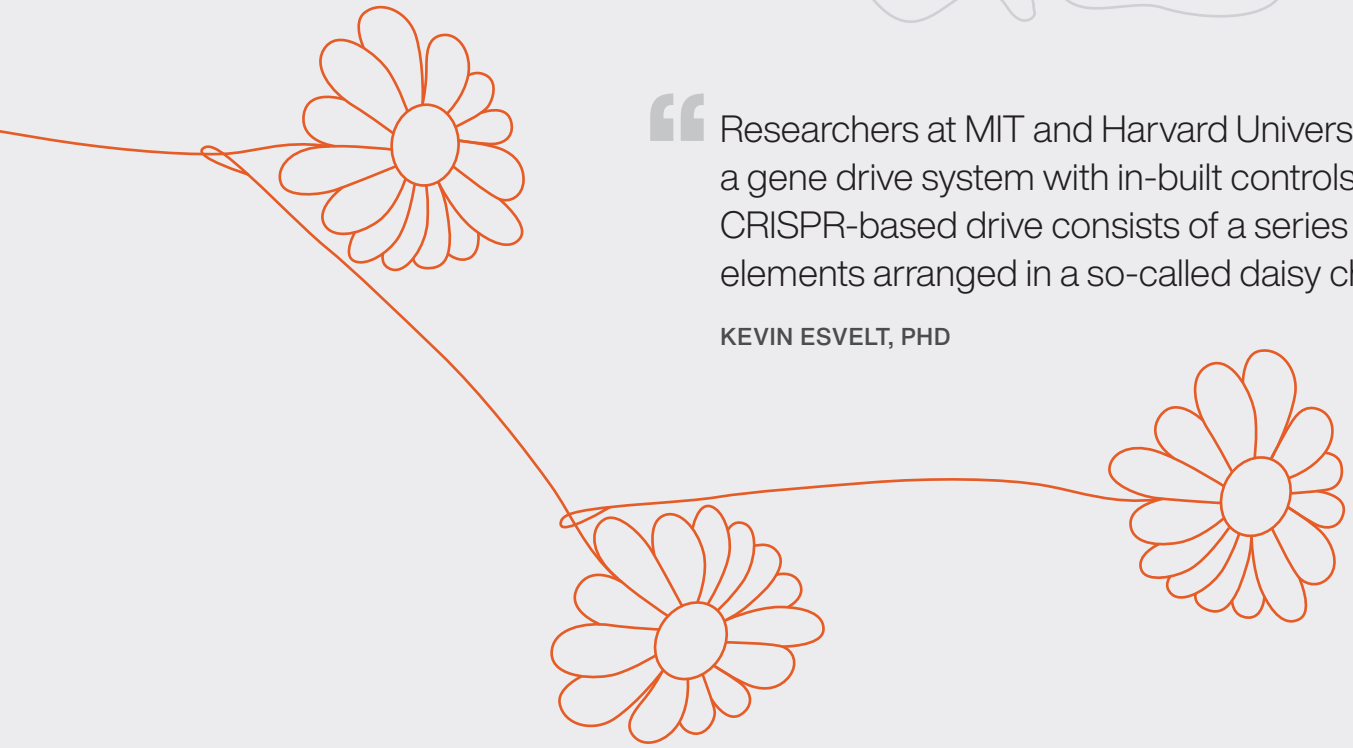
However, previously described versions of gene drives based on the CRISPR genome editing system have the potential to spread far wider than their intended local population—to affect an entire species. The affects could also spread across international boundaries, potentially leading to disputes between countries where no prior agreement had been made.

These types of concerns could significantly delay, if not altogether prevent, the safe testing and introduction of the technology.

### A Gene Drive System with In-built Controls

Now, in a paper published today in the Proceedings of the National Academy of Sciences, researchers at MIT and Harvard University describe a gene drive system with in-built controls.

The CRISPR-based drive consists of a series of genetic elements arranged



> Researchers at MIT and Harvard University describe a gene drive system with in-built controls. The CRISPR-based drive consists of a series of genetic elements arranged in a so-called daisy chain.
>
> KEVIN ESVELT, PHD

in a so-called daisy chain, according to Kevin Esvelt, an assistant professor of media arts and sciences and head of the Sculpting Evolution research group at the MIT Media Lab who co-led the research.

One link within the daisy-drive system encodes the CRISPR gene editing system itself, while each of the other links encode guide RNA sequences. These guide sequences tell the CRISPR system to cut and copy the next link in the chain, Esvelt says.

Adding more links allows the daisy drive system to spread for additional generations within the population.

"Imagine you have a chain of daisies, and at each generation you remove the one on the end. When you run out, the daisy chain drive stops," Esvelt explains.

In this way, a small number of genetically-engineered organisms could be released into the wild to spread the daisy-drive within the local population, and then stop when programmed to.

"We're programming the organism to do CRISPR genome editing on its own, within its reproductive cells, in each generation," Esvelt says.

## A Collaborative Effort

Esvelt developed the system in collaboration with George Church, a professor of genetics at Harvard Medical School, visiting professor at the Media Lab, and a senior associate member at the Broad Institute of MIT and Harvard. Co-first authors Charleston Noble and John Min, both graduate students at Harvard Medical School, led the modelling and the molecular biology experiments designed to ensure the system is evolutionarily stable, respectively.

"If the world is to benefit from new gene-drive technologies, we need to be very confident that we can reverse it and contain it, both theoretically and via controlled tests," Church says

"Many of the applications of gene drives involve islands and other geographical isolations, at least for initial tests, including invasive species and Lyme disease," he noted. "It would be great if these highly motivated local governments can do tests that do not automatically affect adjacent islands or mainlands. The daisy-chain drives offer this."

The research suggests that for every 100 wild counterpart, releasing just

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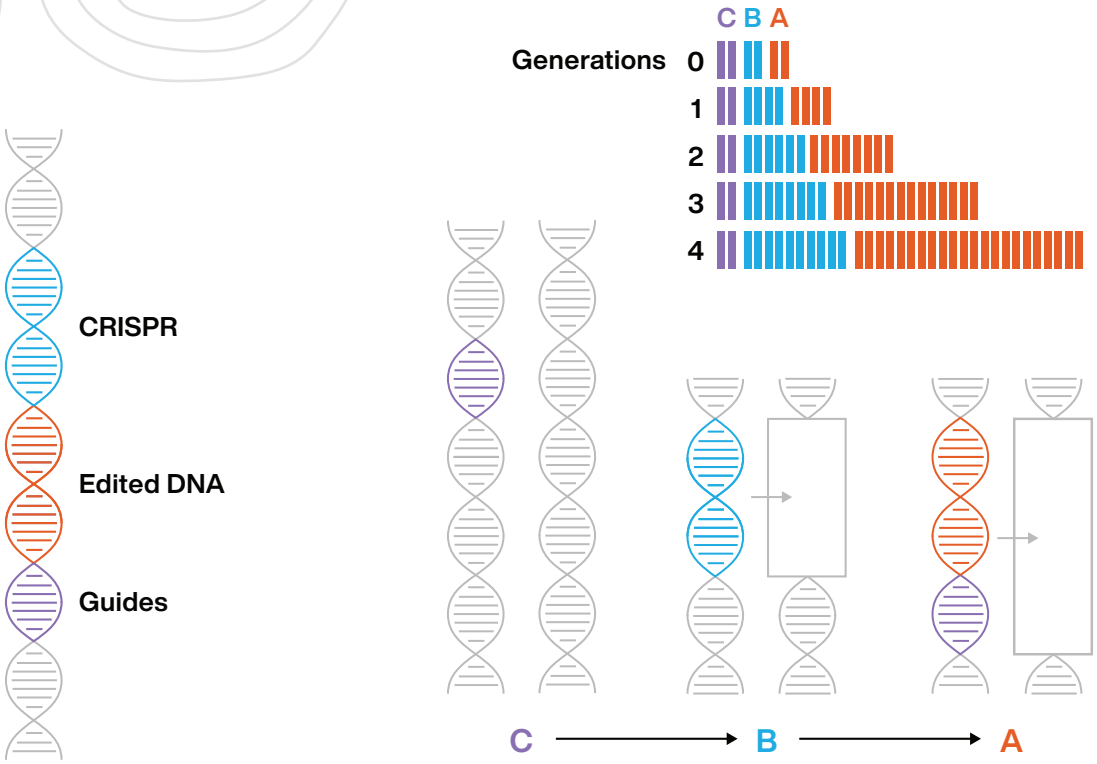



## Previous Gene Drive

Previous gene-drives contained everything they needed to copy themselves in one piece of DNA. But these had the potential to spread far wider than their intended local population—to affect an entire species.

## Daisy-Chain Gene Drive

A daisy-chain gene drive separates the information needed to copy itself and scatters it across the organism's genome. None of the components can drive themselves but they are connected in a linear daisy-chain. Element C helps B to drive. And element B helps A to drive.

one engineered organism with a weak 3-link daisy-drive system, once per generation, should be enough to edit the entire population in about two generations—roughly a year in a fast-reproducing insect. That compares with existing systems that must release at least as many organisms as are already present in a local population, and sometimes 10 or 100 times as many.

The process could take several years in species that reproduce more slowly, such as mice, but would be more humane than the existing use of rodenticides, which can also harm people and predator species, Esvelt says.

## An Alternative to Self-propogating Systems

In 2014, Esvelt and his colleagues first suggested that CRISPR-Cas9 could be used in gene-drive systems, and he has felt a moral responsibility to develop an alternative to self-propagating systems, he says. "Ideally, localization will let each community make decisions about its own environment, without forcing those decsions on others.

According to Professor Luke Alphey, head of arthropod genetics at The Pirbright Institute in the UK, self-propagating drive systems can spread rapidly through target populations. However, such drive systems are also thought likely to spread to all connected populations of the target species—which is desirable if you want to modify the entire species, undesirable if you do not, he says.

> Daisy-drives potentially provide a means to get much of the benefit of this type of gene drive [self-propogating], while constraining spread and also limiting persistence of the gene drive even in the target population.
>
> **LUKE ALPHEY, PHD**

"Daisy-drives potentially provide a means to get much of the benefit of this type of gene drive, while constraining spread and also limiting persistence of the gene drive even in the target population," Alphey says. "That is likely to be highly desirable when one wants to affect one population but not another of the same species, perhaps affecting an invasive pest population but not populations of the same species in its native range."

Alphey was not involved in the initial daisy-drive research, but is now collaborating with Esvelt, including work on the use of daisy-drives in mosquitoes.

Esvelt and the Sculpting Evolution group are also beginning to explore the possible use of this technology to heritably immunize white-footed mice, the primary reservoir of the bacteria responsible for Lyme disease in North America. They are also setting up a research collaboration to explore the use of daisy-drives in Cochliomyia, also known as the New World screwworm, a parasitic fly that produces larvae that eat the living tissue of warm-blooded animals, causing considerable suffering.

In addtition, the researchers are also investigating this technology for use in nematode worms, microscopic creatures that reproduce every three days. This will allow them to carry out laboratory-based evolutionary studies of the daisy-drive engineered organisms, with the goal of ensuring the systems cannot become self-propagating. ///

# Reproductive Sciences

## NOURISHING NEW RESEARCH INTO PARTURITION SCIENCE

**The action of birth is shrouded in elegant complexity.** It is the culmination of biomedical chain reactions, cellular differentiation, and other physiological, behavioral, and environmental mechanisms. Individually, they are measurable—together, much remains a mystery.

For years, the Burroughs Wellcome Fund has recognized reproductive sciences as an undervalued and underfunded area of research. Via our ad hoc grants, we provided early-career development funding for reproductive scientists and for OB/GYN physician-scientists.

In 2008, we began to formally invest in Reproductive Sciences as a major funding program. Today, our focus is to seek new ideas and partnerships to increase research into human parturition.

The program's first efforts were a series of biannual conferences on preterm birth research. Together with the March of Dimes, the Burroughs Wellcome Fund hosted the Biannual Symposium on Preventing Prematurity in 2008, 2010, 2012, and 2014.

Our Reproductive Sciences program is currently headlined by the Preterm Birth Initiative, an award aimed to increase our understanding of the mysteries and mechanisms of spontaneous preterm births—the leading cause of neonatal morbidity and mortality in children. Through these awards, BWF hopes to invigorate multidisciplinary collaborations and attract new investigators towards this area of research.

The triggers and factors of birth—however shrouded and complex—can impart mortal and lasting impacts on human life and well-being. The Burroughs Wellcome Fund intends to rally new talent and new approaches to explore these mysteries—nourishing new research into parturition science.

## Preterm Birth Initiative

As part of our mission to support underserved fields of biomedical research, the Burroughs Wellcome Fund has created a grant to stimulate new insights into the mechanisms underlying spontaneous preterm birth.

Despite medical and technological advances, the rate of preterm births in the United States remains higher today than 20 years ago. Approximately 12 percent of births in the U.S. are considered preterm, and many physiological and behavioral health problems can be attributed to preterm delivery. Worse, preterm birth is currently the leading cause of neonatal morbidity and mortality in children.

For a medical phenomenon with such grave health and social consequences, little is known about preterm birth and its causes. The Burroughs Wellcome Fund intends to change this through its Preterm Birth Initiative.

Through this competitive award, BWF provides sole- or multi-investigator teams up to $500,000 over a four-year period. Principal investigators must be postdoctoral fellows in their final two years of training, or hold a faculty appointment at a degree-granting institution in the U.S. or Canada. Principal investigators must be citizens or permanent residents of the U.S. or Canada.

We want awarded teams to consider approaches in both basic and translational research, linking expertise within and outside of reproductive science. Molecular and computational approaches such as genetics and genomics, immunology, microbiology, evolutionary biology, mathematics, engineering, and other sciences should be interwoven with insights from more traditional aspects of parturition research such as maternal-fetal medicine, obstetrics, and pediatrics. ///

# Study suggests simple way to predict preterm births

Photo: Bryce Vickmark

## TEST OF CERVICAL MUCUS MAY REVEAL PREGNANT WOMEN'S RISK OF GOING INTO LABOR TOO EARLY

**By Anne Trafton | MIT News Office**

Up to 18 percent of babies born worldwide arrive before they are full-term, defined as 37 weeks of gestation. About 1 million of those babies do not survive, and those who do can face developmental problems such as impaired vision or hearing, defects in the heart or lungs, or cognitive impairments.

Currently there is no reliable way to predict whether a woman with a normal pregnancy will go into labor before 37 weeks. However, a study from MIT offers a new approach to evaluating this risk, by analyzing the properties of cervical mucus. The researchers found that cervical mucus from women who delivered their babies before 37 weeks was very different from that of women who delivered later.

This type of analysis could offer an easy way to calculate the risk of early labor, potentially allowing doctors to try to intervene earlier to prevent preterm births.

"Our prediction is that we might be able to identify risk for preterm birth ahead of time, before labor sets in," says Katharina Ribbeck, an associate professor of biological engineering at MIT and the senior author of the study. "Diagnostic tools for this are missing."

Ribbeck worked on the study with Michael House, an associate professor at Tufts University School of Medicine. MIT postdoc Kathryn Smith-Dupont is the first author of the paper, which appears in the Sept. 4 issue of Scientific Reports.

### Barrier to Infection

Ribbeck's lab at MIT investigates the distinctive chemical and mechanical properties of mucus, and how those properties help it to perform many critical roles as part of the body's first line of defense against infection.

> Our prediction is that we might be able to identify risk for preterm birth ahead of time, before labor sets in. Diagnostic tools for this are missing.

**KATHARINA RIBBECK**
AN ASSOCIATE PROFESSOR OF BIOLOGICAL ENGINEERING AT MIT AND THE SENIOR AUTHOR OF THE STUDY

Several years ago, Ribbeck began exploring whether changes in cervical mucus might play a role in preterm births. Between 25 and 40 percent of early births are believed to be caused by infections that occur when microbes reach the uterus through the cervical plug, which is made of mucus and normally blocks access to the uterus.

In a study published in 2013, Ribbeck found that cervical mucus from pregnant women at high risk of early labor was mechanically weaker and more elastic than that of low-risk pregnant women.

For the new study, she and her colleagues decided to investigate the mucus's permeability to small particles. Mucus is formed from polymers known as mucins, and the composition and arrangement of these mucins determine how porous the gel is.

The researchers collected samples from two groups of patients. The low-risk group included pregnant women who came in to their doctors' offices for routine visits around 30 weeks and ended up giving birth after 37 weeks. The high-risk group included women who went into labor early, between 24 and 34 weeks.

Doctors were able to halt labor in these women, and the samples were taken after they were stabilized. They all ended up giving birth before 37 weeks.

The researchers tested the ability of negatively charged spheres about 1 micron in diameter to travel through the mucus, and found a small but statistically insignificant difference in porosity between the high- and low-risk samples. They then decided to do the same test with charged peptide probes, which are small enough to avoid getting stuck in the mucus network but are sensitive to

*continued >*

> Preterm birth is one of the biggest issues we face in child and baby health care around the world. It's an enormous burden to individuals and families. We sorely need a way to identify risk because all of the tools that we have now don't work very well.

**ERROL NORWITZ**
CHAIRMAN OF THE DEPARTMENT OF OBSTETRICS AND GYNECOLOGY AT TUFTS MEDICAL CENTER

the biochemical modifications of the mucus. With these peptide probes, the researchers found a significant differences in mucus permeability and adhesiveness: The peptides were able to pass through samples from high-risk women much more easily.

This suggests that cervical mucus from women at high risk for early labor, for reasons not yet known, may be more susceptible to invasion by potentially harmful bacteria and microbes, making it more likely that those women will experience an infection that leads to preterm birth, Ribbeck says. In addition, the altered mucus may be less able to retain helpful immune system components such as antibodies or antimicrobial peptides, which would normally help to combat infection.

"Mucins display all sorts of immunologically active factors that you may also lose when the adhesive properties change," Ribbeck says.

She suspects that this loss of adhesion might be caused by changes in molecular structure of the mucins, in particular, changes in the number and types of sugar molecules that comprise part of their structure.

## Risk analysis

Currently, the most common way to try to predict the risk of preterm birth is to measure the length of the cervix, but although a shortened cervix is correlated with higher risk, there are also many cases where a shortened cervix does not lead to preterm birth. Another test involves measuring levels of fetal fibronectin, a material that essentially "glues" the fetal membranes to the uterine wall, in vaginal secretions. However, this is not a completely reliable predictor, and furthermore, women can deliver preterm when both cervical length and fetal fibronectin are normal.

"There's no currently well-accepted universal test," says Smith-Dupont. "The pathophysiology and mechanisms of preterm birth are extremely complex, and what works to assess one patient may not work for another."

Ribbeck anticipates that cervical mucus testing could be done early in pregnancy, as part of a routine screen that would reveal whether a woman was at high risk of preterm birth. (This test would determine risk from infection, but not from other potential causes of early labor.)

Errol Norwitz, chairman of the Department of Obstetrics and Gynecology at Tufts Medical Center, who was not involved in the research, says the new study is an innovative approach to combating a problem that has so far proven intractable. Identifying women at high risk, and potentially giving their babies the chance to remain in utero for even a few extra days, could make a big difference, he says.

"Preterm birth is one of the biggest issues we face in child and baby health care around the world. It's an enormous burden to individuals and families," Norwitz says. "We sorely need a way to identify risk because all of the tools that we have now don't work very well."

Through studies of the chemical composition of the altered mucus, Ribbeck also hopes to develop new ways to restore the normal function of the mucus. "If the mucus is thinner or less adhesive than it naturally is, then we can begin to think about factors to add so that we improve its barrier properties," she says.

The research was funded, in part, by the Burroughs Wellcome Fund Preterm Birth Initiative, the National Institutes of Health, and the National Institute of Environmental Health Sciences. ///

# Science Education

## EMPOWERING NORTH CAROLINA'S CHILDREN WITH SCIENTIFIC POTENTIAL

**At the heart of all that we do to support biomedical science** in the U.S. and Canada, one particular ideal drives our intentions: establish relationships and invest in the person. It is this same philosophy that drives our decision to invest in science education in North Carolina.

When the Burroughs Wellcome Fund became a fully independent, philanthropic foundation in 1994, we established our headquarters in the Research Triangle of North Carolina—a powerhouse of scientific innovation in the Nation and the world. In making North Carolina our home state, we also recognized our responsibility to invest in the people and community here.

Looking at the Fund's own strengths and looking at the Research Triangle's academic advantage—a microcosm of the disparity and potential present throughout the Tar Heel State—our imperative was clear. Our science education investment begins with North Carolina's students and educators.

The Burroughs Wellcome Fund is proud to invest in Science Education as one of its major programs. Our goal is to establish relationships and invest in individual access to STEM education—science, technology, engineering, and mathematics—for communities in all 100 counties of North Carolina.

- Through our Student Science Enrichment Program, we are giving K-12 students in North Carolina added opportunities to experience critical thinking and the excitement of discovery—by investing more than $3 million annually for schools, organizations, and institutions to create and deliver science education activities outside the classroom.
- Through our Career Awards for Science and Mathematics Teachers, we look for proven public school teachers in North Carolina whose vision and effort for STEM access in their community serve as shining examples—and we further buoy that teacher's influence and impact with a $175,000 grant for salary, supplies, and professional development opportunities.
- Through our Promoting Innovation in Science and Mathematics awards, we want to give public school teachers with ingenious, classroom-ready ideas for stimulating STEM learning the chance to put their ideas into play—with one-time grants up to $4500 for materials, equipment, and training.
- Finally, we founded the North Carolina Science, Mathematics, and Technology Education Center (SMT). Since 2004, this non-profit organization has amplified our goal of advancing meaningful STEM opportunities in our classrooms—centralizing materials, equipment, and professional development resources for educators to easily access.

Empowering North Carolina's children with scientific potential—that is how we believe the Burroughs Wellcome Fund can best give back to our home state. We can harness the financial and material resources of our many established partnerships to improve public policy, teacher training, the informal science community, and scientist-educator collaborations. We can invest in individual educators whose natural talents can ignite that one student's curiosity and engage them in the scientific process.

If we are successful in these investments, we will have imparted an even greater gift for North Carolina: that our children, regardless of their future career path, have the science literacy to participate fully in civic life—and advance the potential of our state and our Nation.

## Student Science Enrichment Program (SSEP)

As part of our Science Education initiative, the Burroughs Wellcome Fund wants to empower North Carolina's children with scientific potential. This means supporting the good work of talented, licensed educators in our K-12 schools—but it also means connecting our students with STEM enrichment opportunities outside the schoolyard.

Fortunately, some of the best universities, museums, and scientific organizations in the Nation are right in North Carolina—and they are ideal partners for SSEP.

The Burroughs Wellcome Fund created SSEP specifically to fund and support out-of-school STEM activities for K-12 students in North Carolina. SSEP awards provide up to $60,000 per year for three years for the creation and implementation of after-school, weekend, or summer science programs.

SSEP recipients are limited to non-profit institutions within North Carolina, such as colleges, museums, zoos, as well as public and private schools and community groups. Proposed programs must be designed in consideration of school curricula; implemented by well-trained staff; and structured with learning objectives and post-participation assessments.

## Career Awards for Science and Mathematics Teachers (CASMT)

North Carolina has one of the Nation's top scientific economies. And our continued competitiveness in research, medicine, technology, agriculture, and manufacturing relies on a workforce inspired and mentored by a special cadre of equally hardworking professionals: the science and math educators in our public schools.

In our support of science education in North Carolina and in all of our philanthropic activities, the Burroughs Wellcome Fund is guided by one particular ideal: establish relationships and invest in the person.

Just as we prioritize the development of individual scientists, we also created an award program that enhances the professional development of a promising science or mathematics educator to reward the best teachers to inspire our children in the classroom.

The Burroughs Wellcome Fund is proud to recognize through CASMT mid-career, K-12 teachers in North Carolina public schools who have proven their command of science or

mathematics subject matters, demonstrated outstanding consistency and success in pedagogy, and are ready to emerge as mentors and innovators within the STEM community of our state.

These star teachers are awarded $175,000 over a period of five years to support their professional development, augment their equipment needs, and supplement their public salary. Awardees are also encouraged to reach beyond their school to build collegial learning communities within their district or region, and to develop strategies for their personal growth as teaching professionals and leaders of practice.

Our belief in "investing in the person" ensures that each award has life beyond any single grant. That creative, original, and unique ideas will continue to rise throughout an awardee's career—and in turn, strengthen the greater teaching community and empower the scientific potential of North Carolina's children—those are our ultimate reasons for investing in North Carolina's best science and math educators.

## Promoting Innovation in Science and Mathematics (PRISM)

The Burroughs Wellcome Fund created the Promoting Innovation in Science and Mathematics (PRISM) grant to help North Carolina public school teachers create exciting, hands- on learning experiences in class or after school.

The award provides up to $3,000 for one year to cover the costs of equipment, materials, and supplies for instructional use—with an additional $1,500 if additional training is required to implement the new equipment or curriculum.

The grant cannot go towards basic classroom technology equipment such as laptops and projectors, nor can it be used for field trips and guest speakers.

As part of our Science Education initiative, the Burroughs Wellcome Fund wants to empower North Carolina's children with scientific potential. We want to see more students engaged in innovative lessons and activities that spark their enthusiasm and guide them through critical inquiry—positive experiences that help instill a life-long hunger for science and math learning. ///

# Inner Banks STEM Center

## A CONVERSATION WITH ALVIN POWELL

**Interview by Russ Campbell**

After he retired from a 30-year career in the FBI, Alvin Powell retired to Washington, North Carolina in Beaufort County. Now he is the founder and director of the Inner Banks STEM Center. This is an excerpt from an interview with Mr. Powell from the audiocast, #whystem.

**You say you're retired, but you're very active, and you're very active in the STEM community. How did you get involved with STEM?**

Since I grew up in Washington, D.C., where we did not have exposure—at least in my section of Washington, D.C.—to science and technology programs, youth programs... there were no YMCAs, no Boys and Girls Clubs, no Police Athletic League Activities. We did not have that enrichment component. So that when I was in the FBI, I had an opportunity to go to flight school and learn how to fly. I met some really neat people in the science and technology community. When I retired from the FBI as an agent and a pilot, I thought one of the ways I could give back to the community would be to get involved with some kind of science, technology, engineering, and math program to get kids at the middle school level at least interested in this environment.

We chose aviation and boating because background checks and physical fitness components are required in most of those jobs. So, we covered all the bases. A lot of the kids, particularly in the lower income brackets do not think about the consequences of bad decisions growing up as a middle school aged kid. When they do achieve academic success, sometimes their background checks don't come out well and they aren't able to get the job. So, they will sometimes turn to adverse, negative opportunities like joining gangs, hate groups, extremist groups and things like that. We felt like a STEM program in this area was a target rich opportunity to expose kids at a very early age before they started developing negative life skills. It would also show

> We decided to put a STEM program in place to make it fun, but yet to slip in the intellectual learning component and start getting them interested (not intimidated) in taking science and math courses so that when they graduate they will have met professionals in the science and technology ranks.

**ALVIN POWELL**
PRESIDENT
INNER BANKS STEM CENTER

them that no matter what their race, color, creed or socio-economic situation, that education—not violence—is the key to improving their quality of life.

**One of the questions that we're asking ourselves at the Burroughs Wellcome Fund and at the North Carolina Science Math and Technology Education Center is, "Why STEM?" What is it about STEM that enhances the educational opportunities for students?**

That's a great question. Most of the job predictors indicate that employment for kids when they get older will be in the STEM field—whether that's engineering, science, technology, allied health and what have you. Very few jobs now don't require some basic technological savvy. So what we were trying to do is to expose some of these kids, who may be intimidated by math, chemistry, science—not because they can't do it intellectually, but they have just been turned off because of peer pressure and things of that nature.

We decided to put a STEM program in place to make it fun, but yet to slip in the intellectual learning component and start getting them interested (not intimidated) in taking science and math courses so that when they graduate they will have met professionals in the science and technology ranks. They will have met some of us who are pilots and law enforcement, engineers, technologists and what have you. And we will have given them the self-esteem, courage, and confidence to feel that with proper training and discipline and time management they can start working on a STEM career or at least those educational classes so that when they graduate from high school, they will have a definite pattern of thought—and not be intimidated to look at a science and technology career.

The best way to do that is not two weeks before they graduate from high school. But it's to start getting their mindset and self-esteem and confidence in place as a middle school aged kid. We have found too that when you work with kids who are at risk, and not necessarily because of their race or their diversity situation, but also because of their socio-economic status, that their peers do not necessarily encourage them to look at science and technology because they may have been discouraged. By us exposing them to this type of program, we're changing their mindset. And quite a few of our kids, extensively though the grants that we've had from the Burroughs Wellcome Fund, have allowed us to expose kids to some pretty unique technology arenas. And they are now changing their minds about what they want to do with their future.

**What kinds of things are you offering?**

STEM is a broad spectrum. It means a lot, and depending on who you talk to it could mean agriculture, it could be science... so you have to first define what are you going to lock into. You can't be to everyone under the STEM arena. Because of the area where we're located, we are in close proximity to military bases, aviation facilities, a boating community, and some fine academic facilities with engineering programs, we decided to focus on two things that we thought would capture the kids intellectually. ...And then cause them to be interested in learning how these things float or fly. We locked into aviation i.e.: the aerospace community and boating.

> We're going to expose the kids to the confidence to take more courses that may or may not cause them to want them to get involved with aviation or boating, but at least they can see how science and technology plays a part in their everyday life...

ALVIN POWELL

Recently we've also drilled down on the health component because health is always been a part of our program. But now, through the courtesy of a grant from the local community hospital Beaufort Hospital, we're going to start putting together a risk assessment program. And then we're going to add a youth workforce preparedness initiative so we can start looking at the holistic kid and not just STEM without an end goal.

We're going to expose the kids to the confidence to take more courses that may or may not cause them to want them to get involved with aviation or boating, but at least they can see how science and technology plays a part in their everyday life and then they can see how staying physically fit, making their life decisions will cause them to graduate or go into high school with a proper mindset. Then, they will be more career-oriented when they are about to leave high school. That was kind of the reason why we chose aviation and boating because most kids, whether you're 7 or 70, have some interest in airplanes flying overhead or a cool boat passing by and we found that has been very successful in capturing a kid's interest. We hope, as you can see in the banners in the background, once kids see airplanes and actually climb onto an F-15 or KC135 or Harrier Jet or Helicopter they will hopefully ask how it operates or what does it take to fly that or design it—or work on it.

And the same concept with the boating. The kids get a chance to go on some pretty cool boats some of which are owned by the US Coast Guard, then some of the kids are asking what does it take to qualify to operate the boat, to work on it, to design it. So that's just what causes what we call the "intellectual bait trap" to work. So, once we've hooked them, then they want to learn more. That's how we've chosen those three areas but we've also flipped in life skills to emphasize the physical fitness component and also the ability to pass a background check as the kids get older and try to qualify for some of these jobs.

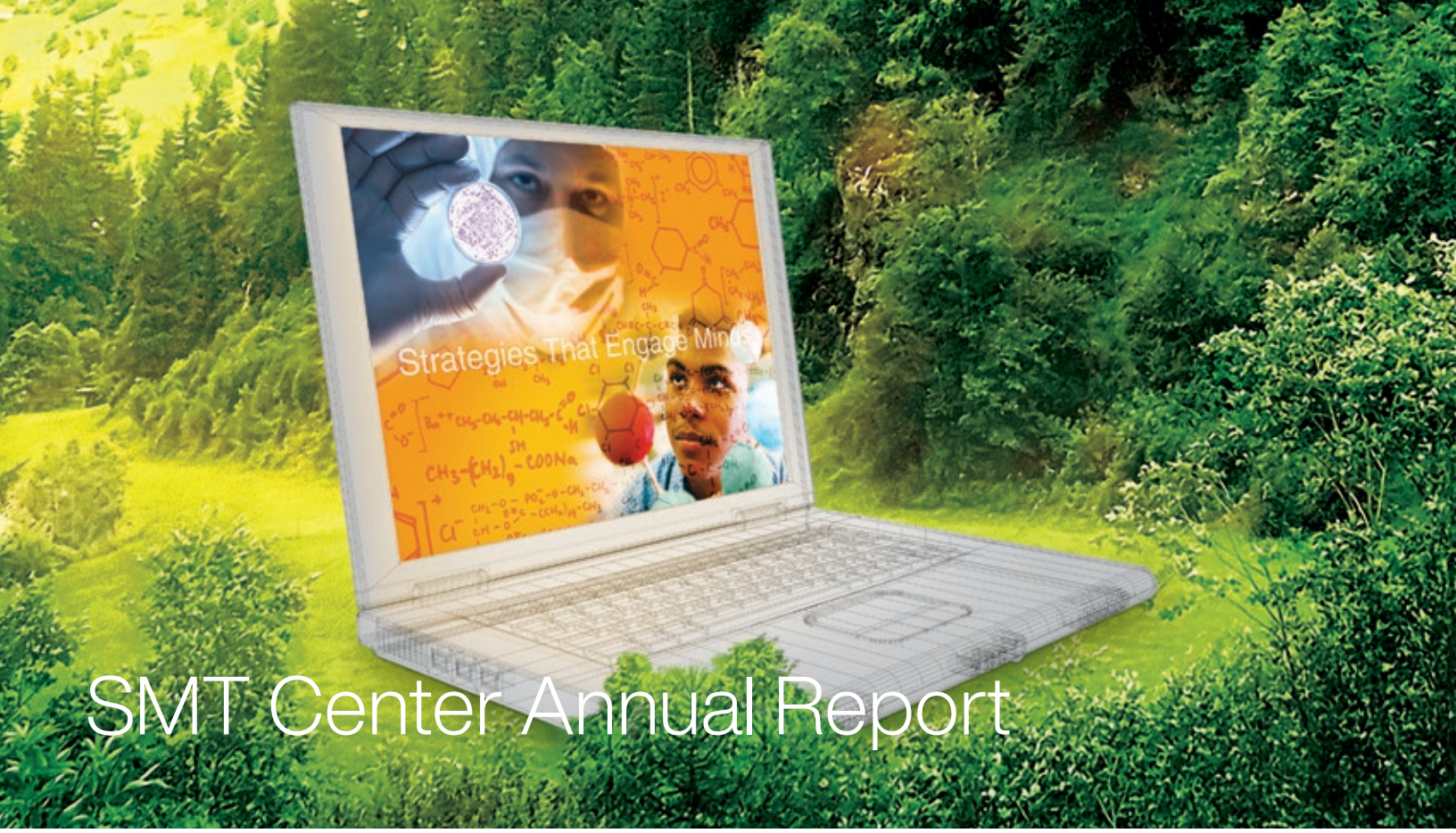
**How has the Burroughs Wellcome Fund Student STEM Enrichment Program enhanced your efforts here at the Inner Banks STEM Center?**

In a nutshell, we could not have done it without it. The SSEP program started financially supporting us in 2015. We were incorporated in 2012 and we started here at the Washington Warren Airport and it was a one week summer camp program and we funded the program through donations. But once we were able to put together our mindset on what we thought the program would be—specific focuses,



strategic plan—we were fortunate enough to write our first grant for the SSEP in 2015. And once we were awarded that grant, we were funded for the year 2015, 2016, and 2017 and that enabled us to go from a one week program to expand our program to a very novel and innovative four week program and several afterschool programs. So it was like going from rags to riches, a dream come true. We would have never been able to expand and put some of our dreams into reality had it not been for the SSEP. Then we were fortunate enough to get a renewal grant that will fund us for 2018-2019-2020.

So we are constantly refining, tweaking, and modifying the funds without exceeding the bottom line as we deal with operational challenges. We try to address what seems to be the most innovative science and technology programs. We would never be able to keep up with the times, or be able to change our philosophies but still keeping within the same STEM concept had it not been for the flexibility that the Burroughs Wellcome Fund grant and personnel —I can't say how much I enjoy talking and working with the folks in your agency that have been supportive and nurturing as we modify, tweak, and try to improve our impact on the kids in this area. ///




# SMT Center Annual Report

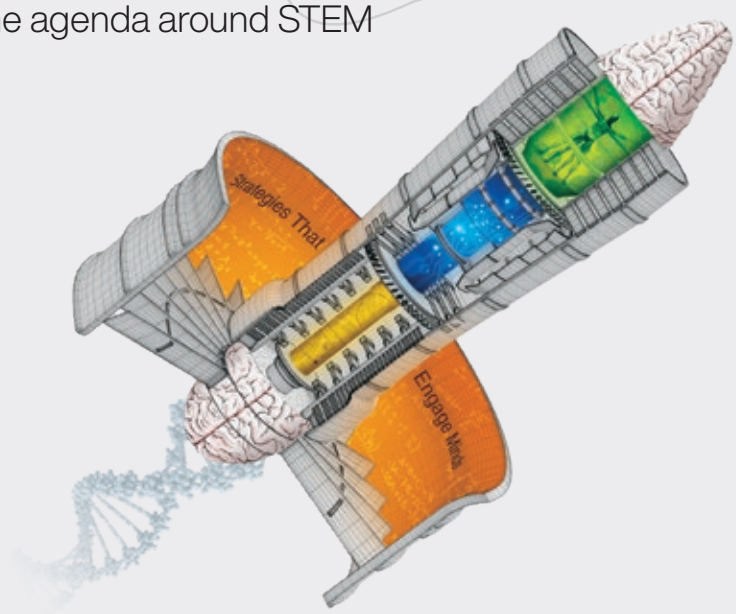
## SEPT 2019 – AUGUST 2020

The North Carolina Science, Mathematics, and Technology Education Center (SMT Center) was incubated by the Burroughs Wellcome Fund in 2002. Since then it has served as a convener and catalyst for STEM education across North Carolina. The SMT Center takes a broad view of STEM referring to it as **Strategies that Engage Minds®** that provides students with an education that is relevant to real world situations.

A partnership between the SMT Center, the North Carolina Inquiry Collaborative Network (NCICN) and the six North Carolina school districts from the i3 grant to provide science kit refurbishing and distribution continues. In the past year, the partnership focused on sustainability and financials planning efforts as well as workshops that deepen the understanding of inquiry-based instructional practices and student-centered learning. Twelve multi-day workshops have been held that have resulted in nearly 1,000 teachers trained to implement at least one STC (Science and Technology Concepts) Unit in their classrooms.

Working with the Friday Institute for Educational Innovation, Golden Leaf Foundation and the N.C. Dept. of Public Instruction, the SMT Center has developed an updated STEM School Progress Rubric to be used by schools as a strategic planning tool for implementing a high-quality STEM school. It is designed to help school teams reflect on the current state of their work, create sustainable plans, experiment with innovations, determine next steps, and track their progress. Schools, using the rubric, can apply to be designated as a STEM School of Distinction. The first version of the rubric has been used as a template in numerous states and the expectation is this rubric will continue to be utilized nationally.

Through sponsorships, leading sessions at various conferences and membership on boards and advisory committees, the SMT Center and BWF continue to shape the agenda around STEM education in North Carolina.




UNC-Charlotte and the SMT Center received funding from the Army Education Outreach Program and Battelle to support STEM student research in rural areas of eastern and western N.C. This program is designed to build the capacity of high school teachers to support student research through Saturday academies for teachers and students. The targeted population for the program is students that are underrepresented in STEM, low income, rural, would-be first-generation college or military dependent.

Through sponsorships, leading sessions at various conferences and membership on boards and advisory committees, the SMT Center and BWF continue to shape the agenda around STEM education in North Carolina. The NC STEM Ecosystem which is led by the SMT Center and BWF connect formal education and extended learning organizations, business and industry, museums and science centers, STEM professionals and grant makers with the goal of providing STEM opportunities across the state. ///

# Science and Philanthropy

The Burroughs Wellcome Fund makes noncompetitive grants for activities and career development opportunities for scientists that fall outside of our competitive award programs, but are closely related to our targeted areas.

We place special priority on working with nonprofit 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 by email. Mailed requests 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.

# Report on Finance

**The Burroughs Wellcome Fund's investments totaled $751.2 million at August 31, 2019, the end of our fiscal year.** 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 are 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 seven voting members, including five 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 $163.8 million. The sector's target allocation was 25 percent, and actual holdings stood at 21.8 percent.
- U.S. small capitalization equity assets had a market value of $112.1 million. The sector's target allocation was 18 percent, and actual holdings stood at 14.9 percent.
- International equity assets had a market value of $194.0 million. The sector's target allocation was 32 percent, and actual holdings stood at 25.8 percent.
- Fixed income assets had a market value of $131.4 million. The sector's target allocation was 22 percent, and actual holdings stood at 17.5 percent.
- Cash equivalent assets had a market value of $9.7 million. The sector's target allocation was 3 percent, and actual holdings stood at 1.3 percent.
- Alternative assets had a market value of $140.2 million. The sector did not have a target allocation, and actual holdings stood at 18.7 percent. The maximum permitted allocation to alternative assets stood at 20.0 percent at cost.

The total market value of BWF's investments decreased by $37.9 million, or 4.8 percent, from the end of the previous fiscal year. This decrease in assets was due mainly to poor returns for world equities in the fourth quarter of 2018. BWF's total investment return before investment management fees for the fiscal year was +1.0 percent. The U.S. large capitalization equity sector returned +7.2 percent, the U.S. small capitalization equity sector had a -12.1 percent loss, the international equity sector lost -0.7 percent for the fiscal year, and fixed income produced a +8.5 percent result.

As of August 31, 2019, BWF employed 16 marketable securities investment managers. In the U.S. large capitalization equity sector, the managers were Brown Advisory; LSV Asset Management; and Martingale Asset Management. BMO Asset Management, Loomis Sayles, Bridge City Asset Management and Essex Investment Management managed U.S. small capitalization equities. Camden Asset Management; C.S. McKee; Rimrock Capital Management; Barings; and Amundi Pioneer were the fixed income managers. Capital Guardian Trust Company; Hardman Johnston Global Advisors; Acadian Asset Management; and Hansberger Growth Investors managed international equities. BWF also held investments in five venture capital funds: Intersouth Partners V and VI, Spray Venture Funds I and II and Mission Ventures II. Winston Partners managed a fund of equity oriented hedge funds. Blackrock Alternative Advisors managed a fund of absolute return strategies. Hamilton Lane Advisors managed three funds of private equity strategies and three private debt strategies. Dyal Capital managed a private equity fund. Neuberger Berman managed an insurance linked strategy. Finally, the Fund internally managed a diversified portfolio of mainly passive investments which was named the Tactical Portfolio. The Tactical Portfolio included investments in U.S. equities, international equities and global bonds.

# Statements of Financial Position

**AUGUST 31, 2019 AND 2018**

*(All dollar amounts presented in thousands)*

| | 2019 | 2018 |
|---|---|---|
| **ASSETS** | | |
| Cash and cash equivalents | $ 5,479 | $ 1,838 |
| Investments | 746,832 | 788,201 |
| Accrued interest and dividends receivable | 1,383 | 1,461 |
| Other assets | 142 | 100 |
| Property and equipment, net | 7,163 | 7,351 |
| Total assets | $ 760,999 | $ 798,951 |
| **LIABILITIES AND NET ASSETS** | | |
| Transactions payable, net | $ 2,639 | $ 1,714 |
| Accounts payable and other liabilities | 1,227 | 1,019 |
| Excise tax payable | 551 | 1,504 |
| Deferred federal excise taxes | 2,259 | 2,680 |
| Unpaid awards | 114,802 | 103,876 |
| Total liabilities | 121,478 | 110,793 |
| Unrestricted net assets | 639,521 | 688,158 |
| Total liabilities and net assets | $ 760,999 | $ 798,951 |

# Statements of Activities

**AUGUST 31, 2019 AND 2018**

*(All dollar amounts presented in thousands)*

| | 2019 | 2018 |
|---|---|---|
| **REVENUES** | | |
| Interest and dividends, less investment expenses of $3,079 and $3,382 in 2019 and 2018, respectively | $ 8,417 | $ 8,075 |
| Net realized gain on sale of investments | 15,725 | 45,372 |
| Total revenues and realized gains | $ 24,142 | $ 53,447 |
| **EXPENSES** | | |
| Program services | $ 45,111 | $ 39,699 |
| Management and general | 6,061 | 7,598 |
| Total expenses before net unrealized appreciation and deferred federal excise tax | 51,172 | 42,297 |
| Net unrealized appreciation (depreciation) of investments, net of provision for deferred federal excise tax benefit / (expense) $421 and $(465) in 2019 and 2018, respectively | (21,607) | 22,476 |
| Change in net assets | (48,637) | 28,626 |
| Net assets at beginning of year | 688,158 | 659,532 |
| Net assets at end of year | $ 639,521 | $ 688,158 |

# Grants Index

**BWF makes all grants to nonprofit organizations.** For most of the programs, 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.

In addition to making competitive awards, BWF makes noncompetitive grants—Ad Hocs—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.

For full audited financials visit **bwfund.org/annualreport**

# Program Summary

**AUGUST 31, 2019**

| | Awarded Net of Cancelled | Amount Paid | Percentage of Total Paid |
|---|---|---|---|
| **BIOMEDICAL SCIENCES** | | | |
| Career Awards in the Medical Sciences | $ 8,690,000 | $ 8,421,813 | |
| Physician-Scientist Institutional Award | 12,500,000 | 2,500,000 | |
| Research Travel Grant | 299,132 | 299,132 | |
| Ad Hoc | 1,046,000 | 751,000 | |
| Total | $ 23,180,132 | $ 11,971,945 | 34% |
| **DIVERSITY IN SCIENCE** | | | |
| Graduate Diversity Enrichment Program | $ 52,500 | $ 12,500 | |
| Postdoctoral Enrichment Program | 859,869 | 979,870 | |
| Ad Hoc | 40,000 | 45,000 | |
| Total | $ 952,369 | $ 1,037,370 | 3% |
| **INFECTIOUS DISEASES** | | | |
| Career Guidance | $ 283,346 | $ 239,835 | |
| Investigators in Pathogenesis of Infectious Disease | 5,558,011 | 5,682,133 | |
| Ad Hoc | 1,082,938 | 1,053,938 | |
| Total | $ 6,924,295 | $ 6,975,906 | 20% |
| **INTERFACES IN SCIENCE** | | | |
| Career Award at the Scientific Interface | $ 4,089,570 | $ 4,329,671 | |
| Ad Hoc | 170,500 | 300,500 | |
| Total | $ 4,260,070 | $ 4,630,171 | 13% |
| **POPULATION SCIENCES** | | | |
| Curriculum Development in Quantitative Thinking | $ – | $ 225,000 | |
| Institutional Program Unifying Population and Laboratory-Based Sciences | – | 2,388,870 | |
| Ad Hoc | 3,000 | 3,000 | |
| Total | $ 3,000 | $ 2,616,870 | 7% |

# Program Summary

**AUGUST 31, 2019**

| | Awarded Net of Cancelled | Amount Paid | Percentage of Total Paid |
|---|---|---|---|
| **REGULATORY SCIENCE** | | | |
| Innovation in Regulatory Science Awards | $ 2,500,788 | $ 1,850,788 | |
| Ad Hoc | 120,000 | 90,000 | |
| Total | $ 2,620,788 | $ 1,940,788 | 6% |
| **REPRODUCTIVE SCIENCES** | | | |
| Preterm Birth Initiative | $ 3,000,000 | $ 1,125,000 | |
| Total | $ 3,000,000 | $ 1,125,000 | 3% |
| **SCIENCE AND PHILANTHROPY** | | | |
| Ad Hoc | $ 348,290 | $ 414,290 | |
| Total | $ 348,290 | $ 414,290 | 1% |
| **SCIENCE EDUCATION** | | | |
| Career Award for Science and Mathematics Teachers | $ 875,000 | $ 465,000 | |
| PRISM Award | – | – | |
| Student STEM Enrichment Program | 1,644,558 | 2,170,510 | |
| Ad Hoc | 3,425,025 | 1,794,025 | |
| Total | $ 5,940,083 | $ 4,429,535 | 13% |
| **GRAND TOTAL** | **$ 46,584,027** | **$ 35,141,874** | **100%** |

# Biomedical Sciences

## Career Awards for Medical Scientists

**Jonathan R Brestoff, MD, PhD**
Washington University
Role of Cell-to-Cell Transfer of Mitochondria in Regulating Metabolism

**Gaurav Das Gaiha, DPhil, MD**
Harvard Medical School
Using Network Theory to Suppress the Latent HIV-1 Reservoir

**Karuna Ganesh, MD, PhD**
Memorial Sloan-Kettering Cancer Center
Emergence of Regenerative Plasticity in Metastasis Stem Cells

**Wei Gu, MD, PhD**
University of California-San Francisco
Modeling Pathogen Cell-free DNA Dynamics in Acute Infections

**Marie A Guerraty, MD, PhD**
University of Pennsylvania
The interplay between cardiomyocyte FOG2 and HIF pathway in Coronary Microvascular Disease

**Rodney Infante, MD, PhD**
University of Texas Southwestern Medical Center-Dallas
Regulation of Cancer Cachexia Wasting by a Tumor-Adipose-Hypothalamic Axis

**Michael George Kattah, MD, PhD**
University of California-San Francisco
A20 and ABIN-1 cooperatively preserve intestinal integrity

**Corey Keller, MD, PhD**
Stanford University
Closing the loop: development of real-time, personalized brain stimulation

**Robert M Samstein, MD, PhD**
Memorial Sloan-Kettering Cancer Center Immunogenicity of Homologous Recombination Defects and Response to Immunotherapy

**Ashley Steed, MD, PhD**
Washington University
Regulation of Host Immunity via Microbially-derived Metabolites Santosha

**Santosha A. Vardhana, MD, PhD**
Memorial Sloan-Kettering Cancer Center
Investigating metabolic susceptibilities of exhausted T-cells

**Andrew Sean Venteicher, MD, PhD**
University of Pittsburgh
Uncovering drivers of immortality in human CNS tumors

**Doris Du Wang, MD, PhD**
University of California-San Francisco
Using adaptive neurostimulation to understand and enhance motor skill learning in Parkinson's Disease

## Collaborative Research Travel Grant

**Ernesto Abel-Santos, D.Phil., PhD**
University of Nevada-Las Vegas

**George W. Agak, PhD**
University of California-Los Angeles

**Yoko Miyamoto Ambrosini, D.V.M., PhD**
Iowa State University

**Manuela Aseye Ayele Ayee, PhD**
Dordt College

**Wadie F. Bahou, MD**
New York University

**Joseph Carrion, PhD**
Hofstra University School of Medicine

**Chun-An Chou, PhD**
Northeastern University

**Rebecca C. Christofferson, PhD**
Louisiana State University

**Heather A. Clark, PhD**
Northeastern University

**Ke Du, PhD**
Rochester Institute of Technology

**Erik Engeberg, PhD**
Florida Atlantic University

**Amal Isaiah, MD, PhD**
University of Maryland-Baltimore

**Adrian Jinich, PhD**
Weill Medical College of Cornell University

**Jesse Vincent Jokerst, PhD**
University of California-San Diego

**Louis Kang, MD, PhD**
University of California-Berkeley

**Oleg K. Karaduta, MD**
University of Arkansas for Medical Sciences

**Budhachandra Khundrakpam, PhD**
McGill University

**KiBum Lee, PhD**
Rutgers University

**Patty J. Lee, MD**
Duke University

**Michael G. Lerner, PhD**
Earlham College

**Jianing Li, PhD**
University of Vermont

**Steven Alexander Lopez, PhD**
Northeastern University

**Diane LaVern-Lygette Nelson, PhD**
Carnegie Mellon University

**Dao Nguyen, MD**
McGill University

**Zakaria Orfi, PhD**
University of Montreal

**Erica Cho Brown Peters, PhD**
University of North Carolina-Chapel Hill

**Tomas Pluskal, PhD**
Massachusetts Institute of Technology

**Elizabeth Marie Ransey, PhD**
Duke University

**Barbara Rivera, PhD**
McGill University

**Maha Saber, PhD**
University of Arizona

**Grigoriy Sereda, PhD**
University of South Dakota

**Argel Aguilar Valles, PhD**
Carleton University

**Kai-tak Wan, PhD**
Northeastern University

**Meni Wanunu, PhD**
Northeastern University

**Kate Lynn White, PhD**
University of Southern California

## Physician Scientist Institutional Award

**Texas A&M University**

**University of California-Los Angeles**

**University of Chicago**

**Washington University**

**Weill Cornell Medicine Physician-Scientist Academnia**

# Career Guidance

## Career Guidance for Trainees

**American Society for Pharmacology and Experimental Therapeutics**
Coaching for Career Development via the ASPET Mentoring Network

**Boston University**
Training Opportunities To Augment Learning (TOTAL)

**Clemson University**
Math in Medicine: Developing Depth and Breadth of Knowledge in Math Sciences PhD Students at Clemson University

**Iowa State University**
Graduate Students Gaining Practical Experience Through Short-Term Team Consulting Projects

**Ohio State University**
Researcher, Mentor, and Teacher: Preparing well rounded scholars

**Western University**
Market validation Laboratory and Business Training

**Vanderbilt University**
Data Science Essentials: Transitioning Biomedical Scientists from the Bench to the Cloud

# Diversity in Science

## Graduate Diversity Enrichment Program

**DUKE UNIVERSITY**

**Alejandro Antonia**
Host-Directed Therapy to Circumvent Immune Evasion by Leishmania major

**Dalton Nathaniel Hughes**
Network Dynamics of Negative and Positive Valence Systems in Decision Making

**Luis Alexander Navarro**
Guided Adsorption of Protein-Bottlebrush Hybrids for Functional Surface Coatings

**Estefany Yamilet Reyes**
Mechanism to evade host immunity by Mucorales fungi

**Blanca Victoria Rodriguez**
Characterizing the association of RNA with bacterial membrane vesicles and their delivery to host cells

**UNIVERSITY OF NORTH CAROLINA-CHAPEL HILL**

**LaKeya Charmaine**
Hardy Using STALs to exploit CD22 on peanut-specific memory B cells to induce tolerance

**Juanita Limas**
A Novel Way of Blocking Origin Licensing and Recapitulating Early Oncogene Activation

**Shenee Chantel Martin**
Examining the molecular consequences of sleep disruption in Alzheimer's disease onset and progression

**Kia Zolee Perez-Vale**
Defining the molecular mechanisms underlying apical-basal polarity establishment and morphogenesis

**Ricardo Rivera-Soto**
Characterizing the role of the PI3K/Akt/mTOR pathway in KSHV-associated malignancies

**Tamara Vital**
Exploring the mechanism underlying a small molecule inhibitor of chromatin accessibility

## Postdoctoral Enrichment Program

**Osama M. Ahmed, PhD**
Princeton University
Neural Mechanisms underlying Locomotor Modulation of Complex Behavior

**Cierra A. Birch, PhD**
University of California-San Diego
Regulation of PAR4 expression and function by F2RL3 methylation

**Korey Brownstein, PhD**
University of Chicago
Discovery of Defense Metabolites and Their Regulatory Effects in Plants

**Alex J. Guseman, PhD**
University of Pittsburgh
Cataracts, a blinding attraction between crystallin proteins

**Nadia Herrera, PhD**
University of California-San Francisco
Investigating the role of ESX-1 in Cell-Cell communication of Mycobacteria

**Barbara Juarez, PhD**
University of Washington
Establishing the pathophysiology of gating charge mutations in neuronal dysfunction and behavioral disruption

**Andrew Kekupa'a Knutson, PhD**
University of Hawaii
Regulation of the hypoxic response by chromatin factors in the mouse heart

**Laramie Denise Lemon, PhD**
Emory University
Links between chromatin status and 3' end mRNA processing

**David Rafael Martinez, PhD**
University of North Carolina-Chapel Hill
Defining Zika virus-specific neutralizing and disease-enhancing IgG responses

**Michaelle Ntala Mayalu, PhD**
California Institute of Technology
Modeling and Implementation of Paradoxical Signaling Components in Bacteria using Control Theoretic Techniques

**Aaron Lavel Moye, PhD**
Harvard University
Role of epithelial-mesenchymal cross talk during early-stage lung cancer

**Diane LaVern-Lygette Nelson, PhD**
Carnegie Mellon University
Mechanisms of Molecular Transport in Drug-loaded Water-in-Perfluorocarbon Emulsions

**Nancy Padilla Coreano, PhD**
Massachusetts Institute of Technology
Neural circuits underlying social dominance in mice

**Brittany Louise Taylor, PhD**
University of Pennsylvania
Therapeutic Potential of Extracellular Vesicles for Tendon Injury Repair and Maintenance

# Infectious Diseases

## Investigators in the Pathogenesis of Infectious Disease

**Theresa Alenghat, DVM., PhD**
University of Cincinnati
Dietary regulation of innate intestinal immunity

**Francis Alonzo, PhD**
Loyola University-Chicago
Deciphering how bacterial pathogens evade innate immunity

**Isaac M. Chiu, PhD**
Harvard Medical School
Neuronal regulation of influenza virus infection

**Jun R. Huh, PhD**
Harvard Medical School
Maternal gut bacteria, viral infection and neurodevelopmental disorder

**Ivaylo Ivanov, PhD**
Columbia University
Regulation of mucosal infections by innate lymphoid cells

**Leigh Knodler, PhD**
Washington State University
Remain confined or break free? Intracellular niche selection by Gram-negative bacteria

**Kristin N. Parent, PhD**
Michigan State University
Enter the goliaths: structure and function of giant virus entry mechanisms

**John W. Schoggins, PhD**
University of Texas Southwestern Medical Center-Dallas
Genetic dissection of innate immune pathways that modulate viral infection

**Kimberley D. Seed, PhD**
University of California-Berkeley
The impact of fluctuating microenvironments on phage-bacteria interactions in the human intestinal tract

**Randy Stockbridge, PhD**
University of Michigan-Ann Arbor
The molecular physiology of long-range electrical communication in bacterial biofilms

**Ellen Yeh, MD, PhD**
Stanford University
Targeting an ancient endosymbiosis in modern-day parasites

# Interfaces in Science

## Career Awards at the Scientific Interface

**Steven Mark Banik, PhD**
Stanford University
Reprogramming proteins for targeted degradation and intracellular trafficking

**Jennifer Ann Noelani Brophy, PhD**
Stanford University

**Fei Chen, PhD**
Massachusetts Institute of Technology
Genomic tools for understanding spatial and dynamic organization of biological tissues

**Víctor García-López, PhD**
Rice University
Molecular machines target, disrupt cell membranes, and kill cancer cells and resistant bacteria

**Livnat Jerby, PhD**
Massachusetts Institute of Technology
Deciphering immune evasion mechanisms in cancer with single-cell technologies

**Christina K. Kim, PhD**
Stanford University
Simultaneous molecular activity recording and transcriptomics of brainwide neural ensembles

**Joseph William Larkin, PhD**
University of California-San Diego
Patterning microbial populations through collective dynamics

**Jeffrey E. Markowitz, PhD**
Harvard Medical School
Resolving the neural mechanisms of reinforcement learning through new behavioral and optical technologies

**Sergey D. Stavisky, PhD**
Stanford University
Brain-computer interfaces to actualize the movements and speech of people with paralysis

**Jeffrey Robert Tithof, PhD**
University of Rochester
Experimentally-validated simulations of cerebrospinal fluid flow through the brain's perivascular network

**Mark Wagner, PhD**
Stanford University
Computations, recurrent dynamics, and learning in the cortex-cerebellum circuit underlying skilled behavior

# Regulatory Science

## Innovation in Regulatory Science Award

**Jessica Myers Franklin, PhD**
Harvard University
Evaluating the validity of real world data for regulatory decision-making through replication of randomized controlled trials

**Brigitte Gomperts, MD, PhD**
University of California-Los Angeles
Developing a screen to test the toxicity of new and emerging tobacco products on the airway epithelium

**Christoph Hornik, MD, PhD**
Duke University
Real world data to support pediatric drug labeling

**Mona Jarrahi, PhD**
University of California-Los Angeles
High-throughput detection of carcinogenic aflatoxins in agricultural food products through terahertz pulsed imaging

**Meghan Moran, PhD**
Johns Hopkins University
Innovative methods to inform regulatory action on tobacco product marketing

# Reproductive Science

## Preterm Birth Initiative

**Nima Aghaeepour, PhD**
Stanford University
Multiomics Modeling of the Immunological Clock of Pregnancy

**Adrian Erlebacher, MD, PhD**
University of California-San Francisco
Epigenetic regulation of labor onset

**Joanna Halkias, MD**
University of California-San Francisco
Harnessing immune regulatory mechanisms to target the fetal inflammatory response in preterm birth

**Mala S. Mahendroo, PhD**
University of Texas Southwestern Medical Center-Dallas
Defining the Spatio-Temporal Drivers of Cervical Remodeling in Pregnancy and Parturition

**Carole R. Mendelson, PhD**
University of Texas Southwestern Medical Center-Dallas
Fetal-Maternal Signaling in the Initiation of Labor

**Aleksandar Stanic-Kostic, MD, PhD**
University of Wisconsin-Madison
Novel Innate Lymphoid Cells in Preterm Birth

# Science Education

## Career Awards for Science and Mathematics Teachers

**Casandra S. Cherry**
Phillips Middle
Edgecombe County Schools

**Renata Crawley**
West Marion Elementary School
McDowell County Schools

**Justin Jones**
Ansonville Elementary School
Anson County Schools

**Beverly Owens**
Kings Mountain Middle School
Cleveland County Schools

**Sallie Senseney**
Mountain Heritage High School
Yancey County Schools

## Student STEM Enrichment Program

**Aurora Fossil Museum**
IMAGINE-NC: Integrating Mathematics and Geology in Eastern North Carolina

**Catawba College**
Girls on outdoor Adventure for Leadership and Science (GALS)

**Communities In Schools of Cape Fear**
STEM After School

**Duke University**
Ignite: Empowering Students through STEM Education

**McClintock Partners In Education**
Pathways Summer Science Camp

**North Carolina State University**
Programmed Robotics in the After-School Makerspace: A Four-County Initiative

**North Carolina State University**
CRECER: Cultivating Research Experiences with Community Engaged Roots

**UNC Institute for the Environment**
STEM Experiences in the Lab and Field (SELF) for Robeson Early College High School Students

**Wake County Public School System**
Exploring STEM Careers

**Western Carolina University**
PEARO: Providing Equitable Access to Robotics Opportunities

# Ad Hoc

## Biomedical Sciences

### Career Development

**American Physician Scientists Association (APSA)**
Support for APSA's 2018-2019 Mentorship Program Expansion

**American Society for Cell Biology**
Support for the Minorities Affairs Committee and Women in Cell Biology Committee Annual Meeting

**Baylor College of Medicine**
Support for the Alexander R. Matzuk 2019-2020 speaker series and meeting support in lieu of honorarium for CAMS advisory member Martin M. Matzuk, MD, PhD

**Federation of American Societies for Experimental Biology**
Support for the FASEB summer research conference on The Biology of Cilia and Flagella

**International Society for Antiviral Research**
Support for the 2019 ISAR Gertrude Elion Memorial Lecture Award and 32nd International Conference on Antiviral Research

**Keystone Symposia**
Support for 2019 underrepresented early career scientist travel awards and fellows program

**Michigan State University**
Support for URM undergraduates to attend the 2019 SSR meeting

**Society for Neuroscience**
Support for Trainee Professional Development Awards

**University of Colorado-Boulder**
Support for the Single Molecule Biophysics meeting

**University of North Carolina-Chapel Hill**
Support for the 8th Annual Oliver Smithies Nobel Symposium

**University of North Carolina-Chapel Hill Lineberger Comprehensive Cancer Center**
Support for the UNC Lineberger Comprehensive Cancer Center 43rd Annual Symposium: Dysregulated Signaling Pathways in Cancer: Insights into Novel Mechanisms and Therapeutic Approaches

### Medical Sciences

**American Foundation for Suicide Prevention**
Support for AFSP's 2019 mission to save lives and bring hope to those affected by suicide in lieu of honorarium for CAMS advisory committee member Sarah H. Lisanby, MD

**American Physician Scientists Association (APSA)**
Support for the American Physician Scientists Association (APSA) 15th Annual Meeting

**Association for Clinical and Translational Science**
Support for the Translational Science meeting

**Duke University Medical Center**
Support for a Physician-Scientist Training Summit for MD-PhD and Post-Graduate Physician-Scientist Training Program Directors

**Gordon Research Conferences**
Support for the Gordon Research Conference on Membrane Protein Folding

**McGill University Faculty of Medicine**
Support for the Canadian Medical Hall of Fame

**University of Toronto Faculty of Medicine**
Support for 2018 Clinician Investigator Trainee Association of Canada (CITAC) Annual General Meeting

## Diversity in Science

**Duke University**
Support for the Inaugural Graduate Diversity Enrichment Networking Event

**Society of General Physiologists**
Support for the Society of General Physiologists 2019 Annual Symposium

**University of Connecticut Health Center**
Support for a new National Roundtable on Black Men and Black Women in Medicine, Engineering, and Science

**University of North Carolina-Chapel Hill**
Support for the 4th Annual Diversity in STEM Conference

## Infectious Disease

### Career Development

**Children's Science Center**
Support for the Children's Science Center in Fairfax, Virginia in lieu of 2019 honorarium to Dr. Maryrose Franko for CGT AC service

**Graduate Career Consortium**
Support for the Graduate Career Consortium's 2019 Annual Meeting Creating Clarity and Community: A Conference for Leaders in Graduate and Postdoctoral Career and Professional Development

**University of Chicago**
Support for a GREAT Group Meeting Pre-Conference Workshop focused on Institutional Efforts to Optimize Mentoring Relationships for Graduate Students and Postdoctoral Scholars

### General

**Aegean Conferences, Inc.**
Support for the 5th International Conference on Model Hosts

**American Society for Microbiology**
Support to sponsor graduate trainees and post-doctoral fellows in experiences to increase their understanding around the profession of microbiology in 2019

**American Society for Virology**
Support for the American Society for Virology 2019 Annual Meeting

**American Society of Tropical Medicine and Hygiene**
Support for the 67th Annual Meeting

**American Society of Tropical Medicine and Hygiene**
Support for the American Committee of Molecular, Cellular and Immunoparasitology (ACMCIP) Scientific Program at the November 2019 Annual Meeting

**Boston Children's Hospital/ Harvard Medical School**
Support for a seminar to be presented by Dr. Nan Yan at Harvard Medical School

**Canadian Association of Postdoctoral Scholars**
Support for the 2018 Canadian Association of Postdoctoral Scholars Annual General Meeting

**Cornell University**
Support for funds to support the organization and running of the 2019 Burroughs Wellcome Fund "Becoming Faculty" workshop

**Cornell University College of Veterinary Medicine**
Support for the 3rd National Colloquium for Combined DVM/PhD Biomedical Scientists

**Federation of American Societies for Experimental Biology**
Support for the FASEB Microbial Pathogenesis: Mechanisms of Infectious Disease Scientific Research Conference

**Genetics Society of America**
Support for the 30th biennial Fungal Genetics Conference

**Georgetown University**
Support for the Emerging Artemisinin Resistance Workshop

**Gordon Research Conferences**
Support for Gordon Research Conference on Tropical Infectious Diseases: From Innovation to Global Health Solutions

**Gordon Research Conferences**
Support for the 2019 Viruses and Cells Gordon Research Conference

**Gordon Research Conferences**
Support for the 2019 Physical Virology Gordon Research Conference

**Gordon Research Conferences**
Support for the Gordon Research Conference (GRC) Phagocytes meeting

**Gordon Research Conferences**
Support for the Malaria Gordon Research Conference

**Gordon Research Conferences**
Support for a meeting on the Immunology of Fungal Infections as part of a Gordon Research Conference (GRC) and Gordon Research Seminar (GRS)

**Gordon Research Conferences**
Support for the Gordon Research Conference on Salmonella Biology and Pathogenesis

**Gordon Research Conferences**
Support for the 2019 Gordon Research Conference on Microbial Adhesion and Signal Transduction

**Hospital for Sick Children**
Support for the International Symposium on the Problems of Listeriosis (ISOPOL) conference

**Marine Biological Laboratory (MBL)**
Support for the C.C. Wang Prize in Molecular Parasitology

**Marine Biological Laboratory (MBL)**
Support for the Biology of Parasitism (BoP) course at the Marine Biological Laboratory

**Memorial Sloan-Kettering Cancer Center**
Support for PATH awardee Michael Shiloh, MD, PhD, to present a semina

**Memorial Sloan-Kettering Cancer Center**
Support for a joint lab meeting for the laboratories of Dr. Robert Cramer and Dr. Tobias Hohl

**Midwinter Conference of Immunologists**
Support for the 58th Annual Midwinter Conference of Immunologists Poster Session Sponsorship

**National Academy of Sciences**
Support for the National Academies' Meeting of Experts on "Emerging Issues in Climate Change and Human Health" in 2019

**New York University School of Medicine**
Support for CABS Awardee Thomas Bernhardt, PhD of Harvard University to present a seminar at New York University

**Pennsylvania State University**
Support for the 2019 Pennsylvania Parasitology Conference (PAraCon)

**Saint Louis Science Center**
Support in lieu of 2019 honorarium to Dr. Thi Nguyen for CGT AC service

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Michael Diamond

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Alexander Ploss

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Manuela Raffatellu

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Stephen Beverley (John Boothroyd)

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Raphael Valdivia (Denise Monack)

**Stanford University**
Support for the Microbiology & Immunology Wednesday Seminar Series: Stacy Horner (Justin Sonnenburg)

**Stony Brook Foundation**
Support for the ICB&DD 13th Annual Symposium, "Frontiers of Infectious Disease Control"

**Trustees of the University of Pennsylvania**
Support for Torres/Cadwell/Shin/Brodsky Joint Host-Pathogen Interaction Research Retreat

**Tufts University**
Support for the Burroughs Wellcome Fund course Becoming Faculty: a short course on launching a scientific career

**University of California-Berkeley**
Support for seminar visit of Sunny Shin, PhD

**University of California-Davis**
Support for the 12th annual Biology and Mathematics in the Bay Area (BaMBA) Conference

**University of California-Merced**
Support for the eighth Advanced Lecture Course on Human fungal pathogens (HFP): molecular mechanisms of host-pathogen interactions and virulence

**University of California-San Diego**
Support for PATH awardee, Igor Brodsky, Ph.D., to present a seminar

**University of California-San Diego**
Support for the Helminth Parasite Molecular Toolbox Travel Awards

**University of California-San Francisco**
UCSF Microbial Pathogenesis Seminar Series: Igor Brodsky, PhD

**University of California-San Francisco**
Support for the 22nd Bay Area Microbial Pathogenesis Symposium (BAMPS)

**University of California-Santa Cruz**
Support for the Bacterial Locomotion and Signal Transduction 2019 Conference

**University of Colorado School of Medicine**
Support for the 2019 International Meeting – Parasitic Helminths: New Perspectives in Biology and Infection

**University of Minnesota College of Veterinary Medicine**
Support for BWF-HHMI partnership veterinary student training program fellow Kristin Snyder

**University of North Carolina-Chapel Hill**
Support for Daniel B. Stetson, PhD, University of Washington, to present a seminar

**University of North Carolina-Chapel Hill**
Support for Julie Pfeiffer, PhD, University of Texas Southwestern Medical Center, to present a seminar

**University of North Carolina-Chapel Hill**
Support for Gregory F. Sonnenberg, PhD, Weill Cornell Medicine, to present a seminar

**University of North Carolina-Chapel Hill**
Support for Harmit Singh Malik, PhD, Fred Hutchison Cancer Research Center, to present a seminar

**University of Pennsylvania**
Support for the 23rd annual Woods Hole Immunoparasitology Meeting

**University of Pennsylvania**
Support for the Molecular Parasitology Meeting (MPM) Faculty Retreat: Reimagining Parasitology for the next 30 years

**University of Pennsylvania School of Veterinary Medicine**
Support for BWF-HHMI partnership veterinary student training program fellow Sabina Hlavaty

**University of Texas Health Science Center-San Antonio**
Support for the meeting on Molecular Helminthology-An integrated approach

**University of Texas Southwestern Medical Center-Dallas**
Support for PATH awardee, Peter Turnbaugh, PhD, to present a seminar

**University of Texas Southwestern Medical Center-Dallas**
Support for a seminar presented by Arturo Casadevall

**University of Texas Southwestern Medical Center-Dallas**
Support for PATH awardee Christina Stallings, PhD to present a seminar

**University of Texas Southwestern Medical Center-Dallas**
Support for Denise Monack, Ph.D to present a seminar

**University of Toledo**
Support for the Midwest Microbial Pathogenesis Conference (MMPC)

**University of Virginia**
Support for the 2019 Mid-Atlantic Microbial Pathogenesis Meeting

**University of Washington**
Support for the meeting "ImmunoSkamania – Envisioning the future of Immunology"

**University of Wisconsin-Madison**
Support for BWF PATH Fellow Adam Lauring, MD, PhD to present a seminar

**Vanderbilt University School of Medicine**
Support for PATH awardee, Aimee Shen, PhD, to present a seminar

**Vanderbilt University School of Medicine**
Support for PATH awardee Catherine Blish, M.D., Ph.D. to present a seminar

**Washington University**
Support for the Gordon Research Conference on Staphylococcal Diseases

## Interfaces in Science

**American Institute of Chemical Engineers**
Support for the Regenerative Engineering Society

**American Psychological Foundation**
Support for the Scholarships to Enhance and Empower Diversity (SEED) program

**American Society of Gene & Cell Therapy**
Support for the 22nd Annual Meeting and Outstanding New Investigator Symposium

**Biophysical Society**
Support for Burroughs Wellcome Fund's sponsored programs at the 63rd Annual Meeting

**Carnegie Mellon University**
Support for the 9th International Workshop on Statistical Analysis of Neural Data (SAND9)

**Computational and Systems Neuroscience (Cosyne)**
Support for the 2019 meeting

**Georgia Tech Research Corporation**
Support for the Quantitative Biosciences Hands-On Modeling Workshop

**Gordon Research Conferences**
Support for the Biomaterials and Tissue Engineering Gordon Research Seminar (GRS)

**Human Vaccines Project**
Support for Scientific Symposium: The Future of Vaccine and Immunotherapy Development – Towards an Artificial Intelligence Driven Model of the Human Immune System

**International Society for Cellular Therapy**
Support for the 2019 Annual Scientific Meeting

**Johns Hopkins University**
Support for Reception for Robophysics: Physics Meets Robotics Session

**Massachusetts Institute of Technology**
Support for junior travel fellowships to the Fluids and Health 2019 Conference

**New York University**
Support for Information Processing in Single Cells / Summer Workshop

**North Carolina State University**
Support for the Joint Department of Biomedical Engineering student CYBATHLON 2020 Team Out of the Gait

**Regents of the University of Michigan**
Support for the Annual National Institutional Research and Academic Development Awards Conference

**Society for Biomaterials**
Support for Travel Fellowships

**University of Pennsylvania**
Support for the 3rd "Bottom Up Cell Biology" special interest subgroup at the American Society for Cell Biology 2018 meeting

## Population and Laboratory Sciences

**American Civil Liberties Union Foundation, Inc.**
Payment in lieu of honorarium for Dr. Julie C. Mitchell for service on the Burroughs Wellcome Fund Quantitative and Statistical Thinking in the Life Sciences Advisory Committee

**Doctors Without Borders USA, Inc.**
Payment in lieu of honorarium for Claudia Neuhauser, PhD for her work on the Burroughs Wellcome Fund Quantitative and Statistical Thinking in the Life Sciences Advisory Committee

## Regulatory Science

**Arkansas Research Alliance**
Support for the 2019 Global Summit for Regulatory Science

**Health Research Alliance, Inc. (HRA)**
General support for 2019

**LaunchBio, Inc.**
Support for LaunchBio, Inc. workshops in regulatory sciences for life science entrepreneurs in 2019

**MidSouth Computational Biology and Bioinformatics Society (MCBIOS)**
Support for the 3rd Annual Massive Analysis Quality Control Society Conference

**National Academy of Sciences**
Support for the Forum on Regenerative Medicine in 2019

**National Academy of Sciences**
Support for the Forum on Drug Discovery, Development, and Translation

**New York Stem Cell Foundation**
Support for the New York Stem Cell Foundation (NYSCF) 2019 Annual Translational Stem Cell Research Conference

**Tissue Engineering & Regenerative Medicine International Society (TERMIS)-Americas**
Support for the TERMIS-AM Annual Conference and Exhibition

## Reproductive Sciences

**Marine Biological Laboratory (MBL)**
Support for the 2019-2021 sessions of the Frontiers in Reproduction course

**Marine Biological Laboratory (MBL)**
Support for the Frontiers in Reproduction (FIR) 22nd Annual Symposium

**Marine Biological Laboratory (MBL)**
Support for the Mike McClure Scholarship for Frontiers in Reproduction 2019

**Society for Reproductive Investigation**
Support for SRI 66th Annual Scientific Meeting: "From Innovation to Impact"

**Society for the Study of Reproduction**
Support for SSR's 52nd Annual Conference: Beyond Possible: Remarkable Transformation of Reproductive Biology

**University of Missouri-Columbia School of Medicine**
Support for the 2019 RSDP Scholar Dinner and Executive Committee Meeting

**University of Missouri-Columbia School of Medicine**
Support for the 2018-2019 RSDP Seed Grant Phase II Scholars

**University of Missouri-Columbia School of Medicine**
Support for RSDP scholar research related expenses 2018-2019

**University of Texas Health Science Center-Houston**
Support for Reproductive Scientists for Women's Health meeting entitled: from Preconception to the Cradle

## Science and Philanthropy

### Communications

**American Association for the Advancement of Science**
Support for the 2019 AAAS Mass Media Fellows Program

**Center for Excellence in Health Care Journalism**
Support for Health Journalism

**National Academy of Sciences**
Support for the Science Communication Initiative: Advancing Science Communication Research and Practice

**North Carolina Community Foundation/North Carolina Network of Grantmakers**
Support for 2018-19

**North Carolina Community Foundation/North Carolina Network of Grantmakers**
Support for 2019-20

**North Carolina State University**
Support for the project titled "Transitioning to Implementation of a Pilot North Carolina Science, Technology, Engineering and Mathematics Policy Fellowship"

**Open Notebook**
Support for the fellowship program and the "Best of TON" book proposal

**Open Notebook**
Support for Science Storytellers

**Sigma Xi, The Scientific Research Society**
Support for Tools for Communicating Science (Sessions Track at Sigma Xi's Annual Meeting)

**Sigma Xi, The Scientific Research Society**
Support for the Science Communicators of North Carolina

**University of California Museum of Paleontology**
Support for the Coalition for the Public Understanding of Science Unconference

**World Federation of Science Journalists**
Support for the 2019 World Conference of Science Journalists

## General Philanthropy

**American Institute of Biological Sciences**
Support for the 2019 AIBS Council Meeting: "Beyond Specimens"

**Association for Women in Science**
Support for renewal of the Burroughs Wellcome Fund-AWIS Partnership dues

**Canadian Association of Postdoctoral Administrators**
Support for the annual conference

**Council on Foundations**
Support for 2019

**Fight for Sight Inc.**
Support for the 2019 Weisenfeld Reception at the Association for Research in Vision and Opthamology Conference

**Food and Environment Reporting Network (FERN)**
Support for the Gastropod Coverage of Biomedical Research

**Foundation Center**
Support for 2018-19

**Friends of Sir M.B. Davis Jewish General Hospital**
Support for the Lady Davis Institute Distinguished Lectures 2018-2019

**Friends of Sir M.B. Davis Jewish General Hospital**
Support for the Distinguished Lectureship Series

**HHT Foundation International**
Support for travel awards to the 13th HHT International Scientific Conference

**Marine Biological Laboratory (MBL)**
Support for marine equipment, supplies and repairs

**Morgridge Institute for Research Foundation**
Support for travel grants for researchers at the Morgridge Institute for Research

**National Humanities Center**
Beyond Despair: Next Steps in Environmental Humanities

**National Postdoctoral Association**
Support for the 17th Annual Conference

**North Carolina Community Foundation/North Carolina Network of Grantmakers**
Support for N.C. Network of Grantmakers Communications

**North Carolina Community Foundation/North Carolina Network of Grantmakers**
Support for the Communications Training Initiative – Phase 1

**PEAK Grantmaking**
Support for 2019-2020

**Teach For America Eastern North Carolina**
Supporting Racial Equity Institute at Teach For America Eastern North Carolina Residency

**University of Wisconsin-Madison**
Suppport for the microscopy outreach effort

## Science Policy

**American Academy of Arts and Sciences**
Support for a new intiative in the biomedical sciences that will increase the involvement of biomedical scientists, including physician-scientists

**National Academy of Sciences**
Support for the workshop titled "Understanding the Current and Future Roles of Staff Scientists in Biomedical Research"

**Queen's University**
Support for the Conferences on Statistics, Science and Public Policy

**Stony Brook Foundation**
Support for Assessing Scientists' Willingness to Engage in Science Communication

## Special Award

**Council for Entrepreneurial Development**
Support for the 35th Anniversary Engine of Innovation event

**Environmental Mutagenesis and Genomics Society**
Support for the symposium: The Mechanisms of Genome Maintenance: A Tribute to Paul Modrich

**Grantmakers for Education**
Support for 2019-20

**Heart Of Los Angeles Youth Inc.**
Support for promoting education, including health and science, to students ages 6-24 in underserved areas of Los Angeles, through the HOLA afterschool program in order to prepare them for post-secondary education

## Science Education

### Special Award

**North Carolina Association for Biomedical Research**
Support for Bridging the Gap: Uniting North Carolina K-16 STEM Education

**North Carolina Department of Public Instruction**
Support for the Burroughs Wellcome Fund North Carolina Teacher of the Year Program

### Science Education

**Afterschool Alliance**
Support for the STEM West Regional Ecosystem – VISTA Member Support

**Alexander Central High School**
Support for professional development activities on behalf of Rebecca Dupuis, finalist for the BWF CASMT Award

**Boys & Girls Club of the Sandhills**
Support for the STEM Enrichment Summer Camp

**Catawba County Schools**
Support for Scaling STEM West

**Duke University**
Support for the BOOST 2019 Field Trips

**EducationNC**
General support

**Johnston County Early College Academy**
Support for professional development activities

**Mooresville Graded School District**
Support for the professional development activities on behalf of Lindsay Smith, BWF CASMT finalist, for the 2019-20 school year

**Mount Olive College**
Support for STEM on the Green

**Movement of Youth**
Support for the NC STEM Mentoring Coalition

**National Association of Academies of Science**
Support for the American Junior Academy of Sciences to host pre-college STEM leaders at the annual AAAS meeting

**North Carolina Museum of Natural Sciences**
Support for RACE 2.0 Exhibit Build Out and Purchase

**North Carolina School of Science and Mathematics Foundation**
Support for the North Carolina STEM Hall of Fame Gala

**North Carolina School of Science and Mathematics Foundation**
Support for the Burroughs Wellcome Fund Endowment for Student Research, Mentorship, and Innovation at the second North Carolina School of Science and Mathematics campus in Morganton, North Carolina

**North Carolina Science Teachers Association**
Support for the 2019-20 Conference

**North Carolina Society of Hispanic Professionals**
Support for the TuPortalSTEM iniative

**North Carolina State University Foundation**
Support for Diversity in Leadership: a 2019-2020 BWF-Kenan Fellowship

**North Carolinas Northeast Economic Development Foundation**
Support for the STEM East Ecosystem: 2019 E2 Summit Support

**RE-Brand NC Education**
Support for the project titled “Shifting the Conversation: Future Focused Schools Led by Future Focused Leaders”

**Robbins Elementary School**
Support for professional development opportunities on behalf of Kimberly Collazo, BWF CASMT finalist, for the 2019-20 school year

**University of North Carolina-Chapel Hill**
Support for the 2018-2019 CASMT Evaluation

**University of North Carolina-Chapel Hill**
Support for the visit of astronauts Charlie Duke and Mae Jemison to visit the Triangle

**University of North Carolina-Chapel Hill**
Support for North Carolina DNA Day for visits by local scientists to high school classrooms throughout the state

**Wake STEM Early College High School**
Get a Grip: Creating Soft Robotic Grippers via Self-folding by Infrared Activation

**Wilkes Early College High School**
Support for professional development activities on behalf of Kelly Pipes, BWF CASMT Award finalist, for the 2019-20 school year

## SMT

**BattelleEd ORG**
Support for the STEMx North Carolina State Participation

**James B. Hunt Jr. Institute for Educational Leadership and Policy Foundation**
Support for the project titled "Supporting College and Career Readiness in North Carolina"

**North Carolina Alliance for School Leadership Development**
Support for Digital Leadership Institute for Superintendents

**North Carolina Alliance for School Leadership Development**
Support for the Aspiring Superintendent Program

**North Carolina Alliance for School Leadership Development**
Support for the Next Generation Superintendent Development Program

**North Carolina Alliance for School Leadership Development**
Support for the expansion of the North Carolina Inquiry Collaborative Network

**North Carolina Association for Biomedical Research**
Support for Bridging the Gap 2018 and 2019 STEM Education Conference

**North Carolina Chamber Foundation**
Support for the North Carolina Chamber Conference on Education and Workforce

**North Carolina Department of Public Instruction**
Support for the NC STEM Schools of Distinction Recognition Program

**North Carolina School of Science and Mathematics Foundation**
Support for the North Carolina Student Academy of Science Delegation to the AAAS/AJAS Annual Meeting

**North Carolina Science Fair Foundation**
Support for the 2019 North Carolina Science and Engineering Fair

**North Carolina Science Fair Foundation**
Support for the North Carolina Science and Engineering Fair Capacity Building Grant

**North Carolina State University**
2020 National Science Olympiad Tournament

**Professional Engineers of North Carolina Education Foundation**
Support for the North Carolina Future City Competition

**Public School Forum of North Carolina**
Support for the North Carolina International Science Challenge

**Research Triangle Institute**
Support for the North Carolina Large District Math and Science Collaborative

**University of North Carolina-Chapel Hill Foundation**
Support for the North Carolina STEM Calendar

**University of North Carolina-Wilmington**
Support for the Fourth Annual PK-12 STEM Education Conference

# 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 BWF's investment policies. This committee is appointed by and reports to the Board of Directors.

## Biomedical Sciences

### CAREER AWARDS FOR MEDICAL SCIENTISTS

**Derek Abbott, MD, PhD (Co-Chair)**
Arline H. and Curtis F. Gavin
Professor of Medicine
Department of Pathology
Case Western Reserve University

**Leslie J. Berg, PhD**
Professor, Department of Pathology
University of Massachusetts Medical School

**Chester W. Brown, MD, PhD**
St. Jude Chair of Excellence in Genetics
Professor of Division Chief of Genetics
Department of Pediatrics
University of Tennessee Health Science Center

**Paul Buckmaster, DVM, PhD**
Professor
Deptartment of Comparative Medicine
Stanford University

**Kathleen H. Burns, MD, PhD**
Professor of Pathology and Oncology
Director, Physician Scientist Training Program
Deputy Director for Research and Programs, Department of Pathology
Johns Hopkins University School of Medicine

**Kathleen Caron, Ph.D. (Co-Chair)**
Professor of Cell Biology & Physiology and Genetics
Chair, Dept. of Cell Biology & Physiology
University of North Carolina-Chapel Hill

**Seth Field, MD, PhD**
Professor of Medicine,
Division of Endocrinology and Metabolism
University of California-San Diego

**Sarah H. Lisanby, MD**
Director, Division of Translational Research
Director, Noninvasive Neuromodulation Unit, Experimental Therapeutics and Pathophysiology Branch
National Institute of Mental Health

**Elizabeth McNally, MD, PhD**
Elizabeth J Ward Chair and Director, Center for Genetic Medicine
Northwestern University Feinberg School of Medicine

**Heather C. Mefford, MD, PhD**
Associate Professor, Pediatrics
Division of Genetic Medicine
University of Washington

**W. Kimryn Rathmell, MD, PhD**
Cornelius Abernathy Craig Professor of Medicine and Biochemistry
Director, Division of Hematology and Oncology
Vanderbilt University Medical Center

**Upinder Singh, MD**
Division Chief, Infectious Diseases and Geographic Medicine
Associate Professor, Departments of Internal Medicine, Microbiology and Immunology
Stanford University School of Medicine

**Barry Sleckman, MD, PhD**
Professor of Pathology and Laboratory Medicine
Weill Cornell Medical College, Cornell University

**John York, PhD**
Natalie Overall Warren Professor and Chair
Department of Biochemistry
Vanderbilt University Medical Center

### COLLABORATIVE RESEARCH TRAVEL GRANTS

**Matthew Redinbo, PhD**
Professor and Chair, Department of Chemistry
University of North Carolina-Chapel Hill

**Keith Weninger, PhD**
Associate Professor, Department of Physics
North Carolina State University

**John York, PhD**
Natalie Overall Warren Professor of Biochemistry
Chair, Department of Biochemistry
Vanderbilt University School of Medicine

### PHYSICIAN-SCIENTIST INSTITUTIONAL AWARD

**Emery N. Brown, MD, PhD**
Warren M. Zapol Professor of Anaesthesia
Harvard Medical School/ Massachusetts General Hospital
Edward Hood Taplin Professor of Medical Engineering and Computational Neuroscience
Massachusetts Institute of Technology

**David N. Cornfield, MD**
Anne T. and Robert M. Bass Professor in Pediatric Pulmonary Medicine
Professor, by courtesy, of Surgery
Stanford University

**Terence S. Dermody, MD**
Vira I. Heinz Professor and Chair of Pediatrics Professor of Microbiology and Molecular Genetics
University of Pittsburgh School of Medicine
Physician-in-Chief and Scientific Director
Children's Hospital of Pittsburgh of UPMC

**Mahalia S. Desruisseaux, MD**
Associate Professor of Internal Medicine(Infectious Diseases)
Yale University School of Medicine

**Kelsey Martin, MD, PhD**
Dean for the David Geffen School of Medicine Professor of Biological Chemistry and Psychiatry and Biobehavioral Sciences
University of California-Los Angeles

**Louis J. Muglia, MD, PhD**
President and CEO
Burroughs Wellcome Fund

## Diversity in Science

### POSTDOCTORAL ENRICHMENT PROGRAM

**Joey V. Barnett, PhD**
Professor
Vanderbilt University

**Kami Kim, MD (Chair)**
Professor
University of South Florida

**George M. Langford, PhD**
Professor of Biology
Dean Emeritus of the College of Arts and Sciences
Syracuse University

**Carla Mattos, PhD**
Professor
Northeastern University

**Gina R. Poe, PhD**
Professor
University of California-Los Angeles

**Michael Summers, PhD**
HHMI Investigator Professor of Chemistry and Biochemistry
University of Maryland, Baltimore County

**Blanton S. Tolbert, PhD**
Professor
Case Western Reserve University

## Infectious Diseases

### INVESTIGATORS IN THE PATHOGENESIS OF INFECTIOUS DISEASE

**Blossom Damania, PhD**
Professor of Microbiology & Immunology and Vice Dean for Research
University of North Carolina-Chapel Hill

**Maurizio Del Poeta, MD**
Professor, Department of Molecular Genetics & Microbiology
Stony Brook School of Medicine

**Michael S. Diamond, MD, PhD**
Professor, Department of Medicine, Molecular Microbiology, Pathology & Immunology
Washington University School of Medicine

**Katherine A. Fitzgerald, PhD**
Professor, Department of Medicine
University of Massachusetts Medical School

**Akiko Iwasaki, PhD**
HHMI Investigator
Professor of Immunobiology, and Molecular, Cellular & Developmental Biology
Yale University School of Medicine

**Denise Kirschner, PhD**
Professor, Department of Microbiology and Immunology
University of Michigan School of Medicine

**Harmit S. Malik, PhD (Chair)**
Member, Division of Basic Sciences & HHMI Investigator
Fred Hutchinson Cancer Research Center

**Eric G. Pamer, MD**
Director, Duchossois Family Institute
University of Chicago

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Department of Statistics, Machine Learning, and the Center for Neural Basis of Cognition
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## Regulatory Science

### INNOVATION IN REGULATORY SCIENCE

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Senior Vice President of Health Economics & Education
Certara

**David Acheson, MD**
President and CEO
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## Reproductive Sciences

### PRETERM BIRTH INITIATIVE

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## Science Education

### CAREER AWARDS FOR SCIENCE AND MATHEMATICS TEACHERS

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The most up-to-date information about our programs, including complete application information, can be found on our website at **www.bwfund.org**.

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