RISING TO THE CHALLENGE

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: Pierre A. Coulombe, PhD

History: Founding department in the world's oldest and largest school of public health, consistently ranked #1 by U.S. News & World Report.

Size and scope: 20 full-time faculty and 80 students. Master's and PhD degrees in reproductive and cancer biology, as well as postdoctoral training, for careers in academic, government, and industrial research.

DEPARTMENTAL PROFILE

The smallest elements of living cells can become the greatest weapons against diseases that threaten the lives of millions. This guiding principle has driven generations of faculty, students, and fellows in the Department of Biochemistry and Molecular Biology (BMB) to delve into the nanoscale phenomena that govern life at its most fundamental level. By studying the genetic and biochemical bases of cellular activity, BMB researchers seek to uncover the mechanisms underlying normal and abnormal biological processes, and define their relevance as opportunities for improving health and treating disease.

The Department’s efforts to define the fine structure, function, and properties of bacteria, viruses, vitamins, enzymes, proteins, genes, and metabolic pathways, as well as cells, tissues, and organs, have produced a series of scientific discoveries that have helped revolutionize public health.

In 1916, Johns Hopkins University established the world’s first graduate school of public health, which married the best of biomedical inquiry with the population-based approach of public health. The first chair of BMB (then named the Department of Chemical Hygiene), E.V. McCollum, identified vitamin D and its role in preventing rickets. McCollum was an influential arbiter of national and international policy in public health, agriculture, and the food industry. McCollum’s pioneering work on vitamin A helped set the stage for the School’s subsequent landmark studies of micronutrients that resulted in massive reductions in rates of blindness and mortality across the developing world.

Since McCollum, every chair of BMB has been at the forefront of applying genetic basic science research to address major public health problems. Roger Herriott, chair from 1948 to 1975, taught the School’s first courses on the properties of DNA and launched the first investigations of nucleic acids at Johns Hopkins. As an expert on the biochemistry of viruses and proteolytic enzymes, his landmark discovery was the role viruses played in spreading infection by injecting bacteria with their DNA. Larry Grossman, chair from 1975 to 1990, developed a highly sensitive assay for measuring the capacity of individuals’ blood cells to repair UVA-induced lesions. This clever assay provided a powerful tool for the molecular epidemiology of skin cancer, and was instrumental in establishing a link between faulty DNA repair and cancer risk.

Roger McMacken, chair from 1990 to 2008, illuminated the important roles of nuclear proteins intimately involved in the fundamental process of DNA replication. He developed and continues to teach the Genomics for Public Health course that introduces concepts in molecular biology and genetics and highlights their relevance and application to public health.

In the recent past, the Department’s strong interest in the biochemical pathways and mechanisms that maintain normal homeostasis has steadily expanded beyond the realm of DNA and the genome to include proteins, which are the ultimate effectors of most biological processes. This
expansion was initially led by McMacken. Pioneering studies by Cecile Pickart, Michael Matunis, and, more recently, Jiou Wang and Anthony Leung on various types of chemical modifications to proteins are shedding new light on the molecular tool kit used by our cells to regulate and maintain protein structure and function in response to genetic and environmental stresses. Failure of these processes underlies the development of chronic, aging-related diseases such as Alzheimer’s, cancer, and many others.

In the March 13, 2014 issue of the prestigious journal *Nature*, Wang’s team published a major discovery in the field of amyotrophic lateral sclerosis (ALS, or Lou Gehrig’s disease): they identified a molecular mechanism that could represent a common denominator among the eclectic collection of gene mutations that are conducive to ALS pathology and, possibly, related neurodegenerative diseases. Wang’s research was funded with a private grant from the Corinne Schwartz family through the ALS Association, and the resulting insights will be critical for designing therapies to interrupt these processes.

BMB’s current chair, Pierre Coulombe, is characterizing the properties and function of keratin proteins, which form cytoskeletal nanofibers, enabling epithelial cells to withstand various forms of stress. Genetic mutations affecting select keratin proteins impair the manufacturing of these cytoskeletal nanofibers, causing devastating blistering diseases in which skin epithelial cells, for instance, are fragile and rupture easily under stress. Some keratins show a tight association with could lead to the identification of better biomarkers and therapeutic targets.

**PRIORITIES FOR DISCOVERY**

In the 21st century, BMB faculty, students and trainees continue to employ an exceptionally broad spectrum of experimental approaches that range from x-ray crystallography to live cell imaging in organisms from budding yeast to humans. The essential ingredient of their contribution to advancing public health has been an intense commitment to following the trail of unanticipated discoveries, big and small, as they unfold in the context of hypothesis-driven laboratory research. The faculty’s research is both basic and applied, often extending from the molecule to the individual patient to the population.

BMB is seeking support for three ongoing scientific initiatives that define the Department and support the School’s mission of discovery.

**Quality Control in Biology: Understanding Disease Risk at a Molecular Level.** Quality control in biology refers to the mechanisms that detect damage incurred to biological macromolecules (such as DNA mutation or misfolded protein) and target them for repair, recycling, or disposal. When these quality control pathways fail, the resulting damaged molecules function abnormally and initiate a cascade of events that result in aging-related diseases such as cancer and various neurodegenerative conditions including Alzheimer’s, Parkinson’s, and Lou Gehrig’s disease. Quality control can also affect susceptibility to infection from pathogens, such as the plasmodia parasite that causes

The Bloomberg School’s founders had such profound faith in the power of basic science research to advance public health that five of the original nine departments were in laboratory fields.
malaria. BMB is poised to emerge as the epicenter of activity at JHU for this important area of biology and medicine.

Susceptibility to Tumorigenesis. A key focal point in BMB is the molecular determinants that set the stage for the inception and growth of tumors. This effort is not only driven by faculty interests but also sustained by a long-standing, highly successful training grant from the National Cancer Institute. While DNA repair continues to be an important area of research activity, the key roles of stress and inflammation are now being pursued as well with the strategic recruitment of new faculty including Pierre Coulombe, Valeria Culotta, Fengyi Wan, Anthony Leung, and Philip Jordan.

The Reproductive and Developmental Origins of Health and Disease. These research activities focus on contraception, infertility, reproductive toxicology, and animal science with broad implications for public health, medicine, and agriculture. Division faculty apply their basic science expertise in areas such as germ stem cell biology, gametogenesis, and fertilization to develop practical methods for advancing public health.

INSTITUTE FOR REPRODUCTIVE BIOLOGY

Reproductive biology is one of the most far-reaching examples of the impact of biomedicine on public health. The Division of Reproductive Biology was established in 1972 in what was then the Department of Population Dynamics. Barry Zirkin, whose research focuses on mammalian spermatogenesis and fertilization, established the Division’s Core Electron Microscopy Lab. The entire Division, along with Zirkin, William Wright, Terry Brown, and Janice Evans, transferred to BMB in 1998. The Division’s unique master's
program was modified and expanded to become BMB’s current master’s program in Reproductive and Cancer Biology.

Today, the Division of Reproductive Biology is directed by Wright, an expert in spermatogenesis. The Division’s activities have been expanded and reinvigorated by the recent recruitment of Philip Jordan and Daniela Drummond-Barbosa, who studies the impact of nutrition on egg production in females using a genetic approach. The Division hosts University-wide teaching, seminars, collaborative research, and educational programs. These activities support efforts to define and characterize the interrelationships among genetic, epigenetic, nutritional, and environmental factors that influence the odds for childhood and adult-onset disease.

DOCTORAL AND POSTDOCTORAL FELLOWSHIPS ARE BMB’S MOST IMPORTANT CAMPAIGN PRIORITY

PhD student Michael Estrella was born in the Brooklyn neighborhood of Bushwick to a single mother who had emigrated from the Dominican Republic. Growing up, Michael remembers that he “was on the receiving end, part of a community that needed help.” Now, as a Sommer Scholar at JHSPH, “I am a researcher, hoping that my work will help protect the health of communities.”

During his first year at a local college, Michael’s mother underwent hip replacement surgery. As he witnessed her arduous recovery, he decided that getting a degree could change not only his life but also the lives of others. He fell in love with science, eventually majoring in chemistry and biology.

Michael’s current research focuses on a process by which bacteria rid themselves of foreign genetic material. He wants to figure out how to control the mechanism at work in hopes of preventing antibiotic resistance. It’s an investigation that he’d like to continue in his own lab someday, with his own cadre of students. Michael assists in teaching the Genome Integrity and Cancer course, which explores the molecular mechanisms devoted to the preservation of genome integrity in cells. “If I can train other scientists,” he says, “that’s the best possible way I can give back.”
An endowment to establish an Institute for Reproductive Biology is a central campaign goal that would enable BMB to consolidate existing strengths and foster new growth and partnerships across the University.

OPPORTUNITIES TO SUPPORT BIOCHEMISTRY AND MOLECULAR BIOLOGY

BMB constantly strives to achieve greater financial stability and self-reliance to maintain full control over its own destiny. The process of discovery is typically slow and methodical. The commitment of time and resources may not generate measurable results in the early stages, but can ultimately have transformative implications for both public health and basic science. The means to achieve this necessary flexibility and independence for BMB fall into three categories: people, programs, and infrastructure.

Endowed scholarships for doctoral students and postdoctoral fellows will enable the Department to continue recruiting top trainees among its ranks and train the future leaders in basic science research for public health.

Priorities for faculty support include endowed professorships for junior and senior faculty, to help anchor the major scientific initiatives set by BMB. Innovation funding would provide support for productive, competitive investigators with lapses in grant funding in spite of outstanding performance in laboratory research. This would sustain continued productivity and retain trained laboratory personnel while a revised application is prepared and submitted for funding. In addition, the Department is co-leading a hybrid science initiative at the School and is seeking the resources needed to attract one or two faculty with a proven expertise in the area of computational biology along with research interests that are relevant to its stated objectives. This effort entails a close partnership with the Department of Biostatistics and other entities within the School.

BMB’s infrastructure requires significant updating in order to meet the present functional and space demands. BMB faculty have always leveraged new technology to integrate the best methods into laboratory instruction, introducing students to cutting-edge strategies, assays, and sophisticated instrumentation that subsequently have become standard tools of investigation. To continue this tradition and maintain the Department’s leadership in the basic science of public health, we must keep investing in the most powerful tools for scientific inquiry.

If the third floor W3600 corridor were renovated, it could house a new Institute for Reproductive Biology that offers a naming opportunity for a major donor. Another priority renovation is the old section of the eighth floor, which is part of the original 1924 School building. The Department intends to merge existing rooms to create two much-needed meeting and class rooms. Finally, the administrative and academic departmental office suites are long overdue for modernization and redesign.

The capital campaign will help BMB invest in its infrastructure and achieve sustainable funding for faculty and students that will elevate the quality and breadth of the Department’s research and teaching activities. BMB has only scratched the surface of its potential to discover answers to our century’s most urgent public health problems.

CAMPAIGN GOALS FOR BIOCHEMISTRY AND MOLECULAR BIOLOGY

- **$5 million** Endowment for the Institute for Reproductive Biology
- **$2.5 million** Endowed professorship in DNA repair and cancer risk
- **$2 million** Computational biology network (including recruitment of a junior faculty member)
- **$5 million** Space renovations (research, teaching, and administration)
- **$1 million** Laboratory equipment
- **$1 million** Innovation research fund
- **$7.5 million** 5 endowed postdoctoral fellowships at $1.5 million each
Cover (clockwise from upper left): BMB faculty member Jiou Wang and his team are making major discoveries to understand the genetic mechanisms that cause ALS and other neurodegenerative diseases; BMB chair Pierre Coulombe uses x-ray crystallography to study the proteins that form the structure of skin cells; BMB faculty, students and trainees employ an exceptionally broad spectrum of experimental approaches; Research on fertilization and other aspects of reproductive biology has a far-reaching impact on public health.

Inside cover: BMB trains future leaders in basic science research for public health.