

Review of the Scientific Approaches used During the FBI's Investigation of the 2001 Bacillus Anthracis Mailings

Committee

Alice P. Gast

Chair

On August 1, 2006, Alice P. Gast became Lehigh University's 13th president. Previously she was the Robert T. Haslam Professor of Chemical Engineering and the Vice President for Research and Associate Provost at Massachusetts Institute of Technology. Prior to moving to MIT in 2001, she spent 16 years as a professor of chemical engineering at Stanford University and at the Stanford Synchrotron Radiation Laboratory. In her research she studies surface and interfacial phenomena, in particular the behavior of complex fluids. Some of her areas of research include colloidal aggregation and ordering, protein lipid interactions and enzymes reactions at surfaces. In 1997 Gast co-authored the sixth edition of "Physical Chemistry of Surfaces." with Arthur Adamson. Professor Gast received her BS in Chemical Engineering from the University of Southern California. After earning her Ph.D. in chemical engineering from Princeton University, Gast spent a postdoctoral year on a NATO fellowship at the École Supérieure de Physique et de Chimie Industrielles in Paris. She returned there for a sabbatical as a Guggenheim Fellow. She was a 1999 Alexander von Humboldt Fellow at the Technical University in Garching, Germany. She received the National Academy of Sciences Award for Initiative in Research, and the Colburn Award of the American Institute of Chemical Engineers. She was elected to the National Academy of Engineering in 2001 and to the American Academy of Arts and Sciences in 2002. She has served on numerous advisory committees including the NRC Board on Chemical Science and Technology, and the Homeland Security Science and Technology Advisory Committee. She was elected to the Board of the American Association for the Advancement of Science in 2006.

David A. Relman

Vice Chair

David A. Relman, M.D., is professor of medicine (infectious diseases and geographic medicine) and of microbiology and immunology at Stanford University School of Medicine, and chief of the infectious disease section at the Veterans Affairs (VA) Palo Alto Health Care System. Dr. Relman received his B.S. in biology from the Massachusetts Institute of Technology and his M.D. from Harvard Medical School. He completed his residency in internal medicine and a clinical fellowship in infectious diseases at Massachusetts General Hospital, Boston, after which he moved to Stanford for a postdoctoral fellowship in 1986 and joined the faculty there in 1994. His major research focus is on understanding the structure and role of the human indigenous microbial communities in health and disease. This work brings together approaches from ecology, population biology, environmental microbiology, genomics, and clinical medicine. A second area of investigation explores the classification structure of humans with systemic infectious diseases, based on patterns of genome-wide gene transcript abundance in blood and other tissues. The goals of this work are to understand mechanisms of host-pathogen interaction, as well as predict clinical outcome early in the disease process. His scientific achievements include the description of a novel approach for identifying previously unknown pathogens; the characterization of a number of new human microbial pathogens, including the agent of Whipple's disease; and some of the most in-depth analyses to date of human indigenous microbial communities. Among his other activities, Dr. Relman currently serves as chair of the Forum on Microbial Threats of the Institute of Medicine (National Academies of Science), is a member of the National Science Advisory Board for Biosecurity, and advises a number of U.S. government departments and agencies on matters related to pathogen diversity, the future life sciences landscape, and the nature of present and future biological threats. He was co-chair of the Committee on Advances in Technology and the Prevention of Their Application to Next Generation Biowarfare Threats for the National Academy of Sciences (NAS), and chair of the Board of Scientific Counselors of the National Institutes of Health (NIH) National Institute of Dental and Craniofacial Research. He received the Squibb Award from the Infectious Diseases Society of America (IDSA) in 2001, the Senior Scholar Award in Global Infectious Diseases from the Ellison Medical Foundation in 2002, an NIH Director's Pioneer Award in 2006, and a Doris Duke Distinguished Clinical Scientist Award in 2006. He is also a fellow of the American Academy of Microbiology.

Arturo Casadevall

Member

Arturo Casadevall is the Leo and Julia Forchheimer Professor of Microbiology & Immunology and Chair of the Department of Microbiology and Immunology at the Albert Einstein College of Medicine. He is also a Professor in the Department of Medicine. He received his B.A. from Queens College, CUNY, and M.S., M.D. and Ph.D. degrees from New York University. His laboratory is interested in the fundamental questions of how microbes cause disease and how the host protects itself against microbes. The laboratory has a multidisciplinary research program spanning several areas of basic immunology and microbiology to address these general questions, which has resulted over 430 publications. His laboratory studies are focused on two microbes: the fungus *Cryptococcus neoformans*, a ubiquitous environmental microbe that is a frequent cause of disease in immunocompromised individuals and *Bacillus anthracis*, which a major agent of biological warfare. He is a fellow of the American Academy of Microbiology and was elected to the American Society for Clinical Investigation, to the American Association of Physicians and as a fellow of the AAAS. Dr. Casadevall has served on numerous advisory committees to the NIH including study sections, strategic planning for the NIAID and the blue ribbon panel on response to bioterrorism. He currently co-chairs the Board of Scientific Counselors for the NIAID and is a member of the National Science Advisory Board for Biosecurity (NSABB). He an editor for *Infection and Immunity*, serves on the editorial boards of several journals, and has been the recipient of numerous awards, most recently the Solomon A. Berson Medical Alumni Achievement Award in Basic Science-NYU School of Medicine 2005 and the IDSA Kass Lecturer in 2008.

Nancy D. Connell

Member

Dr. Connell is professor of medicine at the University of Medicine and Dentistry of New Jersey (UMDNJ)-New Jersey Medical School. She is also director of the UMDNJ Center for BioDefense, which was established in 1999 and is the recipient of \$11.5 million in congressional recommendations (2000-2006) for research into the detection and diagnosis of biological warfare agents and biodefense preparedness. Dr. Connell also is director of the Biosafety Level 3 Facility of UMDNJ's Center for the Study of Emerging and Re-emerging Pathogens and chairs the Recombinant DNA Subcommittee of the university's Institutional Biosafety Committee and she has worked with several international programs on dual use issues. She is past chair of the National Institutes of Health's Center for Scientific Review Study Section HIBP (Host Interactions with Bacterial Pathogens, which reviews bacterial-pathogenesis submissions to the National Institute of Allergy and Infectious Diseases. She is current chair of the F13 infectious diseases and microbiology fellowship panel. Dr. Connell's involvement in biological weapons control began in 1984, when she was chair of the Committee on the Military Use of Biological Research, a subcommittee of the Council for Responsible Genetics, based in Cambridge, Massachusetts. Dr. Connell received her Ph.D. in microbial genetics from Harvard University. Her major research focus is the interaction between *Mycobacterium tuberculosis* and the macrophage.

Thomas V. Inglesby

Member

Thomas V. Inglesby, M.D., is Chief Operating Officer and Deputy Director of the Center for Biosecurity of UPMC and Associate Professor of Medicine and Public Health at the University of Pittsburgh Schools of Medicine and Public Health. He is an infectious disease physician by training. Dr. Inglesby is Coeditor-in-Chief of the peer-reviewed journal *Biosecurity and Bioterrorism: Biodefense Strategy, Practice, and Science*. He has authored a number of widely cited publications on anthrax, smallpox, plague, and biosecurity issues related to medicine and hospital preparedness, public health, science, pandemic planning, and national security. He is a principal editor of the JAMA book entitled *Bioterrorism: Guidelines for Medical and Public Health Management*. Dr. Inglesby was a principal designer, author, and controller of the widely recognized Atlantic Storm exercise of 2005 and of the Dark Winter smallpox exercise of 2001. He has served in advisory and consultative capacities for government, scientific organizations, and academia on issues related to biosecurity—providing briefings for officials in the Administration and for Congressional members and staff; serving on a task force of the Defense Science Board of the DoD and a committee of the National Research Council of the National Academies of Sciences; and participating in an advisory capacity to CDC, NIH, HHS, DHS, the Defense Advanced Research Projects Agency (DARPA), and the Defense Intelligence Agency (DIA). Prior to helping establish the Center for Biosecurity in 2003, Dr. Inglesby was one of the founding members of the Johns Hopkins Center for Civilian Biodefense Strategies, where he served as Deputy Director from 2001 to 2003. He was also a faculty member of the Johns Hopkins School of Medicine from 1999 to 2003. Dr. Inglesby is Board-certified in Infectious Diseases. He received a BA in 1988 from Georgetown University and an MD from the Columbia University College of Physicians and Surgeons in 1992. He completed his Internal Medicine Residency and Infectious Diseases Fellowship training at the Johns Hopkins School of Medicine, and served as Assistant Chief of Service in the Johns Hopkins Department of Medicine in 1996 and 1997.

Murray V. Johnston

Member

Dr. Johnston is a professor in the Department of Chemistry and Biochemistry at the University of Delaware. He began his academic career as an assistant/associate professor of chemistry and a fellow of the Cooperative Institute for Research in Environmental Sciences at the University of Colorado, Boulder. He received a Center for Advanced Study fellowship in 1999, the Outstanding Scholar Award in the College of Arts and Sciences in 2001, the Delaware Section Award of the American Chemical Society in 2003, and the Benjamin Y. H. Liu Award from the American Association for Aerosol Research in 2008. Dr. Johnston's research includes applications of mass spectrometry to a wide array of materials, from airborne particles to biological and polymeric macromolecules. Over the past 15 years he has used real-time single-particle mass spectrometry to study microchemical reactions within particles, heterogeneous reactions between gas-phase and particulate-phase species, and ambient fine-ultrafine particles (50-1000 nm) at various urban sites. His current work emphasizes the use of photoionization aerosol mass spectrometry to characterize organic components of combustion and ambient aerosols, nano aerosol mass spectrometry to characterize individual nanoparticles and macromolecules smaller than about 30 nm, and conventional mass spectrometry to characterize oligomeric compounds in secondary organic aerosols. His work has led to some 140 publications.

Karen Kafadar

Member

Dr. Kafadar is James H. Rudy Professor of Statistics and Physics at Indiana University. She received her B.S. and M.S. degrees from Stanford and her Ph.D. in Statistics from Princeton under John Tukey. Her research focuses on exploratory data analysis, robust methods, characterization of uncertainty in quantitative studies, and analysis of experimental data in the physical, chemical, biological, and engineering sciences. Prior to Indiana University, she was Professor and Chancellor's Scholar in the Departments of Mathematical Sciences and Preventive Medicine & Biometrics at the University of Colorado-Denver; Fellow at the National Cancer Institute (Cancer screening section); and Mathematical Statistician at Hewlett Packard Company (R&D laboratory for RF/Microwave test equipment) and at National Institute of Standards and Technology (where she continues as Guest Faculty Visitor on problems of measurement accuracy, experimental design, and data analysis). Previous engagements include consultancies in industry and government as well as visiting appointments at University of Bath, Virginia Tech, and Iowa State University. She has served on previous NRC committees and chaired the National Academies' Committee on Applied and Theoretical Statistics. She also serves on the editorial boards for several professional journals as Editor or Associate Editor and on the governing boards for the American Statistical Association, the Institute of Mathematical Statistics, and the International Statistical Institute. She is an Elected Fellow of the American Statistical Association and the International Statistical Institute, has authored over 90 journal articles and book chapters, and has advised numerous M.S. and Ph.D. students.

Richard E. Lenski

Member

Richard Lenski is the Hannah Distinguished Professor of Microbial Ecology at Michigan State University. His research explores the genetic mechanisms and ecological processes that underlie evolution. While most evolutionary research uses the comparative method, Lenski pursues an experimental approach using bacteria. In an experiment started 21 years ago, Lenski and his team have watched 12 populations of *E. coli* evolve in the lab for more than 40,000 generations to investigate the phenotypic and genetic dynamics of adaptation and diversification. Lenski and his students have performed other experiments with microbes on the dynamics of host-parasite interactions, the evolution of mutation rates, and even social interactions. Lenski also collaborates with an interdisciplinary team on experiments using digital organisms – computer programs that replicate, mutate, compete, and evolve – to investigate the evolution of complexity. Prof. Lenski has received a MacArthur Foundation Fellowship (1996) and been elected to the National Academy of Sciences (2006).

Richard M. Losick

Member

Richard M. Losick is the Maria Moors Cabot Professor of Biology, a Harvard College Professor, and a Howard Hughes Medical Institute Professor in the Faculty of Arts & Sciences at Harvard University. He received his A.B. in Chemistry at Princeton University and his Ph.D. in Biochemistry at the Massachusetts Institute of Technology. Upon completion of his graduate work, Professor Losick was named a Junior Fellow of the Harvard Society of Fellows when he began his studies on RNA polymerase and the regulation of gene transcription in bacteria. Professor Losick is a past Chairman of the Departments of Cellular and Developmental Biology and Molecular and Cellular Biology at Harvard University. He received the Camille and Henry Dreyfuss Teacher-Scholar Award, and he is a member of the National Academy of Sciences, a Fellow of the American Academy of Arts and Sciences, a Member of the American Philosophical Society, a Fellow of the American Association for the Advancement of Science, a Fellow of the American Academy of Microbiology, and a former Visiting Scholar of the Phi Beta Kappa Society. He is the 2007 recipient of the Selman A. Waksman Award of the National Academy of Sciences and a 2009 recipient of the Canada Gairdner Award.

Alice C. Mignerey

Member

Professor Alice Mignerey is a Nuclear Chemist with research programs in basic nuclear science and in applications of the nuclear analytical technique of Accelerator Mass Spectrometry (AMS) to environmental problems. Professor Mignerey's basic nuclear research is focused on understanding the behavior of nuclear matter under conditions of extreme density (pressure) and temperature. These conditions are postulated to have existed just after the Big Bang, when the protons and neutrons had not yet formed from their constituent quarks and the gluons which hold them together. This so-called quark-gluon plasma has been predicted to be accessible through heavy-ion reactions at high energies. The experimental program is centered at the Brookhaven National Laboratory RHIC accelerator where colliding beams of nuclei reach center-of-mass energies of 200 AGeV, producing conditions mimicking those of the early universe. Prof. Mignerey is a member of the PHOBOS and PHENIX Collaborations at RHIC and the CMS Heavy Ion Group at the CERN LHC. The research program in AMS has concentrated on the uses of the cosmogenic nuclides, such as C-14 and Cl-36, to study ground-water and soil systems. Technique development is currently being carried out with researchers at the Naval Research Laboratory Trace Element AMS facility (TEAMS) to allow dating separate organic fractions in the organic C-14 carbon pool.

David L. Popham

Member

Dr. David L. Popham is a professor in the Department of Biological Sciences at Virginia Tech. He teaches in the areas of microbial genetics and physiology. He directs a research program in the areas of bacterial endospore structure, content, germination, and resistance properties. Dr. Popham has a Ph.D. in microbiology from the University of California-Davis. He held postdoctoral research positions at the Institut de Biologie Physico-Chimique in Paris and at the University of Connecticut Health Science Center before joining the Virginia Tech faculty in 1996. He has over 20 years of experience in research on *Bacillus subtilis* cell wall synthesis, spore formation, and spore resistance properties. More recently his research has expanded into the content, structure, and germination of spores produced by *Bacillus anthracis*, *Clostridium difficile*, and *Clostridium perfringens*. Dr. Popham is a member of the editorial board of the *Journal of Bacteriology* and has served as an ad hoc member of six NIH grant review panels. In 2007, he served on the EPA Federal Insecticide, Fungicide, and Rodenticide Act Scientific Advisory Panel for the development of guidelines for the approval of sporicidal products.

Jed S. Rakoff

Member

Judge Rakoff is a United States District Judge for the Southern District of New York. He was appointed on January 4, 1996, and entered on duty on March 1, 1996. Judge Rakoff graduated with honors in English literature from Swarthmore College (BA 1964), earned his M. Phil. from Balliol College at Oxford University (1966), and graduated cum laude from Harvard Law School (J.D. 1969). He has received honorary degrees from St. Francis University and from Swarthmore. After serving as law clerk to the late Honorable Abraham Freedman of the U.S. Court of Appeals for the Third Circuit, Rakoff spent two years in private practice at Debevoise & Plimpton before joining the U.S. Attorney's Office for the Southern District of New York. He spent seven years with the Office, the last two as Chief of the Business and Securities Fraud Prosecutions Unit. He then returned to private practice where he was a partner first with Mudge, Rose, Guthrie, Alexander & Ferdon, and then with Fried, Frank, Harris, Shriver & Jacobson. He headed both firms' criminal defense and civil RICO sections.

Robert C. Shaler

Member

After obtaining a doctoral degree in Biochemistry from the Pennsylvania State University in 1968, Dr. Shaler worked at the University of Pittsburgh as a professor of chemistry and at the Pittsburgh Crime Laboratory as a criminalist. His research resulted in the development of a bloodstain analysis system, the defacto standard in forensic laboratories until the early 1990's. The New York City Office of Chief Medical Examiner beckoned in 1978. He directed the forensic serology laboratory and performed and directed forensic biological analyses in all New York City homicide investigations. In the wake of the WTC attacks on September 11, 2001, he assumed the responsibility for identifying the people who perished. He designed, organized, and implemented the DNA testing strategy that became the cornerstone for the majority of the identified victims. After the OCME effort to identify the WTC victims paused, he accepted a professorship in the Biochemistry and Molecular Biology Department and the directorship of the forensic science program at the Pennsylvania State University.

Elizabeth A. Thompson

Member

Elizabeth A. Thompson, Professor, received a B.A. in mathematics (1970), a diploma in mathematical statistics (1971), and Ph.D. in statistics (1974), from Cambridge University, UK. In 1974-5 she was a NATO/SRC postdoc in the Department of Genetics, Stanford University. From 1975-81 she was a Fellow of King's College, Cambridge, and from 1981-5 was Fellow and Director of Studies in Mathematics at Newnham College. From 1976-1985 she was a university lecturer in the Department of Pure Mathematics and Mathematical Statistics, University of Cambridge. She joined the faculty of the University of Washington in December 1985, as a professor of statistics. From 1988 to 2004, Dr. Thompson was also professor of biostatistics at University of Washington, and from 2000 to 2005 an adjunct professor of statistics at North Carolina State University. Since Spring 2000, she has been an adjunct professor in genetics (now genome sciences), and from 2006 also in biostatistics at the University of Washington. At the University of Washington, Dr. Thompson was chair of the department of statistics from 1989-94, and was graduate program coordinator in statistics, 1995-8, and 1999-2000. From 1990 to 2002 she was a member of the QERM Interdisciplinary Graduate Program faculty, and served as the alternate QERM Graduate Program Coordinator for 1998-9. From 1999-2002 she was also a member of the interdisciplinary faculty group in computational molecular biology, but since 1999 has focussed primarily on the development of research and education in statistical genetics at the University of Washington. She was elected to the National Academy of Sciences in 2008.

Kasthuri Venkateswaran

Member

Dr. Kasthuri Venkateswaran is a senior research scientist at the California Institute of Technology's Jet Propulsion Laboratory. Dr. Venkateswaran's 32 years of research encompass marine, food and environmental microbiology. He has applied his research in molecular microbial analysis to better understand the ecological aspects of microbes, while conducting field studies in several extreme environments such as deep sea (2,500 m), pristine caves (3,000 m altitude), spacecraft (Mars Odyssey, Genesis, MER, Mars Express, Phoenix, MSL) assembly facility clean rooms (various NASA and European Space Agency facilities), as well as the space environment in Earth orbit (International Space Station). Of particular interest are microbe-environment interactions with emphasis on the environmental limits in which organisms can live. The results are used to model microbe-environment interactions with respect to microbial detection, and the technologies to rapidly monitor them without cultivation. The bioinformatics databases generated by Dr. Venkateswaran are extremely useful in the development of biosensors. Further, these models or information in databases are extrapolated to what is known about the spacecraft surfaces and enclosed habitats in an attempt to determine forward contamination as well as develop countermeasures (develop cleaning and sterilization technologies) to control the problematic microbial species. Specifically, his research into the analysis of clean room environments using state-of-the art molecular analysis coupled with nucleic acid and protein-based microarrays, will allow accurate interpretation of data and implementation of planetary protection policies of present missions, helping to set standards for future life-detection missions.

David R. Walt

Member

David R. Walt is Robinson Professor of Chemistry and Professor of Biomedical Engineering at Tufts University and is a Howard Hughes Medical Institute Professor. He received a B.S. in Chemistry from the University of Michigan and a Ph.D. in Chemical Biology from SUNY at Stony Brook. His laboratory is world-renowned for its pioneering work that applies micro- and nano-technology to urgent biological problems such as the analysis of genetic variation and the behavior of single cells, single molecule detection, as well as the practical application of arrays to the detection of explosives, chemical and biological warfare agents, and food and waterborne pathogens. Dr. Walt is the Scientific Founder and a Director of both Illumina Inc. and Quanterix Corp. He has received numerous national and international awards and honors for his fundamental and applied work in the field of optical sensors and arrays. He is a member of the National Academy of Engineering, a fellow of the American Institute for Medical and Biological Engineering, and a fellow of the American Association for the Advancement of Science. He has served on a number of NRC committees including the Committee on Review and Evaluation Methodology for Biological Point Detectors.