INTERNATIONAL SUMMIT ON

HUMAN GENE EDITING

A GLOBAL DISCUSSION

PLANNING COMMITTEE, SPEAKER, AND MODERATOR BIOGRAPHIES

***David Baltimore,** former president of the California Institute of Technology (Caltech) from 1997-2006, is President Emeritus and the Robert Andrews Millikan Professor of Biology. He is an accomplished researcher, educator, administrator, and public advocate for science and engineering and is considered one of the world's most influential biologists. Awarded the Nobel Prize in Physiology or Medicine in 1975 for his research into viral replication that provided the key to understanding the life cycle of retroviruses, Baltimore has profoundly influenced national science policy on such issues as recombinant DNA research and the AIDS epidemic.

His present research focuses on control of inflammatory and immune responses as well as on the use of gene therapy methods to treat HIV and cancer in a program called "Engineering Immunity." In addition, he co-directs the Joint Center for Translational Medicine, an activity that joins Caltech and the University of California, Los Angeles, in a program to translate basic science discoveries into clinical realities.

Baltimore's numerous honors include the 1999 National Medal of Science and 2000 Warren Alpert Foundation Prize. He is past president and chair of the American Association for the Advancement of Science, and a member of the U.S. National Academy of Sciences and U.S. National Academy of Medicine. He has published nearly 700 peer-reviewed articles. Baltimore received his BA in chemistry from Swarthmore College in 1960 and a PhD in 1964 from The Rockefeller University.

***Françoise Baylis** is a professor and Canada Research Chair in Bioethics and Philosophy at Dalhousie University. She is an elected fellow of the Royal Society of Canada and the Canadian Academy of Health Sciences. Her research aims to move the limits of mainstream bioethics and develop new strategies to allow bioethicists to make just and lasting policy contributions.

Baylis believes that bioethicists need to take on greater advocacy roles and use their talents and expertise in pursuit of social justice. They need to exercise their moral imagination and find creative ways to make policymakers and others in positions of power care. Her current research interests concern women's reproductive health, research involving humans, embryo research, novel genetic technologies, and access to health care. Her work challenges readers to think broadly and deeply about the direction of health, science, and biotechnology. Her most recent book, with Carolyn McLeod, is *Family-making: Contemporary Ethical Challenges* (2014). Her next book, with Angela Ballantyne, is *Clinical Research Involving Pregnant Women: Missed Trials* (2016).

Ruha Benjamin is an assistant professor at the Center for African American Studies and faculty associate in the Program in the History of Science at Princeton University. Benjamin specializes in the interdisciplinary study of science, medicine, and biotechnology; race-ethnicity and gender; health and biopolitics; and the sociology of knowledge. She is the author of *People's Science: Bodies and Rights on the Stem Cell Frontier*, which examines the tension between innovation and equity in the context of state investment in stem cell research and against the backdrop of medical experimentation on subordinate social groups. Her current project, *Provincializing Science: Mapping and Marketing 'Difference' After the Genome*, explores the uptake of genomics in South Africa, India, and the United States with a focus on how and why racial-ethnic and caste categories are incorporated in research on health disparities. Taken together, this body of work addresses debates about how science shapes the social world and how the public can and should engage science.

Benjamin received her BA in sociology and anthropology from Spelman College and MA and PhD in sociology from the University of California, Berkeley, and completed a postdoctoral fellowship at the Institute for Society and Genetics at the University of California, Los Angeles. Prior to joining Princeton

University, she was on the faculty of Boston University and a visiting fellow at Harvard Kennedy School's Science, Technology, and Society program. She has been awarded fellowships and grants from the American Council of Learned Societies, National Science Foundation, Ford Foundation, and the California Institute for Regenerative Medicine, among others. Benjamin is also an honorary research associate at the Centre for Indian Studies in Africa at the University of the Witwatersrand in Johannesburg.

***Paul Berg** is currently Robert W. and Vivian K. Cahill Professor Emeritus and Director Emeritus of the Beckman Center for Molecular and Genetic Medicine, Stanford University School of Medicine. He received his undergraduate degree from Pennsylvania State University and a PhD in biochemistry from Case Western Reserve University. He joined the Stanford School of Medicine faculty in 1959.

Berg has received international recognition for his work on the genetic mechanisms through which cells form proteins. He was awarded the Lasker Basic Medical Research Award and the Nobel Prize in Chemistry for developing methods to map the structure and function of DNA and the development of the recombinant DNA technology. He has also received the National Medal of Science and is an elected member of the U.S. National Academy of Sciences, American Philosophical Society, French Academy of Sciences, and the Royal Society.

Catherine Bliss is an assistant professor of sociology at the University of California, San Francisco. Her research explores the sociology of race, gender, and sexuality in science and society. Bliss's award-winning book *Race Decoded: The Genomic Fight for Social Justice* examines how genomics became today's new science of race. Her latest book project examines convergences in social and genetic science in the post-genomic age, including implications for equality, identity, and belonging.

Peter Braude is emeritus professor of obstetrics and gynaecology at King's College London where formerly he was head of the Department of Women's Health and directed the Centre for Preimplantation Genetic Diagnosis (PGD) for the Guy's and St Thomas' National Health Service Foundation Trust, the largest and most successful PGD program in the United Kingdom. He has been involved in assisted reproduction and embryo research for nearly 40 years.

He has been a member of the Human Fertilisation and Embryology Authority (HFEA), chairman of the Royal College of Obstetricians and Gynaecologists Scientific Advisory Committee, and chair of the expert advisory committee on multiple birth after *in vitro* fertilization, which produced the report "One Child at a Time." More recently he was a member of the HFEA core panel that reviewed the scientific methods to avoid mitochondrial disease and the Nuffield Council on Bioethics panel that considered the ethics of these emerging technologies. He was awarded an OBE in the 2015 New Year's Honours for services to reproductive medicine.

Annelien L. Bredenoord, PhD, is an associate professor of medical ethics at the University Medical Center Utrecht (The Netherlands) as well as a member of the Senate of the Dutch Parliament. She examines the ethics of emerging biomedical technology and has published widely in this field.

Bredenoord is a member of several national and international committees including the Ethics and Public Policy Committee of the International Society for Stem Cell Research and the Young Academy of the Royal Netherlands Academy of Arts and Sciences.

Philip Campbell is editor-in-chief of *Nature* and the Nature Publishing Group. His areas of responsibility include the editorial content of *Natur*e and assuring the long-term quality of all Nature publications. He has a B.Sc. in aeronautical engineering, an M.Sc. in astrophysics, and a PhD and postdoctoral research in upper atmospheric physics. Following his research, he became the physical sciences editor of *Nature* and then, in 1988, the founding editor of *Physics World*, the international magazine of the U.K. Institute of Physics. He returned to *Nature* to take on his current role in 1995.

Campbell has worked with the U.K. government, the European Commission, and the U.S. National Institutes of Health on issues relating to science and its impacts in society. For 10 years, he was a trustee of Cancer Research U.K. He is a founding trustee and chair of the research funding charity MQ: Transforming Mental Health. He is an elected fellow of the Royal Astronomical Society and the Institute of Physics, has honorary degrees from several universities, and was awarded an honorary professorship by the Peking Union Medical College. He is a life member of Clare Hall, Cambridge University. He was awarded a knighthood in the Queen's birthday honors list this year.

Alta Charo is the Warren P. Knowles Professor of Law and Bioethics at the Law School and Medical School of the University of Wisconsin, Madison, where her scholarship focuses on reproductive rights, pharmaceutical development and safety, biotechnology policy, and human subjects research.

Her government services includes membership on President Clinton's National Bioethics Advisory Commission and President Obama's transition team, as well as positions as a policy analyst for the former congressional Office of Technology Assessment, the U.S. Agency for International Development, and the U.S. Food and Drug Administration.

Charo is a member of the U.S. National Academy of Medicine, and co-chaired the Academies' committee on embryonic stem cell research guidelines and served on committees studying topics ranging from childhood vaccination programs to national security concerns about dual-use technologies.

Emmanuelle Charpentier is recognized as a leading expert in regulatory mechanisms underlying processes of infection and immunity in bacterial pathogens. With her recent groundbreaking findings in the field of RNA-mediated regulation based on the CRISPR-Cas9 system, Charpentier laid the foundation for the development of a novel, highly versatile, and specific genome-editing technology that could open up new opportunities in biomedical gene therapies.

Charpentier heads a research group at the Laboratory for Molecular Infection Medicine Sweden (MIMS, part of Nordic-European Molecular Biology Laboratory Partnership for Molecular Medicine) at Umeå University in Sweden. She is also head of the Department of Regulation in Infection Biology at the Helmholtz Centre for Infection Research, Braunschweig, and a professor at the Medical School of Hannover in Germany. In 2015, Charpentier was appointed scientific member of the Max Planck Society and director of the Max Planck Institute for Infection Biology in Berlin.

Charpentier is a member of Leopoldina — the German National Academy of Sciences, fellow of the American Academy of Microbiology, and a member of the European Molecular Biology Organization. She has been awarded numerous prestigious honors including the L'Oréal-UNESCO Award for Women in Science, Otto Warburg Medal, Carus-Medal of Leopoldina, Umeå University EC Jubilee Award, Gruber Genetics Prize, Hansen Family Award, Princess of Asturias Award for Technical and Scientific Research, 11th International Society for Transgenic Technologies Prize, Louis Jeantet Prize for Medicine, Ernst Jung Prize for Medicine, Breakthrough Prize in Life Sciences, Grand Prix Jean-Pierre

LeCocq, Jacob Heskel Gabbay Award in Biotechnology and Medicine, Paul Janssen Award for Biomedical Sciences, Göran Gustafsson Prize, an Alexander von Humboldt Professorship, and the Eric K. Fernström Prize.

George Church is a professor of genetics at Harvard Medical School and director of PersonalGenomes.org, which provides the world's only open-access information on human genomic, environmental, and trait (GET) data. His doctoral studies at Harvard included the first methods for direct genome sequencing, molecular multiplexing, and barcoding. These led to the first genome sequence (pathogen, *Helicobacter pylori*) in 1994. His innovations have contributed to nearly all next-generation genome sequencing methods and companies (CGI, Life, Illumina, nanopore). This, plus chip-based DNA synthesis and stem cell engineering, resulted in founding additional application-based companies spanning fields of medical diagnostics (Knome, Alacris, AbVitro, Pathogenica) and synthetic biology/therapeutics (Joule, Gen9, Editas, Egenesis, enEvolv, WarpDrive). He has also pioneered new privacy, biosafety, environmental, and biosecurity policies.

Church is director of U.S. National Institutes of Health Center for Excellence in Genomic Science. His honors include election to the U.S. National Academy of Sciences and U.S. National Academy of Engineering, and he is a Franklin Bower Laureate for Achievement in Science. He has co-authored 400 papers, 75 patents, and one book (*Regenesis*).

Ralph J. Cicerone is the president of the U.S. National Academy of Sciences (NAS) and chair of the National Academies of Sciences, Engineering, and Medicine. His research in atmospheric chemistry, climate change, and energy has involved him in shaping science and environmental policy at the highest levels nationally and internationally.

Educated at the Massachusetts Institute of Technology (BS in electrical engineering) and the University of Illinois at Champaign-Urbana (MS, PhD in electrical engineering, with a minor in physics), Cicerone has held faculty positions in electrical and computer engineering at the University of Michigan, was a research chemist at the Scripps Institution of Oceanography, and was a senior scientist and the director of the Atmospheric Chemistry Division at the National Center for Atmospheric Research. In 1989, he joined the University of California, Irvine, where he was founding chair of the Department of Earth System Science and appointed the Daniel G. Aldrich Professor of Earth System Science. As dean of the School of Physical Sciences from 1994 to 1998, he recruited outstanding faculty and strengthened the school's curriculum and outreach programs. Immediately prior to his election as NAS president, Cicerone served as chancellor of UC Irvine from 1998 to 2005.

Cicerone has received a number of honorary degrees and many awards for his scientific work, which has focused on atmospheric chemistry, the radiative forcing of climate change due to trace gases, and the sources of atmospheric methane, nitrous oxide, and methyl halide gases. In 1999, the Franklin Institute recognized his fundamental contributions to the understanding of greenhouse gases and ozone depletion and his public policy leadership in protecting the global environment with the Bower Award and Prize for Achievement in Science, one of the most prestigious American awards in science. In 2001, he led an NAS study of the current state of climate change and its impact on the environment and human health, requested by President Bush. And in 2004, the World Cultural Council honored him with the Albert Einstein World Award in Science.

In addition to the National Academy of Sciences, Cicerone is a member of the American Academy of Arts and Sciences, American Philosophical Society, Accademia Nazionale dei Lincei, Russian Academy of Sciences, and the Korean Academy of Science and Technology. He has served as president of the

American Geophysical Union, which recognized Cicerone in 1979 with its James B. Macelwane Award and in 2002 with its Roger Revelle Medal.

Chad Cowan is an associate professor in the Department of Stem Cell and Regenerative Biology at Harvard University and holds appointments at Massachusetts General Hospital in the Center for Regenerative Medicine, Cardiovascular Research Center, and Center for Human Genetics Research. He is an associate member of the Broad Institute of Harvard and MIT and a principal faculty member of the Harvard Stem Cell Institute, where he directs the Diabetes Disease Program and the Induced Pluripotent Stem (iPS) Cell Core Facility. Cowan has led or been a member of several large efforts to utilize stem cells to better understand disease, including the National Heart, Lung, and Blood Institute's Next Gen iPS Cell Project and the Progenitor Cell Biology Consortium. In 2013, Cowan received a Transformative Research Award from the U.S. National Institutes of Health to create isogenic human pluripotent stem cell-based models of human disease mutations. More recently, Cowan has focused on using genome-editing tools as therapeutics, and as a co-founder of CRISPR Therapeutics, he hopes to see these discoveries translated into treatments or cures.

Cowan received his BA and BS with honors from the University of Kansas and his PhD from the University of Texas Southwestern at Dallas. He subsequently completed a Damon Runyon postdoctoral fellowship at Harvard University, was named a Stowers Medical Investigator in 2006 and 2008, and became an assistant professor in 2008.

***George Q. Daley** is the Samuel Lux IV Chair in Hematology/Oncology and the director of the Stem Cell Transplantation Program at Boston Children's Hospital, a professor of biological chemistry and molecular pharmacology at Harvard Medical School, and an investigator of the Howard Hughes Medical Institute. His research explores mechanisms of hematopoietic development, stem cell reprogramming, and cancer.

Daley received his bachelor's degree from Harvard University, PhD in biology from the Massachusetts Institute of Technology, and MD from Harvard Medical School. He is a member of the U.S. National Academy of Medicine and has received the U.S. National Institutes of Health Director's Pioneer Award and the E. Donnall Thomas Prize from the American Society for Hematology.

Marcy Darnovsky is executive director at the Center for Genetics and Society, a Berkeley, California-based public affairs organization working to encourage responsible uses and effective societal governance of human genetic and assisted reproductive technologies and practices. Darnovsky holds a PhD and speaks and writes widely on the new bio-politics, focusing on the social justice, human rights, health equity, and public-interest implications of human biotechnologies.

***Jennifer A. Doudna,** PhD, is the Li Ka Shing Chancellor's Chair in Biomedical and Health Sciences and a professor of molecular and cell biology and of chemistry at the University of California, Berkeley. Her research seeks to understand how RNA molecules control the expression of genetic information and led to insights about CRISPR-Cas9-mediated bacterial immunity that enabled her lab and that of collaborator Emmanuelle Charpentier to re-design this system for efficient genome engineering in animals and plants, creating a transformative technology that is revolutionizing the fields of genetics, molecular biology, and medicine.

Doudna is a Howard Hughes Medical Institute investigator and a member of the U.S. National Academy of Sciences, U.S. National Academy of Medicine, American Academy of Arts and Sciences,

and the National Academy of Inventors. She is a recipient of many awards, including the National Science Foundation's Waterman Award, the Foundation for the U.S. National Institutes of Health's Lurie Prize in Biomedical Sciences, Paul Janssen Award for Biomedical Research, Breakthrough Prize in Life Sciences, Princess of Asturias Award (Spain), Gruber Genetics Prize, and the Massry Prize.

Victor J. Dzau is the president of the U.S. National Academy of Medicine, formerly the Institute of Medicine (IOM). In addition, he serves as chair of the IOM Division Committee of the National Academies of Sciences, Engineering, and Medicine. He is Chancellor Emeritus and James B. Duke Professor of Medicine at Duke University and the past president and chief executive officer of the Duke University Health System. Previously, Dzau was the Hersey Professor of Theory and Practice of Medicine and chairman of medicine at Harvard Medical School's Brigham and Women's Hospital, as well as chairman of the Department of Medicine at Stanford University.

Dzau has made a significant impact on medicine through his seminal research in cardiovascular medicine and genetics, his pioneering of the discipline of vascular medicine, and his leadership in health care innovation. His important work on the renin angiotensin system (RAS) paved the way for the contemporary understanding of RAS in cardiovascular disease and the development of RAS inhibitors as widely used, lifesaving drugs. Dzau also pioneered gene therapy for vascular disease, and his recent work on stem cell paracrine mechanisms and the use of microRNA in direct reprogramming provides novel insight into stem cell biology and regenerative medicine.

Dzau has led efforts to transform medicine through innovation, translation, and globalization. At Duke, for example, he and his colleagues developed the Duke Translational Medicine Institute, Duke Global Health Institute, Duke-National University of Singapore Graduate Medical School, and Duke Institute for Health Innovation. These initiatives create a seamless continuum from discovery and translational sciences to clinical care, and they promote transformative innovation in health care.

Among Dzau's honors and recognitions are the Gustav Nylin Medal from the Swedish Royal College of Medicine; Max Delbrück Medal from Humboldt University, Charité, and Max Planck Institute; Commemorative Gold Medal from the Ludwig-Maximilians-University of Munich; Inaugural Hatter Award from the Medical Research Council of South Africa; Polzer Prize from the European Academy of Sciences and Arts; Novartis Award for Hypertension Research; and the Distinguished Scientist Award and AHA Research Achievement Award from the American Heart Association. Recently, he was awarded the Public Service Medal by the president of Singapore. He has received eight honorary doctorates.

Fola Esan was an elected fellow of the Nigerian Academy of Science in 1985 and has served there in various capacities including editor of *The Proceedings*, Council member, lead for the Forum on Evidence-Based Health Policy Making, chairman of the Health Sciences Committee, and InterAcademy Medical Panel contact.

Esan graduated with an MBBS with honors from the University College, Ibadan, Nigeria (University of London) in 1962, gaining distinctions in pathology and obstetrics and gynaecology. After postgraduate training in Ibadan, London, New York City, and San Francisco, he was appointed professor of haematology in Ibadan in 1975, a position from which he retired in 1988. Esan's area of specialization in hematology is hemoglobinopathies and thalassaemia, for which he received grants and awards including the Langley Memorial Prize of the London School for Tropical Medicine and Hygiene.

Esan has been very closely involved in activities of the Nigerian Medical Association where he served as the secretary of the Western branch for several years and was later elevated to chairman for four years. He was the foundation secretary of the Nigerian Society for Haematology and Blood Transfusion and later served two terms as president. As the foundation secretary of the Faculty of Pathology of National Postgraduate Medical College of Nigeria for 10 years, Esan helped to shape medical postgraduate medical education in Nigeria and the West African region.

Esan served as director of the National Institute for Medical Research, Yaba, Lagos, worked in academic institutions in Saudi Arabia and the United Arab Emirates, and helped set up the Institute of Genetic Chemistry and Laboratory Medicine in Ibadan. He was provost of the College of Medicine, Ekiti State University between 2009 and 2013.

Barbara J. Evans is a professor of law, George Butler Research Professor, and director of the Center for Biotechnology and Law at the University of Houston Law Center, and is an affiliated member of the Center for Medical Ethics and Health Policy at the Baylor College of Medicine. Her research explores legal and ethical issues surrounding the regulation of genomic medical products and services; U.S. constitutional constraints on government regulation of genomic technologies; health data privacy; governance of large-scale health information infrastructures; and antitrust issues affecting genomic data access. This research receives support from the U.S. Food and Drug Administration, U.S. National Institutes of Health/National Human Genome Research Institute, Greenwall Foundation, and the Robert Wood Johnson Foundation.

Evans holds an electrical engineering degree from the University of Texas at Austin, MS and PhD degrees from Stanford University, a JD from Yale Law School, an LL.M. in health law from the University of Houston, and she completed a postdoctoral fellowship in clinical ethics at the M.D. Anderson Cancer Center. Prior to becoming a professor in 2007, she worked as an engineer and later as a partner in the international regulatory practice of a large New York-based law firm. She is licensed to practice law in New York and Texas.

U.S. Congressman **Bill Foster** is a scientist and businessman representing the 11th Congressional District of Illinois. He previously served from March 2008 until January 2011 as the representative of the Illinois 14th Congressional District. Foster is the only physicist in Congress.

Foster serves on the House Committee on Financial Services, a position he also held in the 110th and 111th Congresses, and the House Committee on Science, Space, and Technology. He participated in the creation of several important reforms in the financial services and housing sectors, most notably the Dodd-Frank Wall Street Reform and Consumer Protection Act.

Foster's business career began at age 19 when he and his younger brother co-founded Electronic Theatre Controls Inc., a company that now manufactures over half of the theater lighting equipment in the United States. His scientific career was as a high-energy physicist and particle accelerator designer at Fermi National Accelerator Laboratory (Fermilab). Foster was a member of the team that discovered the top quark, the heaviest known form of matter. He also led the teams that designed and built several scientific facilities and detectors still in use today, including the Recycler Ring, the latest of Fermilab's giant particle accelerators. When he first ran for Congress, his campaign was endorsed by 31 Nobel Prize winners.

Bärbel Friedrich is a member of Leopoldina — the German National Academy of Sciences, for which she has served as vice president since 2005. She has also served as the academic director of the Alfried Krupp Wissenschaftskolleg Greifswald since 2008.

Friedrich studied biology at the University of Göttingen and received her PhD in microbiology in 1973. She then worked as a postdoctoral fellow at the Massachusetts Institute of Technology, a research associate at the University of Göttingen's Institute of Microbiology, and a full professor of microbiology at the Free University of Berlin. From 1994 until her retirement in 2013 she was a full professor of microbiology at Humboldt University in Berlin.

Her research areas include the function and biosynthesis of metalloproteins, enzymatic catalysis of redox proteins and its biotechnological application using hydrogases as a model system, and functional bacterial genomics of facultative lithoautotrophic bacteria. To date, she has published 200 papers. She is a member of the Berlin-Brandenburg Academy of Sciences and Humanities and a corresponding member of the Academies of Sciences of Göttingen and of North Rhine-Westphalia. Furthermore, she was a member of the German Research Council, the German Science Foundation (DFG, for which she was vice president from 1997 to 2003), and the Federal Parliament Committee on Legal and Ethical Aspects of Modern Medicine (2003-2005). Friedrich has received several awards and prizes, including the Arthur-Burkhardt Prize and the Cross of the Order of Merit of the Federal Republic of Germany.

Richard Gold is a James McGill Professor at McGill University's Faculty of Law and Faculty of Medicine. He is also associate dean of graduate studies in the Faculty of Law where he was the founding director of the Centre for Intellectual Property Policy. He teaches in the area of intellectual property and innovation. His research centers on the nexus between innovation, development, and commerce, particularly with respect to biotechnology.

Gold has provided advice to Health Canada, Industry Canada, the Canadian Biotechnology Advisory Committee, Ontario Ministry of Health and Long-Term Care, Organisation for Economic Cooperation and Development (where he was the lead author of the Guidelines on the Licensing of Genetic Inventions and a report on collaborative mechanisms in life science intellectual property), World Health Organization (WHO), World Intellectual Property Organization, and WHO's UNITAID.

Henry (Hank) T. Greely, JD, is the Deane F. and Kate Edelman Johnson Professor of Law and professor, by courtesy, of genetics at Stanford University. He specializes in ethical, legal, and social issues arising from advances in the biosciences, particularly from genetics, neuroscience, and human stem cell research. He directs the Stanford Center for Law and the Biosciences, chairs the California Advisory Committee on Human Stem Cell Research, and serves on the Forum on Neuroscience and Nervous System Disorders of the National Academies of Sciences, Engineering, and Medicine. From 2007 to 2010 he was a co-director of the Law and Neuroscience Project. In 2006, he was elected a fellow of the American Association for Advancement of Science.

Greely graduated from Stanford in 1974 and from Yale Law School in 1977. He served as a law clerk for Judge John Minor Wisdom on the United States Court of Appeals and for Justice Potter Stewart of the United States Supreme Court. After working during the Carter administration in the departments of Defense and Energy, he entered private practice in Los Angeles in 1981 as a litigator with the law firm of Tuttle & Taylor Inc. He began teaching at Stanford in 1985.

Hille Haker, PhD, is the Richard McCormick S.J. Endowed Chair of Catholic Moral Theology at Loyola University Chicago. She previously taught at Harvard Divinity School and at Frankfurt University in Germany. She is president of Societas Ethica, the European Society for Research in Ethics, and a member of the European Group on Ethics in Sciences and New Technologies to the European Commission (EGE). Haker's interests in bioethics concern reproductive medicine, genetic diagnosis, and social ethical questions.

John Harris is director of the Institute for Science, Ethics, and Innovation and of the Wellcome Strategic Programme in the Human Body, Its Scope, Limits, and Future at the University of Manchester, where is he is Lord Alliance Professor of Bioethics.

Harris is the author or editor of 20 books and over 350 papers. He has published in most of the leading philosophical journals in his field including *The Journal of Medical Ethics, Bioethics, The Cambridge Quarterly of Healthcare Ethics, The Hastings Centre Report, Philosophy, The Philosophical Quarterly, The Proceedings of the Aristotelian Society,* and *Philosophy & Public Affairs*. He has also published in many of the leading science journals including *Nature*, *Nature Reviews Genetics*, *Nature Reviews Cancer*, *Science*, *Cell Stem Cell*, *Journal of Clinical Oncology*, *Annals of the New York Academy of Sciences*, *Lancet Oncology*, *Proceedings of the National Academy of Sciences*, and *The British Medical Journal*. His books include *The Value of Life*; *Wonderwoman and Superman*; *Clones Genes and Immortality*; *Bioethics*; *A Companion to Genethics: Philosophy and The Genetic Revolution* (Blackwell's Companions to Philosophy Series); *On Cloning*; and *Enhancing Evolution*. His new book, *How to Be Good*, will be published in 2016.

John P. Holdren is Assistant to the President for Science and Technology, director of the White House Office of Science and Technology Policy, and co-chair of the President's Council of Advisors on Science and Technology (PCAST). Prior to joining the Obama administration, Holdren was Teresa and John Heinz Professor of Environmental Policy and director of the Program on Science, Technology, and Public Policy at Harvard's Kennedy School of Government, as well as professor in Harvard's Department of Earth and Planetary Sciences and director of the independent, nonprofit Woods Hole Research Center. Previously he was on the faculty of the University of California, Berkeley, where he co-founded in 1973 and co-led until 1996 the interdisciplinary graduate degree program in energy and resources. During the Clinton administration, Holdren served as a member of PCAST through both terms and in that capacity chaired studies requested by President Clinton on preventing theft of nuclear materials, disposition of surplus weapon plutonium, the prospects of fusion energy, U.S. energy R&D strategy, and international cooperation on energy-technology innovation.

Holdren holds advanced degrees in aerospace engineering and theoretical plasma physics from the Massachusetts Institute of Technology and Stanford University. He is a member of the U.S. National Academy of Sciences, U.S. National Academy of Engineering, and American Academy of Arts and Sciences, as well as a foreign member of the Royal Society and former president of the American Association for the Advancement of Science. His awards include the Heinz Award in Public Policy, Tyler Prize for Environmental Achievement, Volvo Environment Prize, and a MacArthur Foundation Fellowship.

Tetsuya Ishii is a professor at the Office of Health and Safety, Hokkaido University, Japan. His interests are the ethics of genetic engineering, stem cells, and assisted reproductive technology.

Rudolf Jaenisch is a professor of biology at the Whitehead Institute and the Department of Biology at the Massachusetts Institute of Technology. He generated the first transgenic mice carrying exogenous DNA in the germline and was the first to use insertional mutagenesis for identifying genes crucial for embryonic development.

Perhaps his most fundamental contributions have been in the study of epigenetic processes during development. In particular, Jaenisch showed that methylation of DNA plays important roles in gene expression, imprinting, and X-inactivation, as well as in diseases such as cancer and mental retardation. His work has focused on mammalian cloning and has defined some of the molecular mechanisms that are crucial for the nuclear reprogramming. More recently, Jaenisch is using direct reprogramming of somatic cells to generate induced pluripotent stem (iPS) cells in the culture dish. These cells are relevant to establish an *in vitro* system to study major human diseases and eventually to derive cells that could be used for "customized" therapy.

Maria Jasin's lab at Memorial Sloan Kettering Cancer Center performed the first gene-editing experiment, expressing a rare-cutting endonuclease to generate a DNA double-strand break (DSB) in the mammalian genome and developing genetic and molecular assays to identify DSB repair events. These experiments established a crucial role for both homologous recombination (HR), also called homology-directed repair, and nonhomologous end-joining (NHEJ) in DSB repair. A DSB repaired by NHEJ leads to a variety of mutations in the genome, while a DSB repaired by HR leads to a predetermined modification. Whereas a role for NHEJ was suspected, the major role discovered for HR in DSB repair changed our understanding of how mammalian cells deal with this potentially lethal/oncogenic DNA lesion.

With the approaches established in the lab, the breast cancer suppressors BRCA1 and BRCA2 were determined to be crucial for HR repair, thus implicating HR as a tumor suppression mechanism. These proteins were also discovered to be critical for the prevention of DNA damage through their role in protecting stalled replication forks. The lab also has a major effort directed at understanding the generation and repair of programmed DSBs during meiotic progression, which are essential for gametogenesis.

Jasin holds a PhD from the Massachusetts Institute of Technology and was a postdoctoral fellow at the University of Zürich and at Stanford University in the Department of Biochemistry.

Weizhi Ji is director of the Chinese Academy of Sciences' Kunming Institute of Zoology (KIZ). His administrative responsibilities as director of KIZ and the KIZ Conservation Biology Center involve the oversight of all aspects of research on conservation biology. For the past 15 years, Ji's research has been on the reproductive biology of primates with the emphasis on *in vitro* culture of gametes. Part of the objective of this research is to develop and use modern techniques in reproductive technologies for the conservation of endangered primates and other species of Chinese mammals.

Ji completed a PhD in zoology at KIZ in 1987, followed by a postdoctoral fellowship at the University of Oregon. He was a Smithsonian Fellow in 1990 and a visiting professor at the University of Wisconsin in 1995 and 1997.

Pierre Jouannet is professor emeritus at Paris Descartes University. His main interests have been in basic, clinical, and ethical issues of human fertility and assisted reproductive technology. He is a

member of the Académie Nationale de Médecine and of the ethics committee of INSERM (Institut National de la Santé et de la Recherche Médicale).

J. Keith Joung is a leading innovator in the field of genome editing. He is currently the Jim and Ann Orr Research Scholar, associate chief of pathology for research at Massachusetts General Hospital, and a professor of pathology at Harvard Medical School. Joung has been a pioneer in the development of important technologies for targeted genome editing and epigenome editing of human cells.

Joung has received numerous awards including a U.S. National Institutes of Health (NIH) Director's Pioneer Award, NIH Director's Transformative Research Project R01 Award, and election into the American Association of University Pathologists. He is a Scientific Advisory Board member of the Keystone Symposia, Horizon Discovery, and Transposagen Biopharmaceuticals. He is also a scientific co-founder of Editas Medicine, a company dedicated to the translation of genome-editing technologies for therapy of human diseases.

Joung holds a PhD in genetics from Harvard University, an MD from Harvard Medical School, and an AB in biochemical sciences from Harvard College.

Daniel J. Kevles writes about issues in science, technology, and society, including law, past and present. His work has dealt with a variety of legal topics — due process in allegations of scientific fraud and misconduct, genetic information and privacy, classification and national security, reproductive technologies, and intellectual property in plants, animals, and human genes. He is currently completing a history of innovation and ownership in living organisms since the 17th century and will teach a course on the subject at Columbia University's History Department.

His works include *The Baltimore Case: A Trial of Politics, Science, and Character*; *In the Name of Eugenics: Genetics and the Uses of Human Heredity*; and *The Physicists: The History of a Scientific Community in Modern America.* He is also co-editor, with Leroy Hood, of *The Code of Codes: Scientific and Social Issues in the Human Genome Project* and is a co-author of *Inventing America: A History of the United States.* His articles, essays, and reviews have appeared in scholarly and popular journals including *The New York Times, The New Yorker, The New York Review of Books,* and *The Times Literary Supplement*. From 1964 to 2001, he taught at the California Institute of Technology. In 2001 he joined the faculty of Yale University where he was the Stanley Woodward Professor of History and taught regularly as an adjunct in the Law School until his retirement this past June. This year he is also affiliated with New York University Law School as an Interdisciplinary Fellow.

Jin-Soo Kim is an entrepreneur and chemist-turned-biologist. He graduated from Seoul National University with a major in chemistry and then earned a master's degree in chemistry from Seoul National University and a PhD in biochemistry from the University of Wisconsin, Madison. After postdoctoral training at Howard Hughes Medical Institute/Massachusetts Institute of Technology, he came back to Seoul in 1997 to serve as a principal investigator at Samsung Biomedical Research Institute. He co-founded ToolGen Inc. in 1999, a biotechnology company focused on genome editing, and served as chief executive officer and chief science officer for the subsequent six years. He joined the faculty of the Department of Chemistry at Seoul National University in 2005 and is now director of Center for Genome Engineering at the university's Institute for Basic Science.

Throughout his scientific career in industry and academia, Kim has developed and improved three different types of programmable nucleases — ZFNs, TALENs, and CRISPR-Cas9. These tools are now widely used for genome editing in human stem cells, model organisms, livestock, and plants.

Jonathan Kimmelman is an associate professor in the Biomedical Ethics Unit/Social Studies of Medicine at McGill University. He has cross appointments in experimental medicine, epidemiology, biostatistics and occupational health, and human genetics. Kimmelman holds a PhD in molecular biophysics and biochemistry from Yale University. His research revolves around the ethical, social and policy dimensions of testing novel medical technologies in human beings ("translational clinical research"). Current projects are investigating risk, prediction, validity, and knowledge value across the trajectory of drug development. Another set of projects is pursuing alternative frameworks and understandings concerning the role and content of clinical research ethics. Kimmelman directs the Group for Studies of Translation, Ethics, and Medicine.

In 2006, he received the Institute of Genetics Maud Menten New Investigator Prize and currently holds a Canadian Institutes of Health Research (CIHR) New Investigator Award. Kimmelman chaired the ethics committee of the American Society of Gene and Cell Therapy, 2008-2010, and chairs the ethics committee of the International Society of Stem Cell Research. He also served on the CIHR Stem Cell Oversight Committee, was a member of the Institute of Medicine's Committee on Ethics Principles and Guidelines for Health Standards for Long Duration and Exploration Spaceflights, and is a current member of the Gene and Cell Therapy Data and Safety Monitoring Board of National Heart, Lung, and Blood Institute. His book, *Gene Transfer and the Ethics of First-in-Human Trials: Lost in Translation*, was published by Cambridge University Press.

***Eric S. Lander** is founding director of the Broad Institute of Harvard and MIT. A geneticist, molecular biologist, and mathematician, he pioneered key principles for discovering the genes underlying human diseases and helped to bring these principles into reality as one of the leaders of the international Human Genome Project. His research has ranged over many aspects of the human genome — including the genetic basis of inherited diseases and cancer, human population history, evolutionary forces, regulatory elements, long non-coding RNAs, and three-dimensional folding of the genome.

Lander was appointed by President Obama in 2008 to co-chair the President's Council of Advisors on Science and Technology (PCAST), which advises the White House on matters that include health, manufacturing, energy, communications, nanotechnology, and national security. He earned his BA from Princeton University and PhD from the University of Oxford as a Rhodes Scholar and has co-founded several successful biotechnology firms.

Ephrat Levy-Lahad is a professor of internal medicine and medical genetics at the Hebrew University of Jerusalem and director of the Medical Genetics Institute at Shaare Zedek Medical Center in Jerusalem. She received her medical degree from the Hebrew University-Hadassah Medical School in Jerusalem, and is board-certified in internal medicine (Israel) and in clinical genetics and clinical molecular genetics (Israel and USA).

Levy-Lahad's clinical laboratory includes cancer genetics diagnostics and a large preimplantation diagnosis service. Her research laboratory focuses on genetics of breast cancer, in particular the BRCA1 and BRCA2 genes, and on genetic and environmental factors that affect the risk associated with these mutations. She also studies application of genetic testing to population screening and large-scale prevention efforts. Another focus of her research is elucidating the genetic basis of rare diseases,

including discoveries of novel genes for neurological phenotypes and for defects in ovarian development.

Levy-Lahad is highly involved in bioethical aspects of genetic research, and is currently co-chair of the Israel National Bioethics Council. She is a member of Israel's National Council for Gynecology, Perinatal Medicine, and Genetics and the National Council for Digital Health Innovation. Internationally, she was a member of UNESCO's (United Nations Educational, Scientific, and Cultural Organization) International Bioethics Committee (2006-2009) and the International Society for Stem Cell Research's Task Force on the Clinical Translation of Stem Cells.

Jinsong Li is a professor at the State Key Laboratory of Cell Biology, Institute of Biochemistry and Cell Biology (SIBCB) of the Shanghai Institutes for Biological Sciences. His research is to establish high-efficient reprogramming strategies, generate high-quality reprogrammed cells, elucidate molecular mechanism of epigenetic reprogramming, as well as to treat genetic diseases using CRISPR-Cas9 technology.

Li has published extensively in numerous peer-reviewed journals including *Cell*, *Nature*, *Cell Stem Cell*, *Proceedings of the National Academy of Sciences*, and *Cell Research*. He obtained his PhD from the Chinese Academy of Sciences' Institute of Zoology in 2002, followed by postdoctoral training at The Rockefeller University before joining SIBCB in 2007.

***Robin Lovell-Badge** is a group leader and head of the Division of Stem Cell Biology and Developmental Genetics at the Francis Crick Institute. He obtained his B.Sc. in zoology and PhD in embryology at University College London, carrying out mouse stem cell and embryo research with Martin Evans. After postdoctoral research in Cambridge and then in Paris, he established his independent laboratory in 1982 at the Medical Research Council (MRC) Mammalian Development Unit, University College, London, directed by Anne McLaren.

In 1988, Lovell-Badge moved to the MRC National Institute for Medical Research, becoming head of division in 1993. He has had long-standing interests in the biology of stem cells, how genes work in the context of embryo development, and how decisions of cell fate are made. Major themes of his current work include sex determination, development of the nervous system and pituitary, and the biology of stem cells within the early embryo, central nervous system, and pituitary. He is also very active in both public engagement and policy work, notably around stem cells, genetics, human embryo and animal research, and in ways science is regulated and disseminated.

Lovell-Badge is a member of the European Molecular Biology Organization, fellow of the Academy of Medical Sciences, and fellow of the Royal Society. He has received the Louis Jeantet Prize for Medicine, Amory Prize (awarded by the American Academy of Arts and Sciences), Feldberg Foundation Prize, and the Waddington Medal of the British Society for Developmental Biology. He is also a distinguished visiting professor at the University of Hong Kong and the president of the Institute of Animal Technologists.

Gary Marchant is Regent's Professor and the Lincoln Professor of Emerging Technologies, Law, and Ethics at the Sandra Day O'Connor College of Law at Arizona State University (ASU). He is also director of the Program on Governance of Emerging Technologies at the Center for Law, Science, and Innovation, a professor of life sciences, and Distinguished Sustainability Scientist in the Global Institute of Sustainability, all at ASU.

Marchant has a PhD in genetics from the University of British Columbia, a master's of public policy from Harvard's Kennedy School of Government, and a JD from Harvard Law School. Prior to joining the ASU faculty in 1999, he was a partner in the Washington, D.C. office of the law firm Kirkland & Ellis, where his practice focused on regulatory and science-law matters. Marchant teaches and researches in the areas of environmental law; risk assessment and risk management; genetics and the law; biotechnology law; food and drug law; legal aspects of nanotechnology; governance of emerging technologies; and law, science, and technology.

Jennifer Merchant, PhD, is a professor at the Law and Political Science School of the Université Paris II. She spent several semesters as a visiting scholar at Tulane University (The Murphy Institute, Center for Ethics and Public Affairs) and the University of Michigan, Ann Arbor (Institute for Research on Women and Gender). Her research focuses on comparative public policy in the realm of bioethical issues in France, Europe, and the United States, with emphasis on the impact on women.

Merchant has been an active member in both the Gender and Health Research and Embryo Research Groups of the INSERM (Institut National de la Santé et de la Recherche Médicale) Ethics Committee since 2012. She was named member of the Institut Universitaire de France in 2013. Currently, she is directing a collective work, *Access to ART: France/Belgium*, and drafting a monograph, *The Institutionalization of Bioethics: France/United States*.

Keymanthri Moodley is a professor in the Department of Medicine and director of the Center for Medical Ethics and Law, Faculty of Health Sciences, Stellenbosch University, South Africa. Her research interests include health research ethics, HIV cure and prevention ethics, and biobanking.

Moodley has served on the National Health Research Ethics Council and the Board of the South African Medical Research Council. Internationally, she has participated in two World Health Organization Strategic Advisory Groups of Experts researching immunization during humanitarian crises and Ebola vaccines and vaccinations. At the invitation of the U.S. National Institutes of Health (NIH), she has served on the HIV Preventive Research Data and Safety Monitoring Board (DSMB) and on the NIH African DSMB. She is principal investigator on three NIH grants, one of which explores the ethical, legal, and social issues around genomics and biobanking.

In 2014 she was appointed to the International AIDS Society HIV Cure International Scientific Working Group. Her center at Stellenbosch University was recently designated as a Collaborating Center in Bioethics by the World Health Organization, one of seven in the world and the first on the African continent. Moodley obtained an executive MBA at the University of Cape Town. She is a member of the Academy of Science of South Africa.

Indira Nath is former senior professor and head of the Department of Biotechnology, All India Institute of Medical Sciences (AIIMS), and former Raja Ramanna Fellow and Emeritus Professor, National Institute of Pathology, New Delhi. She received an MBBS and MD in pathology from AIIMS, and later served on the AIIMS faculty, making pioneering contributions to immunology of infectious diseases with special interest in human leprosy. She mentored many M.Biotech, MD, and PhD students and contributes to education, medical, and science policies and women scientists' issues at national and international levels. She is the chair for the Health and Well-being in Changing Urban Environment, a program of the International Council of Science, member of the InterAcademy Panel for Ethics, and was co-chair for the IAP-IAC project on research integrity. She has been a member of the Scientific Advisory Committee to Cabinet, Foreign Secretary, Indian National Science Academy (1995-1997);

council member (1992-1994 and 1998-2006) and vice president (2001-2003) of the Indian Academy of Sciences, Bangalore; and chairperson, Women Scientists Programme, Department of Science and Technology, Government of India (2003).

Nath has received several awards, notably Padma Shri; Chevalier Ordre National du Merite, France; Silver Banner, Tuscany, Italy; L'Oreal UNESCO Award for Women in Science (Asia Pacific); SS Bhatnagar Award; and the Basanti Devi Amir Chand Award by the Indian Council of Medical Research. She was elected fellow of the Indian National Science Academy, Delhi; National Academy of Sciences (India), Allahabad; Indian Academy of Sciences, Bangalore; National Academy of Medical Sciences (India); Royal College of Pathology; and the Academy of Sciences for the Developing World (TWAS). She was conferred an honorary D.Sc. by Pierre and Marie Curie University, Paris.

Staffan Normark is a physician, microbiologist, and infectious disease researcher, and much of his research has focused on the molecular basis for pneumococcal disease.

Normark was awarded his PhD at Umeå University in 1971, and by the end of the decade, he was one of the first Swedish scientists to utilize new genetic engineering tools in infection-related research. In 1980, he was made a professor at Umeå University, and in 1989 was recruited as professor and chairman of molecular microbiology by Washington University in St. Louis. He returned to Sweden in 1993 as professor of medical microbiology at Karolinska Institute. From 1999 to 2005 he also served as the executive director of the Swedish Foundation for Strategic Research.

Normark is a member of the Royal Swedish Academy of Sciences and held the position of permanent secretary from 2010 until 2015. He is also a member of the Royal Swedish Academy of Engineering Sciences and winner of the Göran Gustafsson Prize in medicine.

Kyle Orwig joined the faculty of the University of Pittsburgh in 2003 and is currently a professor of obstetrics, gynecology, and reproductive sciences and director of research in the Reproductive Endocrinology and Infertility Division. Orwig has been continuously funded by U.S. National Institutes of Health and other sources for research focused primarily on stem cells, spermatogenic lineage development, and fertility and infertility in rodents, monkeys, and men.

Orwig is the founding director of the Fertility Preservation Program at the University of Pittsburgh Medical Center. In this capacity, his group is keenly interested in developing novel therapies (e.g., stem cell therapies and gene therapies) for treating cases of infertility that are not amenable to established assisted reproductive technologies.

***Pilar N. Ossorio,** PhD, JD, is a professor of law and bioethics, co-director of the Neurobiology and Law Program, and co-director of the Research Ethics Consultation Service at the University of Wisconsin, Madison. Ossorio is also the Inaugural Ethics Scholar-in-Residence at the Morgridge Institute for Research. Her research interests include governance of large-scale bioscience research, ethical issues in computational biology and big data science, regulation of research with human participants, data sharing in bioscience, ethical issues in genetics, and the use of racial categories in biomedical research and health care.

Ossorio has served on advisory committees for the U.S. National Institutes of Health, U.S. Food and Drug Administration, Institute of Medicine, Health Canada, and the White House. She is currently a member of the Secretary's Advisory Committee on Human Research Protections, advising the U.S. Department of Health and Human Services on regulatory reform and improvements in regulatory

implementation, and is also a member of the Council of Advisors for the National Heart, Lung, and Blood Institute. She has been involved in several large genomics projects, including the 1,000 Genomes Project and the U.S. Human Microbiome Project.

***Duanqing Pei** is a professor of stem cell biology and also serves as the director general at the Chinese Academy of Sciences' Guangzhou Institutes of Biomedicine and Health (GIBH), in Guangzhou, China. He obtained his PhD from the University of Pennsylvania in 1991 and trained as a postdoctoral fellow at the University of Michigan before becoming a faculty member at the University of Minnesota School of Medicine in 1996. He joined the Medical Faculty at Tsinghua University in Beijing in 2002 and moved to the newly formed GIBH in 2004.

Pei studied the transcription regulation of hepatitis B virus (HBV) for his thesis by identifying C/EBP as a repressor for HBV transcription and dissecting the transactivation domains in C/EBP. Then he shifted his research interest into the field of extracellular matrix remodeling by studying the structure and function of matrix metalloproteinases (MMPs). He cloned several novel members of the MMP family, and uncovered the unique intracellular activation mechanism of MMPs with the proprotein convertase system and the intracellular trafficking of membrane-bound MMPs.

Upon returning to China, he once again changed his field of study and started working on pluripotency first and then reprogramming. The Pei lab in Tsinghua began to publish in the stem cell field on the structure and function of Oct4, Sox2, FoxD3, Essrb, and Nanog, and their interdependent relationship toward pluripotency. Based on the understanding of these factors, the Pei lab was the first in China to create mouse induced pluripotent stem (iPS) cells using a non-selective system, and then improved the iPS process systematically. The Pei lab subsequently disseminated the iPS technology in China by providing not only resources but also training workshops. Recent publications from the Pei lab includes the discovery of vitamin C as a potent booster for iPS cell generation and a mesenchymal to epithelial transition initiates the reprogramming process of mouse fibroblasts. Now, his lab continues to explore new ways to improve iPS technology, dissect the reprogramming mechanisms driven by Oct4/Sox2/Klf4 or fewer factors, and employ iPS cells to model human diseases *in vitro*.

Matthew Porteus is an associate professor of pediatrics in the Division of Stem Cell Transplantation and Regenerative Medicine at Stanford University. Clinically, he cares for children undergoing hematopoietic stem cell transplantation for both malignant and non-malignant diseases. His research has focused on using homologous recombination to modify somatic stem cells as therapy for patients with genetic diseases and infectious diseases.

K. Vijay Raghavan is secretary to the Government of India Ministry of Science and Technology's Department of Biotechnology (and on *lien* as distinguished professor in the area of developmental genetics from the National Centre of Biological Sciences, Tata Institute of Fundamental Research Bangalore). He is a fellow of the Indian Science Academies and the Royal Society, and a foreign associate of the U.S. National Academy of Sciences. The Government of India awarded one of its highest honors, the Padma Shri, to him in 2013.

A developmental biologist who uses genetics, cell biology, and behavior to study how the function of neural and neuromuscular circuits is established and maintained, Raghavan studied chemical engineering at the Indian Institute of Technology, Kanpur, and holds a PhD in molecular biology from the Tata Institute of Fundamental Research, Mumbai. Between 1984 and 1988, he was a research fellow and then a senior research fellow at the California Institute of Technology, Pasadena.

Klaus Rajewsky and his collaborators developed a general method of targeted mutagenesis in mouse embryonic stem cells by introducing bacteriophage- and yeast-derived recombination systems, which opened the way for conditional gene targeting. Using this and other novel approaches in their immunological work, they developed, together with N.A. Mitchison and N.K. Jerne, the antigen-bridge model of T-B cell cooperation, identified the B cell antigen receptor as a survival determinant of B cells, and characterized germinal centers as the sites of antibody somatic hypermutation and memory cell formation as well as the major source of human B cell lymphomas. The latter work included the identification of Hodgkin lymphoma as a germinal center-derived tumor. His group's most recent work has focused on mechanisms of microRNA control and the development of mouse models of human B cell lymphomas.

After postdoctoral work at the Institut Pasteur in Paris, Rajewsky built an immunology department at the Institute for Genetics at the University of Cologne, where he stayed for 38 years, with a part-time appointment as founding program coordinator of the European Molecular Biology Laboratory's mouse biology program at Monterotondo near Rome. He then worked for 10 years at Harvard Medical School in Boston, and is now at the Max Delbrück Center for Molecular Medicine in Berlin.

Thomas Reiss has been the head of the Competence Center Emerging Technologies at the Fraunhofer Institute for Systems and Innovation Research (Fraunhofer ISI) since 2005. Before that, he was the head of the Innovations in Biotechnology Department. From August 2006 to March 2007 he was also deputy director of the Fraunhofer ISI.

His research focuses on national and sectoral innovation systems; monitoring, foresight, and assessment of new technologies; and innovation policies. Reiss holds a doctoral degree in molecular biology from Freiburg University, and is a member of the Executive Board of the Europen Graphene Flagship, Management Committee of the European Techno-Economic Policy Support Network (ETEPS), and the Peer Review Panel of the European Science Foundation.

David Relman is the Thomas C. and Joan M. Merigan Professor in the Departments of Medicine and of Microbiology and Immunology at Stanford University, and chief of infectious diseases at the VA Palo Alto Health Care System. He received an SB in biology from the Massachusetts Institute of Technology and an MD from Harvard Medical School, completed his clinical training in internal medicine and infectious diseases at Massachusetts General Hospital, served as a postdoctoral fellow in microbiology at Stanford University, and joined the faculty at Stanford in 1994.

Relman's current research focus is the human indigenous microbiota (microbiome), and in particular the nature and mechanisms of variation in patterns of microbial diversity in the human body as a function of time (microbial succession) and space (biogeography within the host landscape) and in response to perturbation, e.g., antibiotics (community robustness and resilience).

Relman also advises the U.S. government and nongovernmental organizations in matters pertaining to microbiology, emerging infectious diseases, and biosecurity. He currently serves as chair of the National Academies of Sciences, Engineering, and Medicine's Forum on Microbial Threats, a member of the National Science Advisory Board for Biosecurity, and a member of the Physical and Life Sciences Directorate Review Committee for Lawrence Livermore National Laboratory, and advises several 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 has served as chair of the Board of Scientific Counselors of the National Institute of Dental and Craniofacial Research and as a member of the Board of Directors of the Infectious Diseases Society of America (IDSA). Relman co-

chaired a three-year National Research Council study that produced *Globalization, Biosecurity, and the Future of the Life Sciences*. He is a fellow of the American Academy of Microbiology and a member of the Association of American Physicians. Relman received the Squibb Award from the IDSA in 2001 and was the recipient of both the U.S. National Institutes of Health Director's Pioneer Award and the Distinguished Clinical Scientist Award from the Doris Duke Charitable Foundation in 2006.

Janet Rossant is a senior scientist in the Developmental and Stem Cell Biology Program at the Hospital for Sick Children and University Professor in the Department of Molecular Genetics at the University of Toronto.

She received her undergraduate degree from the University of Oxford and her PhD from the University of Cambridge. Her research interests are focused on understanding the development of the early mammalian embryo and its derived stem cells. She has been active in the development of stem-cell derived technologies for generating mouse models of human disease and is a founding member of the International Knock-out Mouse Consortium.

Ismail Serageldin is the founding director of the Bibliotheca Alexandrina (BA), the new Library of Alexandria, inaugurated in 2002. He also chairs the Board of Directors for each of the BA's affiliated research institutes and museums. In 2014, he was appointed adviser to the Egyptian prime minister in matters concerning culture, science, and museums.

Serageldin has served as a member or in a leadership role of numerous advisory committees for academic, research, scientific, and international institutions and civil society efforts, including as co-chair of the Nizami Ganjavi International Center; chair of the Executive Council of the World Digital Library; co-chair of the InterAcademy Panel on Capacity Building for Science in 2003-2004; co-chair of the African Union's panel for biotechnology in 2006 and for science, technology, and innovation in 2012-2013; vice president of the World Bank; chairman of the Consultative Group on International Agricultural Research; and founder and former chairman of the Global Water Partnership and the Consultative Group to Assist the Poorest.

Serageldin has published over 100 books and monographs and over 500 papers on a variety of topics, including biotechnology, rural development, sustainability, and the value of science to society. He was a professor at Collège de France, Paris, and distinguished professor at Wageningen University in the Netherlands. He has hosted a cultural program on television in Egypt and developed a TV science series in Arabic and English. He holds a BS in engineering from Cairo University and a master's degree and PhD from Harvard University and has received 34 honorary doctorates.

Bill Skarnes is a senior group leader at the Wellcome Trust Sanger Institute and leads the Stem Cell Engineering Team. He received his PhD in molecular and medical genetics from the University of Toronto. In 1997, Skarnes was appointed assistant professor at the University of California, Berkeley. Here, his laboratory demonstrated the value of large-scale mutant embryonic stem (ES) cell resources for gene-based, phenotype-driven screens in mice. With colleagues in the Bay Area, Skarnes initiated the BayGenomics program, the first large public gene-trap resource.

Skarnes joined the Wellcome Trust Sanger Institute in 2003 were he established a high-throughput pipeline for the production of thousands of targeted gene mutations in mouse ES cells with funding from the European Union and U.S. National Institutes of Health. This mutant ES cell collection is the foundation for ongoing efforts to elucidate the function of all 20,000 genes in the mouse. His

laboratory is currently exploiting new genome-editing technology for the study of gene function and disease modelling in human stem cells.

John Skehel has been a leader in virology research for over 30 years and has provided major insights into the molecular basis of how viruses recognize and infect their host cells. Skehel focuses on the virus that causes influenza, of which there are 3 million to 5 million cases a year worldwide, resulting in up to 500,000 deaths.

Skehel headed the World Health Organization Collaborating Centre for Reference and Research on Influenza between 1975 and 1993 and was the director of the National Institute for Medical Research from 1987-2006. His pioneering research was recognized in 1996 when he received a knighthood. Skehel is a fellow of the U.K.'s Academy of Medical Sciences and the Royal Society.

Azim Surani received his PhD at Cambridge University under 2010 Nobel laureate Robert Edwards. His research focuses on epigenetic mechanisms following his discovery of genomic imprinting, of novel mammalian imprinted genes and their functions, and the establishment of imprints during gametogenesis following global erasure of DNA methylation. He has contributed extensively to the mammalian germline biology, including the genetic basis of primordial germ cell specification in human and mouse, and on the *in vitro* specification of primordial germ cells from human and mouse embryonic stem cells and induced pluripotent stem cells. His studies also include epigenetic programming of the germline towards the establishment of totipotent/pluripotent states.

Surani is based at the Wellcome Trust Cancer Research UK Gurdon Institute at the University of Cambridge, where he is currently the director of germline and epigenomics research. He is a fellow of the Royal Society, fellow of the Academy of Medical Sciences, member of the European Molecular Biology Organization, and a fellow of the Third World Academy of Sciences. His awards include the McEwen Award for Innovation by the International Society of Stem Cell Research, a Nehru Fellowship by the Indian Government, and a Royal Medal awarded by the Royal Society.

Sharon F. Terry is president and chief executive officer of Genetic Alliance, a network of more than 10,000 organizations, of which 1,200 are disease advocacy organizations. Genetic Alliance engages individuals, families, and communities to transform health. Terry is also a co-founder of the Genetic Alliance Registry and Biobank.

Terry is also the founding chief executive officer of PXE International, a research advocacy organization for pseudoxanthoma elasticum (PXE), a genetic condition that affects her two adult children. As co-discoverer of the gene associated with PXE, she holds the patent for ABCC6 to act as its steward and has assigned her rights to the foundation. She developed a diagnostic test and conducts clinical trials. She is the author of 140 peer-reviewed papers, of which 30 are PXE clinical studies.

In her focus at the forefront of consumer participation in genetics research, services, and policy, Terry serves in a leadership role on many major national and international organizations, including the Accelerating Medicines Partnership, Institute of Medicine's Roundtable on Translating Genomic-Based Research for Health, PubMed Central National Advisory Committee, PhenX scientific advisory board, Global Alliance for Genomics and Health, International Rare Disease Research Consortium Executive Committee, and as founding president of EspeRare Foundation of Geneva, Switzerland. She is on the editorial boards of several journals and is an editor of *Genome*. She led the coalition that was instrumental in the passage of the Genetic Information Nondiscrimination Act.

***Adrian Thrasher** is professor of paediatric immunology, Wellcome Trust Principal Research Fellow, and head of the Infection, Immunity, Inflammation, and Physiological Medicine Academic Programme at the University College London Institute of Child Health (ICH). He is also director of the Clinical Gene Therapy Programme and Gene Stem and Cellular Therapies theme leader of the Biomedical Research Centre at ICH/Great Ormond Street Hospital for Children (GOSH). Thrasher is principal investigator on several clinical trials for immunodeficiency and directs the clinical gene therapy Good Manufacturing Practices facility, managing a team of trial coordinators, clinical scientists, and quality systems personnel.

Thrasher has a long-standing research and clinical interest in development and application of gene therapy. His clinical focus is the diagnosis and treatment of patients with primary immunodeficiency (PID). His specialist interests include the pathophysiology of PID syndromes especially Wiskott-Aldrich Syndrome (WAS), disorders of innate immunity, Autoimmune Lymphoproliferative Syndrome, the actin cytoskeleton in haematopoietic cells, and thymus transplantation. His team at ICH/GOSH is conducting trials of somatic gene therapy for various forms of PID including SCID-X1, CGD, ADA-SCID, and WAS.

Charis Thompson is Chancellor's Professor and chair of the Department of Gender and Women's Studies and the Center for the Science, Technology, and Medicine in Society and director of the Li Ka Shing Program in Gender and Science at the University of California, Berkeley. She is also RQIF Professor, Department of Sociology, London School of Economics and Political Science.

Thompson is the author of the books *Making Parents: The Ontological Choreography of Reproductive Technologies* and *Good Science: The Ethical Choreography of Stem Cell Research,* in addition to numerous articles on scientific research, biomedicine, biodiversity, social justice, and governance. She serves on the Stem Cell Research Oversight Committee of UC Berkeley and previously served on the Children's Hospital Oakland Research Institute Stem Cell Research Oversight Committee. She is currently a member of the London-based Nuffield Council on Bioethics Working Group on Genome Editing.

Fyodor Urnov is project leader and senior scientist at Sangamo BioSciences Inc., where he co-developed human genome editing with engineered zinc finger nucleases (ZFNs). Urnov previously led the company's research and development efforts in deploying genome editing for crop trait engineering (in partnership with Dow Agrosciences), in generation of engineered cell lines for manufacturing, for improved generation of transgenic animals, and as research reagents (in partnership with Sigma-Aldrich). In his current role as project leader for the Hemoglobinopathies, Urnov heads Sangamo's partnership with Biogen to develop genome editing as a one-time, lasting treatment for beta-thalassemia and sickle cell disease.

Urnov is also an associate adjunct professor in the Department of Molecular and Cell Biology at the University of California, Berkeley. He received his PhD from Brown University and holds a B.Sc. in biology from Moscow State University. He is an author on more than 60 scientific publications and an inventor on more than 90 issued and pending U.S. patents related to ZFP technology.

Marco Weinberg is a molecular biologist whose research career has focused on the study of RNA biology and gene regulation and the role of engineered nucleic acids as novel antiviral therapeutics. The emphasis of his therapeutic work has been on chronic viral diseases such as HIV and HBV. Weinberg has pioneered the use of fast-cleaving hammerhead ribozymes, short and long hairpin RNAs, mirtrons, aptamers, and CRISPR-Cas9 tools as powerful gene modifying agents against viral targets. His

work on antisense non-coding RNAs as epigenetic modulators of gene expression has opened-up several new avenues for translational research using novel strategies to silence and activate viral genes.

He completed his PhD at the University of the Witwatersrand, South Africa, in 2002 and was a James Gear International Postdoctoral Fellow at the Beckman Research Institute in California with John Rossi, a pioneer in RNA gene therapy for HIV. For the last three years, Weinberg has been mostly working at the Scripps Research Institute in California, where he is currently an assistant professor. He also is an associate professor at the University of the Witwatersrand.

Weinberg has published over 57 papers, reviews, and book chapters, and is a co-inventor of eight patents. He is on the editorial board of *Molecular Therapy-Nucleic Acids* and the *South African Journal of Science*. He has been an active member for more than 11 years of the American Society of Gene and Cell Therapy. Lastly, he is very proud of successfully mentoring to completion 20 graduated doctoral and masters students as well as five postdoctoral fellows.

Jonathan Weissman is a Howard Hughes Medical Institute investigator and professor of cellular and molecular pharmacology at the University of California, San Francisco. He received his undergraduate physics degree from Harvard College. After obtaining a PhD in physics from the Massachusetts Institute of Technology, where he worked with Peter Kim, Weissman pursued postdoctoral fellowship training in Arthur Horwich's laboratory at Yale University School of Medicine. Weissman's numerous honors include the 2008 Raymond and Beverly Sackler International Prize in Biophysics and the 2015 U.S. National Academy of Sciences Award for Scientific Discovery, as well as election to the U.S. National Academy of Sciences and the American Academy of Microbiology.

***Ernst-Ludwig Winnacker** is currently professor emeritus at the University of Munich. He studied chemistry at ETH Zurich, Switzerland, where he obtained his PhD, and did postdoctoral research at the University of California, Berkeley, and the Karolinska Institute. Winnacker held professorships at the University of Cologne and the University of Munich's Institute of Biochemistry, and from 1984-1997 he was director of the Laboratory of Molecular Biology at the Gene Center in Munich. Winnacker's main research interests are virus/cell interactions and the mechanisms of gene expression in higher cells and prion diseases.

Winnacker served as president of the German Research Foundation and as first secretary general of the European Research Council. He was also secretary general of the Human Frontier Science Program Organization. Winnacker was awarded an honorary doctorate from the Veterinary University of Vienna and the Medical Faculties of the Universities of Würzburg and Munich. He is a member of Leopoldina, the German National Academy of Sciences, and the U.S. National Academy of Medicine. He has received several awards, among them the Order of the Rising Sun Gold and Silver Star from Japan, the International Science and Technology Cooperation Award from the People's Republic of China, the Leibniz Medal, and the Robert Koch Medal.

Zhihong Xu is a professor at the Peking University and Shanghai Institute of Plant Physiology and Ecology. He is also currently the chairman of the Chinese Society of Plant Biology and president of the China National Committee of Man & Biosphere, UNESCO (United Nations Educational, Scientific, and Cultural Organization). He is an elected fellow of the Chinese Academy of Sciences and was awarded the academy's award in natural science in 1990.

Xu has had an illustrious and varied career and received many awards from institutions outside China, including an honorary D.Sc. from De Montfort University in 1994 and the University of Nottingham in 2000. His research interests include plant development and hormone regulation and plant biotechnology.

Feng Zhang joined the Broad Institute of Harvard and MIT as a core member in 2011. Zhang is also an investigator at the McGovern Institute for Brain Research at MIT and an assistant professor with a joint appointment in the departments of Brain and Cognitive Sciences and Biological Engineering. As a student, he played a major role in the development of optogenetics, a technology that allows the brain's electrical activity to be controlled with light-sensitive proteins. He is now working to extend this molecular engineering approach to other aspects of brain function, such as gene expression, and to develop new approaches to understanding and eventually treating brain diseases.

Zhang is a Searle Scholar and has received both a Director's Transformative Research Award and a Director's Pioneer Award from the U.S. National Institutes of Health. In 2012, he shared the Perl-UNC (University of North Carolina) Prize for his role in the development of optogenetics. Zhang holds an AB in chemistry and physics from Harvard College and a PhD in chemistry from Stanford University.

***Qi Zhou,** PhD, is the chief scientist of the Stem Cell and Regenerative Medicine Program of the Chinese Academy of Sciences (CAS), director of the State Key Laboratory of Stem Cell and Reproductive Biology, and the deputy director of the Institute of Zoology, CAS. Zhou's work concentrates on the mechanisms of cell reprogramming, cell fate control, obtaining and maintenance of stem cell pluripotency, etc. In addition, he establishes animal models, including mouse, rat, porcine, primate, and cell models, for studying human diseases. He is also dedicated to promoting the application of stem cells to clinical application.

Among other academic responsibilities, Zhou is the representative of China to the International Stem Cell Forum (ISCF), a member of the Annual Meeting Program Committee of the International Society for Stem Cell Research (2014-2015), vice president of the Chinese Society for Cell Biology, and president of the Chinese Society for Stem Cell Research. He has served on various scientific advisory boards for both the Ministry of Science and Technology of the People's Republic of China and the National Natural Science Foundation of China.

*Member of the Summit Planning Committee