RISING TO THE CHALLENGE: A CALL TO ACTION

Rising to the Challenge: The Campaign for Johns Hopkins will raise unprecedented levels of support to attract, sustain, and empower the students and faculty of Johns Hopkins, who through their work improve the lives of millions around the world. Together with our philanthropic partners we will:

ADVANCE DISCOVERY AND CREATIVITY through support of our exceptional faculty. Their innovative work drives the development of new knowledge, new forms of expression, and new ways to save lives and improve health across our core disciplines in science and technology, the humanities and arts, and public health and medicine.

ENRICH THE STUDENT EXPERIENCE by investing in scholarships and fellowships, inspirational spaces for collaborative learning and social opportunities, and new programs that will enhance student-faculty interactions, ensure diversity on campus, link learning in the classroom to life after graduation, and strengthen connections between our students and our communities.

SOLVE GLOBAL PROBLEMS AS ONE UNIVERSITY by creating new cross-disciplinary solutions in crucial areas such as sustaining global water resources, revitalizing America’s cities, advancing the health of individuals and populations, and understanding how we learn and teach.

With your help, the Bloomberg School will play a key role in the success of the campaign.
DEPARTMENT AT A GLANCE

Chair: Diane E. Griffin, MD, PhD

History: Founded in 1918, the Department is the world’s oldest immunology and virology research unit, at the first independent graduate school of public health, consistently ranked #1 by U.S. News & World Report.

Size and scope: 29 full-time faculty and 130 students. Research opportunities in parasitology, virology, bacteriology, vaccine development, host innate and adaptive immunity, pathogenesis, autoimmunity, bioinformatics, ecology of infectious diseases, and medical entomology.

Centers: Johns Hopkins Autoimmune Disease Research Center; Johns Hopkins Malaria Research Institute.

DEPARTMENTAL PROFILE

Contrary to a long series of rose-colored reports that infectious diseases are a thing of the past, nothing could be further from the truth. Smallpox remains the only disease eradicated worldwide, while malaria afflicts 225 million people every year and kills nearly 800,000. Even the public health revolutions ushered in by antibiotics and vaccines are threatened by drug-resistant organisms and a growing anti-immunization movement. Effective prevention and treatment of infectious disease requires a fully developed scientific understanding of the classic elements of the “epidemiological triangle”—the pathogenic agent, host response, and environment—and the interactions among them. By studying the basic biological mechanisms involved in disease processes and the body’s response to them, researchers in the Department of Molecular Microbiology and Immunology (MMI) can supply knowledge essential for solving a wide range of public health problems.

Since its founding in 1916, the Johns Hopkins Bloomberg School of Public Health (JHSPH) has amassed an unparalleled wealth of experience as the foremost academic research and training center for U.S. and global public health. The School’s first dean, William Henry Welch, ensured that basic science research to advance public health and medicine would always be at the core of the University’s identity and mission. Welch modeled the School on his two previous successes, the Johns Hopkins School of Medicine and the Rockefeller Institute for Medical Research, which set the modern standard of excellence for medical education and research. Five of the original nine departments in the School of Hygiene and Public Health were dedicated to the bench sciences of biochemistry, physiology, bacteriology, immunology, and medical zoology. The new school married the best of biomedical inquiry with the population-based approach of public health, which has remained the hallmark of the Bloomberg School of Public Health for nearly a century.

The present Department of Molecular Microbiology and Immunology evolved from the founding departments of Medical Zoology, Bacteriology, and Immunology. Collectively, they have produced a series of scientific discoveries that have revolutionized public health. The early research conducted at Johns Hopkins on malaria, hookworm, and other major tropical diseases established it as a leading center of parasitology and tropical medicine.

Robert Hegner’s avian model of malaria enabled researchers to develop and test effective synthetic anti-malarial agents that saved the lives of World War II soldiers and millions around the world. Thomas B. Turner, chair of Microbiology from 1939 to 1957, was a leader of the National Research Council’s cooperative clinical testing of penicillin therapy for syphilis, which became the model for the modern randomized, controlled clinical trial. Immunologist Manfred M. Mayer elucidated the fundamental structure and function of the complement system, particularly its hemolytic action. By identifying methods of virus purification that produced the highest yields and purity of antigens, his lab made fundamental contributions.
to developing diagnostic complement fixation blood tests and improved vaccines. Mayer's research also produced major insights into the immunology of malaria and polio and the serodiagnosis of syphilis.

From 1961 to 1976, the Department of Pathobiology, chaired by Frederik Bang, hosted the Johns Hopkins Center for Medical Research and Training in Calcutta, India. CMRT researchers published more than 400 articles in Indian, American, and international journals that provided fundamental knowledge for treating and preventing the worst global disease scourges: diarrheal and respiratory diseases, hookworm, urban filariasis, leprosy, zoonotic diseases, and the role of malnutrition in infection. Breakthroughs made possible by JHSPH researchers have played a major role in dramatically reducing morbidity and mortality from these diseases over the past half century.

For centuries, India and many other tropical countries experienced devastating cholera epidemics in conjunction with seasonal flooding, with mortality highest among infants and children. Charles Carpenter and R. Bradley Sack conducted groundbreaking laboratory and clinical research on cholera that resulted in developing a specially formulated oral rehydration solution (ORS) therapy that reduced child mortality from cholera from 50 percent without treatment to less than 4 percent with ORS. This cost-effective and practical alternative to traditional hospital-based IV rehydration therapy became the global standard for management of childhood diarrhea.

Noel R. Rose, chair of Immunology and Infectious Diseases from 1981 to 1994, rejuvenated the program in immunology to emphasize protective immunity in infectious disease and immune-mediated disorders, including HIV/AIDS, hantavirus, human papilloma virus, tuberculosis, and malaria. Rose increased the quality and size of the graduate program by landing a highly competitive NIH training grant on the Molecular Basis of Infectious Disease. Rose’s pioneering studies on autoimmune thyroiditis in the 1950s helped initiate the modern era of research on autoimmune disease. His team has continued to make major breakthroughs in revealing the genetic, infectious, and environmental factors that increase risk for autoimmune disease and trigger its onset. In 1999, Rose became the founding director of the Johns Hopkins Autoimmune Disease Research Center, which coordinates and promotes clinical and basic science research on at least 80 known autoimmune diseases that attack every system in the body.

When Diane E. Griffin succeeded Rose as chair in 1994, she renamed the department Molecular Microbiology and Immunology to reflect increased attention to the molecular mechanisms underlying infectious and immunologic disease. Griffin’s lab studies the function of antibodies and T cells in clearing virus from the nervous system during encephalitis. Because this clearance occurs without harming the infected cells, these studies provide new understanding of antibody- and cytokine-mediated control of intracellular virus replication and why virus genomes may persist to cause late neurologic disease. Studies are also focused on measles, an important cause of childhood morbidity and mortality that causes immune suppression and increases susceptibility to other infections. Griffin established that the measles virus genome persists in the body for months to years after an acute infection. Her research in Zambia has examined the effect of HIV infection on measles infection and immunization, with the startling conclusion that the presence of measles virus suppresses HIV replication. These studies have used a rhesus monkey model to identify the mechanisms of suppression and protective immunity and provide critical clues for development of new vaccines.

In 2001, Griffin spearheaded the creation of the Johns Hopkins Malaria Research Institute (JHMRI), which attracted a critical mass of malaria experts from around the world to mount a multidisciplinary assault on all aspects of transmission, from the Plasmodium parasite to the mosquito vector to the genes and proteins involved at the molecular level. JHMRI has established a malaria field research station in southern Zambia and has greatly benefited the department by broadening faculty expertise and strengthening resources and infrastructure.

In 2008, Griffin was succeeded as director of JHMRI by Peter C. Agre, whose research in red-blood-cell biochemistry identified the first known membrane defects in congenital hemolytic anemias (spherocytosis) and produced the first isolation of the Rh blood group antigens. In 1992, his laboratory discovered the aquaporins, a family of water channel proteins found through-
Molecular Microbiology and Immunology

The Department of Molecular Microbiology and Immunology continues to pursue the unfinished agendas for fighting infectious diseases. To do so, the Department must invest in people and the tools they need to continue battling the world’s most challenging, widespread health issues. The campaign will help MMI achieve more sustainable funding for faculty, training programs, and research, and to invest in infrastructure that will maximize the quality and breadth of research and teaching activities.

In the area of faculty support, MMI’s highest priority is to establish a new endowed professorship for a senior faculty member and short-term support for junior faculty. Endowed Emerging Scholar professorships would provide short-term (three- to five-year) rotating positions for early stage investigators doing innovative, groundbreaking research. This support would allow MMI to recruit junior investigators in new fields and provide them time to generate the preliminary data for competitive grant applications. Innovation funding (9-12 months) would provide bridge research support for productive investigators with temporary lapses in grant funding. This funding would sustain productivity and retain trained laboratory personnel, thus greatly increasing the likelihood of restored external funding.

Throughout MMI’s rich history, graduate and postgraduate research training in microbiology and immunology has been a top priority. Although MMI is mid-sized among JHSPH departments, it has the largest postdoctoral program. JHSPH has the opportunity to establish a new PhD program in Molecular Epidemiology that would cross train students in laboratory sciences relevant to epidemiologic investigations and would bridge the departments of MMI, Biochemistry and Molecular Biology, Epidemiology, and Environmental Health Sciences. Epidemiological studies can often identify risks for certain diseases, such as cancer or infection, but cannot determine the mechanisms involved in the increased risk. This innovative program would train leaders in this critical area where the Bloomberg School is uniquely positioned to provide training. To launch the program, four new doctoral scholarships providing five years of tuition and a stipend are needed.

MMI is also eager to develop timely, innovative minicourses that benefit students, fellows, and faculty throughout the Bloomberg School and the University. Each year, the Department would offer three to five minicourses lasting one to two days that would provide hands-on training and address new areas of knowledge and techniques with broad scientific applications, such as...
as microarray analysis or confocal microscopy.

The Department’s top priority for research support is funding for three new centers of excellence.

**Center for Human Immunology**—Many immunologic investigations focus on studies of mice, but these studies often are not predictive of human responses to infections and vaccines. Human studies are more difficult, but developing techniques for defining human responses is necessary for designing vaccines and treatment for bacterial, viral, and parasitic infections. This effort would capitalize on the work of Ying Zhang (tuberculosis), Richard Markham and Joseph Margolick (HIV), Diane Griffin (measles), Jay Bream (influenza), and Photini Sinnis, Gary Ketner, and Jelena Levitskaya (malaria). Specific needs are for advanced equipment for flow cytometry and support for postdoctoral fellows and students to be trained in analysis of human immune responses.

**Center for the Study of Infectious Disease Pathogenesis**—Susceptibility to infectious diseases varies dramatically among individuals, with outcomes ranging from mild/unrecognized disease to chronic or fatal disease. Differences are determined by sex and specific genetic mutations that may affect pathogen replication or the immune response. A recent body of research indicates that chronic diseases are often a consequence of acute infections that occurred many years ago. For example, cervical and head/neck cancers are caused by infection with human papilloma virus, and hepatocellular carcinomas result from infection with hepatitis B or hepatitis C viruses. Understanding these infectious diseases and their consequences has led to vaccines that now prevent these cancers. Further work is needed to identify infectious diseases mechanisms that later cause chronic disease and why the immune response is not effective. In addition, recent studies have revealed that the normal microbial flora (gut, respiratory tract, skin) also influences outcome, but the mechanisms are poorly understood. The Center would build on the pathogenesis work of Keerti Shah (HPV and cancer), Sabra Klein (male/female differences), Diane Griffin (virus persistence), Fidel Zavala (malaria immunity), Xiaofang Yu (HIV), and Andrew Pekosz (respiratory viruses). Specific needs include recruitment of new faculty (particularly one to two bacteriologists), specialized mouse and in vivo imaging facilities, and improved capacity for computational biology and genomics.

**Center for Ecology and Spatial Analysis of Disease**—Most emerging infectious diseases are transmitted to humans from animal and insect reservoirs. These pathogens are often maintained in their natural reservoirs in ecologically and geographically restricted sites influenced by local fluctuations in climate. Geographic information systems and satellite imaging combined with data collected in the field allow analysis of the spatial distribution of infection and changes in vector and animal reservoir habitats that can predict outbreaks of disease. Identification of spatial clustering of many diseases permits targeted interventions. This center would expand and leverage the work of Douglas Norris and Clive Shiff (vector biology) and Gregory Glass (ecology/GIS). Specific needs include an endowed senior professorship to support a key individual to lead the effort, one to two new faculty in the areas of spatial analysis and/or field biology, and advanced computer and graphing infrastructure.

The Department’s most pressing infrastructure needs are for improved imaging of the immune response and infection at the cellular and organ levels. Experiments on mammalian cells that investigate the cellular events surrounding the entry, multiplication, and exit of pathogens require imaging at micrometer resolution. An upgrade of the Department’s flow cytometry, microscopes, and software, and the acquisition of new in vivo imaging capabilities, will
generate exceptional, high-resolution images of the microbes under study, improved quantification of biological processes, and tracking of the spread of infections in vivo.

**ImageStream flow cytometer**—Efficient assessment of immune responses often relies on the multi-parameter analysis of small numbers of important cells, often below 1 percent of total peripheral blood lymphocytes, and requires multispectral imaging flow cytometry. ImageStream technology combines flow cytometry and microscopy and produces multiple images per cell for qualitative and quantitative imaging. These applications are needed for numerous disciplines within the Department, including immunology, virology, microbiology, parasitology, and drug discovery.

**Microscopy Center upgrade**—Currently, the MMI facility has three microscopes, but the inverted microscope is not sufficiently powerful for high-quality live cell imaging. The microscopes need to be updated for faster, higher magnification imaging and with improved computer hardware and software and temperature-controlled CO2 for imaging under physiological conditions. Updating the inverted microscope will improve options for all cellular biology laboratories using the facility (at least 12 groups). A high-speed spinning disk confocal microscope can be adapted to our current inverted microscope to expand the capability for fixed, live cell, and multipositional imaging in 2D or interactive 3D. This will allow researchers to observe living cells in the process of becoming infected.

**IVIS in vivo imaging**—Imaging of the infectious process as it progresses is crucial for determining the extent of infection and pace of progression. In vivo imaging with pathogens that express luciferase, or another appropriate tag, allows quantitative evaluation of the effect of therapeutic agents or vaccines on pathogen growth in vivo. This technology is applicable to virus, bacteria, and parasite infection, as well as tumors.

These important tools for the Department’s most innovative research will help faculty enhance publications, increase MMI’s competitive edge for grants, and forge collaborations across the School of Public Health. As the primary base for the School’s research in infectious disease, the expertise of Molecular Microbiology and Immunology faculty in areas such as mapping and predicting malaria and other globally significant diseases will prove essential to the university’s signature initiatives in global health. MMI has only scratched the surface of its potential to discover the answers to our century’s most urgent public health problems by illuminating the basic biological and immunological mechanisms that ignite disease.

| CAMPAIGN GOALS FOR MOLECULAR MICROBIOLOGY AND IMMUNOLOGY |
|-----------------|--------------------------------------------------|
| **$20,000**     | MMI minicourses and lectures                    |
| **$20,000**     | Microscopy Center upgrade                       |
| **$100,000**    | Innovation fund                                 |
| **$150,000**    | IVIS in vivo imaging system                     |
| **$200,000**    | ImageStream flow cytometer                      |
| **$300,000**    | Spinning disk confocal microscope               |
| **$1 million**  | Emerging Scholars fund to recruit new junior faculty |
| **$3.5 million**| Endowed senior professorship                    |
| **$3.5 million**| Endowed professorship for vector biology/ecology|
| **$4.5 million**| 3 Endowed Emerging Scholar professorships at $1.5 million per endowment|
| **$5 million**  | Endowment for Center for Human Immunology       |
| **$5 million**  | Endowment for Center for the Study of Infectious Disease Pathogenesis |
| **$5 million**  | Endowment for Center for Ecology and Spatial Analysis of Disease |
| **$6 million**  | 4 Molecular Epidemiology doctoral scholarships at $1.5 million per endowment |