Industrialization of Biology: A Roadmap to Accelerate Advanced Manufacturing of Chemicals

Committee

Thomas M. Connelly, Jr.

Chair

Thomas M. Connelly, Jr. is Executive Vice President, Chief Innovation Officer at Dupont and a member of the company's Office of the Chief Executive. He has responsibility for Science & Technology and the geographic regions outside the United States, as well as Integrated Operations which includes Operations, Sourcing & Logistics and Engineering. He joined DuPont in 1977 as research engineer at the DuPont Experimental Station in Wilmington, Delaware. He held a number of technical leadership roles including laboratory director in the United Kingdom and Switzerland. He led a number of major DuPont businesses including Delrin, Kevlar, and Teflon, while based in the United States, Europe and Asia. In January 1999 he was named Vice President and General Manager - DuPont Fluoroproducts. He was named Senior Vice President and Chief Science & Technology Officer in September 2001. He was named Executive Vice President in June 2006. Dr. Connelly graduated with highest honors from Princeton University with degrees in Chemical Engineering and Economics. As a Winston Churchill Scholar, he received his doctorate in chemical engineering from the University of Cambridge. He serves in advisory roles to the U.S. Government and the Republic of Singapore.

Michelle Chang

Member

Michelle Chang is Assistant Professor of Chemistry at the University of California (UC), Berkeley. Her research applies the approaches of mechanistic biochemistry, molecular and cell biology, metabolic engineering, and synthetic biology to address problems in energy and human health. Among her projects are the design and creation of new biosynthetic pathways in microbial hosts for in vivo production of biofuels from abundant crop feedstocks and pharmaceuticals from natural products or natural product scaffolds. She earned a Ph.D. from the Massachusetts Institute of Technology in 2004, did postdoctoral work at UC Berkeley, and joined its faculty in 2007. She received the Arnold and Mabel Beckman Young Investigator Award in 2008 and the Agilent Early Career Award in 2010.

Lionel Clarke

Member

Lionel Clarke is Team Leader, Biodomain Open Innovation for Shell Projects And Technology at the Shell Technology Centre Thornton, UK. In this role he is responsible for planning and delivery of Shell strategic research and technology programmes across the Biodomain, deploying internal andexternal resources to deliver innovative solutions to market. Prior to joining Shell in 1981, Dr. Clarke graduated from Imperial College, London, after which he studied as an elected University Research Fellow in Cambridge University, and as a Royal Society European Research Fellow in the University of Grenoble, France. During this period he published numerous papers and a book and received various publication awards. Within Shell, he has worked extensively, taking ideas from lab to market at the interface between fuels and engines, including the worldwide removal and replacement of leaded gasoline and the introduction of cleaner and improved performance fuels in developed and developing markets. Working with the Brazilian fuels market for a number of years gave him early first-hand experience of the potential, as well as practical issues, associated with the use of bio-fuels. Clarke has been responsible for facilitating the planning and delivery of strategic research programs across the biodomain within Shell for more than ten years. Clarke chaired the UK Synthetic Biology Roadmap coordination group during 2012 and is now Co-Chairman of the UK Synthetic Biology Leadership Council.

Andrew Ellington

Member

Dr. Andrew Ellington received his B.S. in Biochemistry from Michigan State University in 1981, and his Ph.D. in Biochemistry and Molecular Biology from Harvard in 1988. As a graduate student he worked with Dr. Steve Benner on the evolutionary optimization of dehydrogenase isozymes. His post-doctoral work was with Dr. Jack Szostak at Massachusetts General Hospital, where he developed methods for the in vitro selection of functional nucleic acids and coined the term 'aptamer.' Dr. Ellington began his academic career as an Assistant Professor of Chemistry at Indiana University in 1992, and continued to develop selection methods. He has previously received the Office of Naval Research Young Investigator, Cottrell, and Pew Scholar awards. In 1998 he moved to the University of Texas at Austin and is now the Fraser Professor of Biochemistry in the Department of Molecular Biosciences. Dr. Ellington was a member of the Defense Science Studies Group of the Institute for Defense Analysis, and has actively advised numerous government agencies on biodefense and biotechnology issues, including serving on the Biochem2020 panel of the DIA. Most recently he was named a National Security Science and Engineering Faculty Fellow and an AAAS Fellow. He has served on the boards of numerous companies and helped found the aptamer company Archemix. Dr. Ellington's lab works centers on the development of nucleic acid circuitry for point-of-care diagnostics, and on accelerating the evolution of proteins and cells through the introduction of novel chemistries.

Nathan J. Hillson

Member

Nathan Hillson is a Biochemist Staff Scientist at Lawrence Berkeley National Laboratory (LBNL), Director of Synthetic Biology at the Joint Bioenergy Institute, and Program Lead of Genome Engineering at the Joint Genome Institute. His responsibilities are to develop and demonstrate experimental wetware, software, and laboratory automation devices that facilitate, accelerate, and standardize the engineering of microbes. He earned a Ph.D. in Biophysics from Harvard Medical School and was a Postdoctoral Research Fellow at the Stanford University School of Medicine. He joined LBNL in 2009.

Richard A. Johnson

Member

Rick Johnson is the CEO and Founder of Global Helix LLC, a consulting and government strategy firm based in Washington, D.C. Rick has worked extensively on the linkage of global developments and strategies with fundamental research, innovation and entrepreneurship. After 30 years, he retired as Senior Partner in the Washington, D.C. office of Arnold & Porter LLP but continues to serve as Senior Counsel. He specializes in: (1) legal and regulatory issues related to fundamental research, innovation and collaborative mechanisms; and (2) new research, public-private and multi-stakeholder mechanisms for linking fundamental research, entrepreneurship and innovation with emerging technologies for development, especially in the life sciences and in nanotechnology. He served as General Counsel for International Trade at the U.S. Commerce Department, where he was responsible for both U.S. trade policy and international technology issues. He serves as the Chairman or Vice-Chairman of three committees with the Business and Industry Advisory Committee to the Organisation for Economic Co-operation and Development: Technology, Biotechnology and Life Sciences, and Nanotechnology. Rick also is a member of the MIT Corporation Visiting Committee, the Brown Corporation’s Advisory Council on Biology and Medicine and its Brain Sciences Institute, the MIT Global Innovation Initiative, and several advisory groups focused on the changing nature of S&T policy and innovation in a new era of convergence, complexity, and computation. He also is a co-chair of the National Academies' synthetic biology project, a Director of the BioBricks Foundation, and a frequent participant with the U.S. State Department's S&T global outreach projects. In addition to synthetic biology, he currently is involved in a number of global policy initiatives related to emerging infrastructure for global RD&D, new policy projects related to linking "big data" and societal grand challenges, and public-private models for converging technologies to address global health needs. Mr. Johnson received his M.S. from the Massachusetts Institute of Technology where he was a National Science Foundation National Fellow and his undergraduate degree with Highest Honors from Brown.

Dr. Kristala L. Jones Prather

Member

Kristala Jones Prather is the Theodore T. Miller Associate Professor of Chemical Engineering at MIT and an investigator in the multi-institutional Synthetic Biology Engineering Research Center (SynBERC) funded by the National Science Foundation (USA). She received an S.B. degree from MIT in 1994 and Ph.D. from the University of California, Berkeley (1999), and worked 4 years in BioProcess Research and Development at the Merck Research Labs (Rahway, NJ) prior to joining the faculty of MIT. Her research interests are centered on the design and assembly of recombinant microorganisms for the production of small molecules, with additional efforts in novel bioprocess design approaches. Research combines the traditions of metabolic engineering with the practices of biocatalysis to expand and optimize the biosynthetic capacity of microbial systems. A particular focus is the elucidation of design principles for the production of unnatural organic compounds within the framework of the burgeoning field of synthetic biology. Prather is the recipient of a Camille and Henry Dreyfus Foundation New Faculty Award (2004), an Office of Naval Research Young Investigator Award (2005), a Technology Review “TR35” Young Innovator Award (2007), a National Science Foundation CAREER Award (2010), and the Biochemical Engineering Journal Young Investigator Award (2011). Additional honors include selection as the Van Ness Lecturer at Rensselaer Polytechnic Institute (2012) and a Young Scientist of the World Economic Forum Annual Meeting of the New Champions (2012). Prather has been recognized for excellence in teaching with the C. Michael Mohr Outstanding Faculty Award for Undergraduate Teaching in the Dept. of Chemical Engineering (2006) and the MIT School of Engineering Junior Bose Award for Excellence in Teaching (2010).

Jay D. Keasling

Member

Dr. Jay D. Keasling is a Professor of Chemical Engineering and Bioengineering at the University of California, Berkeley. He is also Acting Deputy Laboratory Director of the Lawrence Berkeley National Laboratory, the Founding Director of the Synthetic Biology Department at UC Berkeley, and chief executive officer of the Joint BioEnergy Institute. He co-founded Codon Devices Inc. in 2004 and Amyris, Inc. (formerly Amyris Biotechnologies, Inc.) in 2003. He is considered one of the foremost authorities in synthetic biology, especially in the field of metabolic engineering. Other, related research interests include Systems Biology and Environmental Biotechnology. Keasling's current research involves the metabolic engineering of the Escherichia coli bacterium, to produce the anti-malarial drug artemisinin. Although it is an effective, proven treatment for malaria, current methods of producing artemisinin (found naturally in the plant Artemisia annua) are considered too expensive to cost-effectively eliminate malaria from developing countries. Jay Keasling received his Bachelor's Degree at the University of Nebraska-Lincoln. He received his Ph.D. from the University of Michigan in 1991. He did post-doctoral work at Stanford University in Biochemistry from 1991 to 1992.

Stephen S. Laderman

Member

Stephen Laderman, Ph.D. is Director of the Molecular Tools Laboratory at Agilent Laboratories. He directs R&D programs aimed at inventing and developing leading-edge measurement solutions for research and diagnostics. His Lab applies biology, chemistry, and computer science expertise to the investigation and development of novel reagents, assay protocols, and computational methods that enable new methods in emerging fields within molecular cellular biology, molecular medicine and synthetic biology. After receiving his A.B. from Wesleyan University in Physics and his Ph.D. from Stanford University in Materials Science and Engineering, Laderman joined Hewlett-Packard (HP) Laboratories in 1984 as a member of technical staff, subsequently holding a variety of research and management positions there and in technology intensive businesses.

Pilar N. Ossorio

Member

Dr. Ossorio is Professor of Law and Bioethics at the University of Wisconsin, Madison (UW), where she is on the faculties of the Law School and the Department of Medical History and Bioethics at the Medical School. In 2011, she became the inaugural Ethics Scholar-in-Residence at the Morgridge Institute for Research, the private, nonprofit research institute that is part of the Wisconsin Institutes of Discovery. She also serves as the co-director of UW's Law and Neuroscience Program, as a faculty member in the UW Masters in Biotechnology Studies program, and as Program Faculty in the Graduate Program in Population Health. Prior to taking her position at UW, she was Director of the Genetics Section of the Institute for Ethics at the American Medical Association, and taught as adjunct faculty at the University of Chicago Law School. Dr. Ossorio received her Ph.D. in Microbiology and Immunology in 1990 from Stanford University. She went on to complete a post-doctoral fellowship in cell biology at Yale University School of Medicine. Throughout the 1990's, Dr. Ossorio also worked as a consultant for the federal program on the Ethical, Legal, and Social Implications (ELSI) of the Human Genome Project, and in 1994 she took a full time position with the Department of Energy's ELSI program. In 1993 she served on the Ethics Working Group for President Clinton's Health Care Reform Task Force. She received her JD from the University of California at Berkeley School of Law in 1997. While at Berkeley, she was elected to the legal honor society Order of the Coif and received several awards for outstanding legal scholarship.

Reshma Shetty

Member

Dr. Reshma Shetty graduated from MIT with a Ph.D. in Biological Engineering in 2008, during which she worked on building digital logic in cells. Dr. Shetty has been active in synthetic biology for several years and co-organized SB1.0, the first international conference in synthetic biology in 2004. In 2008, Forbes magazine named Reshma one of Eight People Inventing the Future, and in 2011, Fast Company named her one of 100 Most Creative People in Business. Reshma and colleagues have founded synthetic biology company Ginkgo Bioworks, Inc., which makes and sells engineered microorganisms for food, fuels, and pharmaceuticals production.

Christopher A. Voigt

Member

Dr. Christopher Voigt is an Associate Professor in the Department of Biological Engineering at the Massachusetts Institute of Technology. He holds a joint appointment as a Chemist Scientist at Lawrence Berkeley National Labs, is an Adjunct Professor of Chemical Engineering at the Korea Advanced Institute of Science and Technology (KAIST), and an Honorary Fellow at Imperial College. Prior to joining MIT, he received his B.SE in Chemical Engineering from the University of Michigan (1998), a Ph.D. in Biochemistry/ Biophysics at the California Institute of Technology (2002), performed postdoctoral work in the Bioengineering Department of the University of California – Berkeley (2003), and was a faculty member in the Department of Pharmaceutical Chemistry at the University of California – San Francisco (2003-2011).

Huimin Zhao

Member

Dr. Huimin Zhao is the Centennial Endowed Chair Professor of chemical and biomolecular engineering, and professor of chemistry, biochemistry, biophysics, and bioengineering at the University of Illinois at Urbana-Champaign and the visiting principle investigator of the Metabollic Engineering Research Laboratory (MERL) in the Agency for Science, Technology and Research (A*STAR) of Singapore. Prior to joining the faculty at the University of Illinois in 2000, Dr. Zhao worked at the Dow Chemical company for two years. Zhao's primary research interests are in the development and application of synthesis biology tools to address society's most daunting challenges in health, energy, and sustainability, and in the fundamental aspects of enzyme catalysis, cell metabolism, and gene regulation. Dr. Zhao has received numerous research and teaching awards and honors, including Guggenheim Fellowship (2012), Fellow of the American Association for the Advancement of Science (AAAS) (2010), Fellow of the American Institute of Medical and Biological Engineering (AIMBE) (2009), and others. He has authored and co-authored 170 research articles and 20 issued and pending patent applications, several of which are being licensed by industry. In addition, he has given plenary, keynote, or invited lectures in more than 200 international meetings and institutions. Professor Zhao received his B.S. in Biology from the University of Science and Technology of China in 1992. He earned a Ph.D. in Chemistry from the California Institute of Technology in 1998.