SETTING THE STAGE FOR THE NEXT CENTURY
“The establishment of public health laboratory service has been one of America’s chief contributions to the field of preventive medicine. The development of this division is in itself a striking illustration of this renaissance of medical science.”

Augustus B. Wadsworth, M.D., Director
On the occasion of the 25th anniversary of the Division of Laboratories & Research

“As we enter the era of precision medicine, traditional definitions of health and disease are changing. Standing at the crossroads of multiple biological and environmental disciplines, public health laboratories will play an essential role in connecting the different sciences to promote the health of our citizens and communities.”

Jill Taylor, Ph.D., Director
On the occasion of the 100th anniversary of the founding of Wadsworth Center
Excellence in research has been a hallmark of the Wadsworth Center since founding director, Augustus B. Wadsworth, declared scientific investigation an essential component of public health services. This bedrock principle has sustained the organization since Dr. Wadsworth joined the then Division of Laboratories and Research (DLR) in 1914. The intervening century has brought growth and change, challenges and successes. This year scientists celebrate 100 years of Wadsworth’s vision and the center that bears his name while training their sights on the evolving future of health-related research.

New York’s premier public health laboratory is poised at the intersection of science, medicine and health. At Wadsworth, researchers collaborate with colleagues across the corridor and across the globe; cross scientific disciplines for new insights; employ the most advanced technologies; and rely on Department of Health epidemiologists, environmental health specialists and others to meet the mission of protecting and promoting the health of New York State citizens.

Health is protected by rapid and accurate identification of genetic diseases, infectious agents and environmental threats. Health is promoted by research on the causes of disease, the discovery of new preventive measures, and the development of diagnostic tests and effective therapies. All are the purview of the Wadsworth Center. All are science in the pursuit of health.
Fresh from touring prominent European laboratories after medical school, Augustus Wadsworth established himself as an infectious disease specialist in the hotbed of bacteriology that was New York City in the early 20th century. Proponents of the new science had used laboratory diagnostics and studies, along with antisera treatments, to make inroads against communicable diseases. Chief among them was Hermann M. Biggs, credited with controlling tuberculosis and diphtheria. Named State Health Commissioner in 1914, Biggs scanned the city’s scientific landscape and, impressed with Wadsworth, recruited him to lead the state laboratory.

As director for the next 30 years, Augustus Wadsworth transformed the organization from three small buildings on Yates Street in Albany into two campuses, an expansive complex on New Scotland Avenue and the farm in Guilderland, where horses used in antisera production were housed. He built more than an institution. He built a vision of public health science. His focus: standardization, education and investigation.

On Wadsworth’s arrival, protocols in the Yates Street laboratory were rewritten to ensure accuracy in diagnostics and purity of in-demand therapeutics. As the number and types of tests grew, procedures were carefully recorded, eventually leading to the 1926 DLR publication, Standard Methods, used in major clinical and research laboratories around the world. New editions were published in 1939 and 1947.

Standardization was ingrained in technical staff, and required of those at local laboratories approved by the Department, sometimes via on-site training. Volunteers with appropriate education could participate in a two-year certificate program, a DLR imprimatur that virtually guaranteed future employment. Scientific staff regularly presented seminars prior to publishing their research. Wadsworth even had scientists from the DLR’s Branch Laboratory (1914–1954) in New York City travel to Albany’s Central Laboratory for seminars. The meetings continued during the World Wars, despite critical staff shortages.
If one principle distinguished Augustus Wadsworth and his institution from the outset, it was his belief -- shared with Commissioner Biggs -- that the routine work of diagnostics and therapeutics benefited from research and investigations. The very name they chose for the institution underscored this conviction: Division of Laboratories and Research. As DLR director, Wadsworth continued his own studies of pneumococcal infections, recruited and encouraged other researchers, expanded facilities and acquired instruments to support their efforts and the state’s needs, and thus created a rich scientific environment from which emerged significant achievements, then and ongoing.

The Value of Research in Public Health Laboratories: Wadsworth’s Vision Leads to Landmark Achievements

1926 First Standard Methods of analysis for public health testing published

1941 Syphilis test standardized with the chemically-defined antigen, cardiolipin

1948 Coxsackie virus isolated and characterized

1950 Nystatin discovered, the first safe and effective antifungal antibiotic

1965 A model newborn screening program established and new assays developed, allowing detection of more treatable conditions

1978 Studies on arboviruses begin and expand to include Eastern Equine Encephalitis, Dengue, West Nile and Chikungunya viruses to define more effective and targeted control measures

1978 Sophisticated analytical methods developed to assess the toxicity of complex environmental mixtures

1981 Electron microscopy and computer processing used to analyze 3D structures of large biomolecules, discovering new targets for antibiotics and a potential new treatment strategy for Fragile X syndrome

1983 Vaccinia virus used as a vector to express selected genes from pathogens to make safer vaccines

1984 Mobile genetic elements known as introns discovered in bacteria

1991 A brain-computer interface system developed, allowing “locked-in” patients to communicate, and brain surgery and spinal cord rehabilitation improved by related studies

2001 Sensitive biomonitoring analytics used to detect low levels of environmental toxins in human samples

2006 Whole genome studies define genes associated with Parkinson’s disease, allowing genetic testing for disease susceptibility

2008 HIV studies lead to development of an HIV tropism assay to predict disease progression
The Present Moment: Scientific Focus Areas

A century later, echoes persist from Augustus Wadsworth’s era: a scientist today researches ricin antitoxin, rather than diphtheria antisera; others study tuberculosis, but on the molecular level and focused on drug resistance; outbreak investigators are as relentless as ever, but track the outbreak’s path with DNA sequence analysis; standards persevere across both clinical and environmental laboratories; and students pursue a Master of Science in Laboratory Sciences, instead of a simple certificate.

Yet much has changed. Genetics and genomics have come to the fore. Pathogens spread more rapidly by global travel, and are sometimes deliberately spread with malicious intent. Climate change has created new habitats for disease vectors, such as mosquitoes infected with tropical viruses. Environmental exposures have grown more frequent and complex. Technologies have multiplied, as have the number of research publications.

As the natural and man-made worlds evolve, public health likewise must adapt and change. Respectful of its past, indeed, now named after its founding director, the present-day Wadsworth Center enters its second century confident of its research strengths but mindful of the need for continuous evaluation. By building on its strengths, a historic institution will meet 21st century challenges.
The completion of the Human Genome Project in 2003 created headlines and great expectations. Individuals have benefited from the discovery of disease susceptibility genes, such as HLA-DR for Parkinson’s disease, or the identification of gene variants associated with therapeutic drug metabolism, for example. Yet the translation of genetic discoveries into widespread clinical applications has just begun.

Population health, the domain of public health, has benefited largely outside of the limelight. At Wadsworth, genomic technologies have played a major role in both diagnostic and research programs, in disciplines from infectious disease to genetic disorders.

The pioneering Newborn Screening Program has employed DNA sequencing technologies to determine the genetic basis of diseases screened in infants, and to identify novel genetic causes of birth defects. The Biodefense Laboratory, experienced before 9/11 and primed to respond thereafter, has used sequencing in surveillance of biothreat agents, such as the causative agent of botulism poisoning.

Foodborne disease outbreaks, which sicken one in six Americans each year, have been tracked more precisely and rapidly with DNA sequencing. In collaboration with the Food and Drug Administration since 2012, Wadsworth has fully sequenced many genomes of the bacterium Salmonella, a frequent cause of food-borne illness. Newly emerging pathogens have been more readily identified, and known infectious agents more closely studied, including E. coli, influenza and West Nile virus. Next-generation sequencing technologies continue to accelerate this progress.

Wadsworth’s extensive experience with sequencing, along with robust computing and bioinformatics expertise to analyze genomic data, has led to partnerships with federal and state agencies, and academic and research centers. Advanced molecular technologies promise to transform clinical diagnostics, patient care and tracking of public health threats, including hospital-acquired infections and drug-resistant pathogens. All technologies and efforts are geared towards improving health.
Linking Exposures to Health

Environmental contamination at Love Canal in western New York in the late 1970s was a trial by fire for the Department of Health. For policy makers to even begin assessing the public health impact, they needed to know the identity and extent of buried industrial wastes. To make the unknown known, Wadsworth chemists developed a novel methodology to measure complex environmental mixtures; it was the gold standard for years to come. More than 30 years later, Wadsworth researchers remain at the frontier of environmental risk analysis. Today, that means biomonitoring.

Biomonitoring measures chemicals or their by-products directly in human tissue and body fluids. This internal measure indicates an individual’s total exposure to a potential health threat, whether an environmental pollutant or a dietary chemical. For example, detection of a nicotine metabolite in blood or saliva provides evidence of second-hand smoke exposure, rather than deducing exposure from indoor air measurements.

Wadsworth’s federally-supported biomonitoring program has developed exquisitely sensitive analytics using sophisticated technologies, including mass spectrometry. The resulting capacity to perform large-scale population-based biomonitoring and biomarker research is second only to the Centers for Disease Control and Prevention.

Biomarkers of exposure and effect are natural partners to epidemiology and environmental health studies that associate toxicants or lifestyle with adverse health outcomes, including heart disease, cancer, diabetes and other chronic conditions. Biomonitoring can underscore these findings, indicate new linkages, or reveal disparities in the health and disease status of specific New York State populations.
Adaptive Neurotechnologies

The economic burden of neurological disorders or trauma is immense, the human burden, incalculable. At the turn of the 21st century, it was estimated that the annual cost to the U.S. of traumatic brain injuries alone was $60 billion. The 12,000 new spinal cord injuries occurring each year present equally high costs. Injured individuals, along with those affected by stroke, amyotrophic lateral sclerosis, Parkinson’s disease and other neuromuscular disorders are the focus of efforts to develop assistive technologies that can improve quality of life.

Since the mid-1980s, pioneering research at Wadsworth Center has been at the forefront of efforts to capture brain signals recorded from the scalp and translate them into communication and control devices. Relying on brain signals alone, patients without voluntary muscle movement can use the brain-computer interface (BCI) technology to send email, use synthetic speech or operate environmental controls. The BCI system, which interacts in real time with the central nervous system, has moved to clinical trials.

The electroencephalography (EEG)-based BCI research continues in parallel with studies of electrocorticographic (ECoG) signals recorded from the brain’s surface, with the goal of mapping and understanding brain processes to aid neurological diagnosis and treatment. Additional studies examine the plasticity of the central nervous system, particularly the pathways and structures that maintain this ability and promote learning in the spinal cord. The results could improve rehabilitation protocols and offer functional recovery for spinal cord-injured patients. With substantial federal support, the team of scientists, engineers and clinicians is now focusing on clinical translation of their research findings, and broad dissemination of resulting technologies through online and onsite training programs.
Tuberculosis (TB) was second only to measles as the causative agent of communicable disease deaths in New York State when Augustus Wadsworth arrived in Albany 100 years ago. It remains a challenge. Today the state has the third-highest number of TB cases in the country. Of concern is the growing number of individuals infected with strains of M. tuberculosis which are resistant to first-, and in some cases, second-line drugs. Multi-drug resistant TB has increased more than three-fold in the last five years alone.

TB has company. Bacterial pathogens that cause meningitis, pneumonia, blood and intestinal infections, and other serious illnesses also have become antibiotic-resistant. Whether acquired in hospitals or community settings, they pose a greater risk for morbidity and mortality, causing 23,000 deaths and two million illnesses in the country each year.

Faster diagnoses and more precise therapeutics can reverse the trend. What’s needed is a better understanding of the pathogenic bacteria’s biology, how they adapt to elude previously effective drugs, what mutations are associated with drug resistance, and where in their replication cycle novel drug targets might exist.

With a special focus on M. tuberculosis, Wadsworth investigators use cellular and molecular approaches to study the mechanisms by which bacteria initiate and maintain infections. They use high-throughput genomic technologies to sequence bacterial genomes and identify genes associated with virulence and drug resistance, which are potential targets for new therapies. Other resources include Biosafety Level 3 laboratories where TB isolates can be identified and characterized; an extensive collection of antibiotic-resistant strains; and a track record for developing and validating state-of-the-art diagnostic assays.
Control of Vector-borne Diseases

In the last quarter century, New York State has been challenged by emerging or re-emerging infections. Many are zoonotic diseases that are transmitted directly by an animal bite, or indirectly by mosquitoes and ticks that feed on infected animals. These include an historic epidemic of raccoon rabies in the early 1990s; the first appearance in the United States of the mosquito-borne West Nile virus in 1999; and the geographic spread of Lyme disease-carrying ticks. Eight thousand cases of Lyme disease were reported statewide in 2011, the same year that New York led the country with cases of babesiosis, a tick-borne parasite.

The threat continues. Pathogens and vectors evolve and adapt. Global travel, climate change and other factors enable them to establish a foothold in previously inhospitable regions. The arrival of the Asian tiger mosquito in New York State, for example, resulted in the state’s first locally-acquired case of Dengue fever in 2013. A similar concern looms about the Chikungunya virus.

Wadsworth Center is well positioned to study zoonotic diseases, especially arboviruses carried by ticks and mosquitoes. Scientists research transmission cycles from animal reservoir to vector to human; the ecology and evolution of viruses, notably West Nile and Dengue; the geographic and temporal distribution of vectors; and other factors that drive disease outbreaks. Their studies are supported by exceptional resources, including a state-of-the-art insectary, a bat vivarium, and a repository of animal, mosquito and tick specimens from surveillance and testing. Wadsworth colleagues expert in microbial genomics, structural biology and clinical diagnostics enrich this research, as do Department of Health epidemiologists. Their ultimate goals: to develop predictive and control measures, and identify targets for antiviral drug development.
Three-dimensional Electron Microscopy

Wadsworth Center’s 3D-EM Group has long been at the forefront in developing the latest advances in electron microscopy and image-processing techniques to study cellular processes and microbial pathogens at near-atomic resolution. Several techniques pioneered at Wadsworth are now used by scientists around the world for modern biomedical research. These studies have provided unprecedented structural detail in understanding how proteins interact in normal and diseased states. Scientists in the 3D-EM group currently pursue federally-funded research projects of biomedical and public health relevance. For example, understanding the protein translation machinery in bacteria and mammals is relevant to a wide range of diseases, from TB to Fragile X Syndrome, as well as to identifying sites for new drug targets.

Other scientists study the mechanism by which stimulation of muscle by neurons leads to muscle contraction. Malfunctions of this process are relevant to several skeletal muscle diseases, such as malignant hyperthermia and muscular dystrophy, as well as a number of cardiac disorders. Malfunctions of extra-cellular sensors such as cilia can lead to numerous developmental defects and fatal kidney diseases. Understanding their precise structure will help identify potential therapeutic drug targets.
In 2014, the Wadsworth Center granted its first Master of Science in Laboratory Sciences degrees. The two-year intensive program of study combines lecture-based learning with an extensive amount of direct laboratory training. Students experience laboratory science in action in areas such as clinical immunology, microbiology and infectious disease, molecular biology, biochemistry, biomonitoring, and laboratory operations and management. The program is designed to train the next generation of public health laboratory managers.

School of Public Health
www.albany.edu/sph/

The University at Albany School of Public Health is a joint venture between the Department of Health and the University at Albany. Wadsworth scientists serve as faculty in the School’s Department of Biomedical Sciences and the Department of Environmental Health Sciences, where students may earn masters and doctoral degrees.

Postdoctoral Training
Wadsworth Center also supports an active postdoctoral fellowship program including the federally-funded BioDefense and Emerging Infectious Disease Fellows program.
Augustus Wadsworth’s vision of standardization has been translated into a laboratory quality assurance program for both clinical and environmental laboratories operating in New York State. New York’s comprehensive laboratory oversight programs incorporate proficiency testing, which is the distribution of specimen panels to evaluate a laboratory’s ability to perform tests; on-site inspection of laboratory facilities and practices; review of laboratory director and personnel qualifications; provision of scientific and technical consulting services as a resource to regulated laboratories; and, on the clinical side, review of laboratory-developed methods.

New York’s approval of a laboratory-developed test is nationally held as a mark of high approval of technical and clinical validity, and New York is seen as a leader in the field. The mission of New York’s regulatory programs is to ensure the health and safety of New York citizens by assuring the quality of all laboratory testing. Approximately 70 percent of medical diagnoses and treatment decisions are based on laboratory test results. Just as in the research field, the laboratory testing field is continually evolving and Wadsworth’s regulatory programs continue to adapt to meet new challenges.
Wadsworth Center resides in the Department of Health’s Office of Public Health, along with the Center for Community Health, the Center for Environmental Health, and the AIDS Institute. Wadsworth scientists work closely with epidemiologists, infectious disease experts, environmental health specialists and others from the Centers, in support of the Department’s mission.

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