

Decadal Survey on Biological and Physical Sciences in Space

Committee

Elizabeth R. Cantwell

Co-Chair

ELIZABETH R. CANTWELL is the deputy associate laboratory director in the National Security Directorate of the Oak Ridge National Laboratory, where she was recently promoted from the position of director of the Office of Strategy in the Threat Reduction Directorate. Prior to joining Oak Ridge, she was the deputy division leader for science and technology in the International Space and Response (ISR) Division at Los Alamos National Laboratory. As division leader for ISR, she was responsible for execution of projects from small principal investigator (PI)-driven basic science through delivery of large satellites and instruments into the space environment or other field deployments. Until June 2005, she served as the section leader for the Micro and Nanotechnology Center at Lawrence Livermore's Engineering Research Center for fabricating small sensors and devices. She began her career building life support systems for human spaceflight missions with NASA, and later went on to serve as a program manager in the Life Sciences Division at NASA Headquarters. Dr. Cantwell earned her Ph.D. in mechanical engineering from the University of California at Berkeley. Her NRC experience includes past membership on the Committee on NASA's Bioastronautics Critical Path Roadmap, the Space Station Panel of the Review of NASA Strategic Roadmaps, the Committee on Technology for Human/Robotic Exploration and Development of Space, and the Committee on Advanced Technology for Human Support in Space.

Wendy Kohrt

Co-Chair

WENDY KOHRT is a professor of medicine and associate chief of research affairs in geriatric medicine at the University of Colorado Denver Anschutz Medical Campus, and adjunct professor of integrative physiology at the University of Colorado-Boulder. Her research interests are aging, exercise, regional adiposity, energy metabolism, hormone replacement, and the effects of changes in the endocrine system on human physiology. She has written articles on increasing bone mineral density, exercise, and the preservation of bone health, lower-body adiposity and metabolic protection in postmenopausal women, and protection of bone mass by estrogens and raloxifene during exercise-induced weight loss. She is currently a consultant to NASA's Johnson Space Center (JSC) for the Exercise Countermeasures Program Investigator Team working on optimization of the exercise prescription for the preservation of musculoskeletal and cardiovascular health on the International Space Station (ISS). She is the PI of a study, "Exercise to Counteract Loss of Bone and Muscle During Androgen Deprivation Therapy in Men with Prostate Cancer," funded by the Department of Defense (DOD), and a clinical trial, "COX Inhibition and Musculoskeletal Responses to Exercise," funded by the National Institute on Aging. Her intervention studies have involved exercise, weight loss, and/or hormone therapy. Another focus of Dr. Kohrt's research is on bone health in aging and the extent to which lifestyle behaviors can protect against bone loss. She is a member of the American College of Sports Medicine, the American Society for Bone Mineral Research, and the Endocrine Society, among others. Dr. Kohrt received her B.S. in physical education and mathematics from the University of Wisconsin-Stevens Point, her M.S. and Ph.D. in exercise science from Arizona State University, and completed postdoctoral research training in applied physiology and gerontology at Washington University School of Medicine in St. Louis. She has extensive advisory committee experience as both member and chair, including NASA program reviews and such high profile committees as the U.S. Physical Activity Guidelines Advisory Committee. She has no prior NRC experience.

Lars Berglund

Member

LARS BERGLUND is director of the Clinical and Translational Science Center (CTSC) at the University of California, Davis (UC Davis), Health System. Dr. Berglund is also a professor of medicine and associate dean for clinical and translational research at UC Davis and serves as staff physician at the Sacramento VA Medical Center. Dr. Berglund's research focus is in the area of lipoprotein metabolism and cardiovascular disease and his research is funded by the National Heart, Lung and Blood Institute. He is a member of the editorial board of Arteriosclerosis, Thrombosis and Vascular Biology, the Journal of Clinical Endocrinology and Metabolism, and Metabolic Syndrome and Related Disorders. He is a member of the National Institutes of Health's (NIH's) AIDS, Clinical Research and Epidemiology study section and of the American Heart Association Peer Review Committee. As CTSC director, Dr. Berglund ensures that administrative, patient care and research reporting procedures are carried out in conformity with NIH, UC Davis, and Department of Veterans Affairs policies. In addition, he sets goals and standards for the CTSC, encourages clinical investigators to use the CTSC, and fosters collaborations between clinical and basic science investigators. He received both his Ph.D. and his M.D. from the University of Uppsala, Sweden, and completed his internship and residency in Internal Medicine and Clinical Chemistry at the Karolinska Institute, Stockholm, Sweden. He has no prior NRC experience.

Nicholas P. Bigelow

Member

NICHOLAS P. BIGELOW is the Lee A. DuBridge Professor of Physics and Optics, chair of the Department of Physics and Astronomy, and senior scientist at the Laboratory for Laser Energetics, Quantum Optics, and Quantum Physics at the University of Rochester. Dr. Bigelow's research interests are in the areas of quantum optics and quantum physics. His recent work has focused on the creation and study of ultra-cold quantum gases, the manipulation and control of atomic motion using light pressure forces, the laser cooling and trapping of atoms and molecules, Bose-Einstein Condensation, and the basic quantum nature of the basic atom-photon interaction. Prior to joining the faculty at the University of Rochester, Dr. Bigelow worked on the technical staff at AT&T Bell Laboratories, then went to the Ecole Normale Supérieure in Paris, France, where he worked in the Laboratoire Kastler-Brossel. In addition to numerous awards, including a Young Investigator Award from the National Science Foundation, Dr. Bigelow is the chair of the Fundamental Physics Discipline Working Group in the NASA Microgravity Physics Program. Dr. Bigelow received his B.S. in engineering physics and in electrical engineering from Lehigh University, and his M.S. and Ph.D. in physics from Cornell University. Dr. Bigelow has served on the NRC's Panel on Physical Sciences.

Leonard H. Caveny

Member

LEONARD H. CAVENY is an aerospace consultant and former director of science and technology for the Ballistic Missile Defense Organization (BMDO). His previous experience also includes service as deputy director of innovative science and technology for the Strategic Defense Initiative Organization (SDIO), staff specialist for the Office of the Deputy Undersecretary for Research and Advanced Technology for the DOD, and program manager for energy conversion for the Air Force Office of Scientific Research. From 1969 to 1980, as a senior profession staff of Princeton University's Aerospace and Mechanical Sciences

Department, he guided graduate student research and served as principal investigator. Dr. Caveny's expertise includes solid rocket propulsion, aerothermochemistry flight experiments, electric propulsion, space solar power, diagnostics of reacting flows, combustion, propellants,

refractory materials, and aeroacoustics. He earned his B.S. and M.S. in mechanical engineering from the Georgia Institute of Technology, and his Ph.D. in mechanical engineering from the University of Alabama. He is a Fellow of the American Institute of Aeronautics and Astronautics (AIAA). He served on the NRC's Committee for the Review of NASA's Pioneering Revolutionary Technology Program and as chair of the NRC Panel to

Review Air Force Office of Scientific Research Proposals in Propulsion.

Vijay K. Dhir

Member

VIJAY DHIR, NAE, is a professor and dean of the Henry Samueli School of Engineering and Applied Science at the University of California, Los Angeles (UCLA). He was previously the chair of the UCLA Department of Mechanical and Aerospace Engineering. His research focuses on two-phase heat transfer, boiling and condensation, thermal and hydrodynamic stability, thermal hydraulics of nuclear reactors, microgravity heat transfer, and soil remediation. In addition to his work at UCLA, for the past 30 years Dr. Dhir has been a consultant for numerous organizations, including General Electric Corporation, Rockwell International, the Nuclear Regulatory Commission, and the Los Alamos National Laboratory and the Brookhaven National Laboratory. His work on boiling heat transfer and nuclear reactor thermal hydraulics and safety were the impetus for his being elected to the National Academy of Engineering. Dr. Dhir is also a fellow of the American Society of Mechanical Engineers (ASME) and the American Nuclear Society, a recipient of ASME's Heat Transfer Memorial Award, and the senior technical editor for ASME's Journal of Heat Transfer. Since 1999, a team of researchers led by Dr. Dhir has been taking part in a NASA research program to examine the effects of boiling in space. He received his B.S. in mechanical engineering from Punjab University in India, his M.Tech. in mechanical engineering from the Indian Institute of Technology, and his Ph.D. in mechanical engineering from the University of Kentucky.

Joel E. Dimsdale

Member

JOEL DIMSDALE is a professor of psychiatry and co-leader of the Cancer Symptom Control Research Program at the University of California, San Diego (UCSD), Moores Comprehensive Cancer Center. Dr. Dimsdale's major research interests include sympathetic nervous system physiology as it relates to stress, blood pressure, and sleep; cultural factors in illness; and quality of life, and his clinical subspecialty is consultation psychiatry. He is an active investigator, a former career awardee of the American Heart Association, and past-president of the Academy of Behavioral Medicine Research, the American Psychosomatic Society, and the Society of Behavioral Medicine. Dr. Dimsdale is also on numerous editorial boards, is editor-in-chief emeritus of Psychosomatic Medicine, and is a previous guest editor of Circulation, and former chair of the Sleep Research Society's Committee on Research. He has been a consultant to the President's Commission on Mental Health, the Institute of Medicine, and is a long-time reviewer for NIH. Dr. Dimsdale is the former chair of the UCSD Academic Senate. Dr. Dimsdale received his B.A. in biology from Carleton College, and his M.A. in sociology and M.D. from Stanford University. In 1980 he served on the advisory committee and was Vice-Chairman of the clinical panel for the Institute of Medicine conference on Bio-behavioral Approaches to Sudden Death.

Nikolaos A. Gatsonis

Member

NIKOLAOS A. GATSONIS is the George I. Alden Professor of Engineering, associate head of the Mechanical Engineering Department, and director of the Aerospace Engineering Program at Worcester Polytechnic Institute (WPI). From 1991 to 1993 he was a postdoctoral Fellow at the Space Department of the Johns Hopkins University Applied Physics Laboratory. His research interests include simulation methods and modeling of macro- to nano-scale fluid and plasma transport processes, and development of plasma diagnostics. Dr. Gatsonis' research in spacecraft/environment interactions, spacecraft electric propulsion, and micro-propulsion, involved participation in several space-flight and ground-based experiments. His research has been supported by AFOSR, JHU APL, NASA, NSF, and through industrial collaborations. In addition to numerous awards, including the WPI Trustees Award for Outstanding Research and Creative Scholarship, Dr. Gatsonis was an Associate Editor of the AIAA Journal of Spacecraft and Rockets (2003-2006), a member of the AIAA Electric Propulsion Technical Committee (1998-2003) and the AIAA Space Science Technical Committee (1992-1996). He received his undergraduate degree in Physics from the Aristotle University of Thessaloniki in Greece, an M.S. in Atmospheric Science from the University of Michigan, and M.S. and Ph.D. degrees in the Department of Aeronautics and Astronautics of the Massachusetts Institute of Technology. He has no prior NRC experience.

Simon Gilroy

Member

SIMON GILROY is professor of botany in the Botany Department at the University of Wisconsin at Madison. Dr. Gilroy's research utilizes a multidisciplinary approach to study the interaction of environmental sensing and development in plants. One area of focus in his work is on understanding the molecules involved in the signals that allow plants to monitor and adapt to their environment—specifically, how these signals are perceived and translated to the development and control of a plant's growth. Dr. Gilroy and his team have investigated the cellular basis for gravity and mechano-signaling in the growing root and, in one approach, have mapped the sensory cells in the root using laser ablation and investigated the signaling events in these cells in response to gravity and touch stimulation. Another major project is focused on defining the signaling pathways responsible for plant hormone action. Among his recent publications in this field, is *Plant Tropisms* (edited with P.H. Masson), a comprehensive review of the current state of knowledge on the molecular and cell biological processes that govern plant tropisms. Dr. Gilroy received his Ph.D. in botany from the University of Edinburgh. He served as a board member of the American Society for Space and Gravitational Biology. He has no prior NRC experience.

Benjamin D. Levine

Member

BENJAMIN D. LEVINE is a professor of internal medicine and cardiology and director of the Institute for Exercise and Environmental Medicine (IEEM) at Southwestern Medical School. His specialties are in cardiovascular disease and aerospace medicine. Dr. Levine's clinical interests include exercise physiology, high altitude and aerospace medicine, preventative cardiology, and syncope and orthostatic intolerance. His research interests include cardiovascular adaption to exercise training/exercise physiology, circulatory control including autonomic function mechanism of orthostatic hypotension aging, and high altitude physiology. Approximately half of his research is supported by NASA, and within IEEM, the Cardiovascular Physiology/Autonomic Function Laboratory specializes in studying how deconditioning (i.e., bed rest or spaceflight) affects the heart and circulation, and how blood pressure, heart and brain function are regulated in normal aging, hypertension, and heart failure. Dr. Levine is currently the Cardiovascular Team Leader for the National Space Biomedical Research Institute, and the PI of the Integrated Cardiovascular In 1989 he was a Fulbright Scholar, whereupon he participated in an international exchange program at the August Krogh Institute of the University of Copenhagen in Denmark, known for research in physiology and biochemistry. Dr. Levine is a member of the American Heart Association, the American College of Sports Medicine, and the American College of Cardiology, among others. In 2007, he received a Citation Award from the American College of Sports Medicine for substantial and distinguished contribution to exercise science research. Dr. Levine received his M.D. from Harvard University. He has no prior NRC experience.

Rodolfo R. Llinas

Member

RUDOLFO R. LLINAS, NAS, is the Thomas and Suzanne Murphy Professor of Neuroscience and chair of the Department of Physiology and Neuroscience at New York University Medical Center. His research pertains mostly to neuroscience from the molecular to the cognitive level. Dr. Llinas focuses on the intrinsic electrophysiological properties of mammalian neurons in vitro. In particular, he studies the ionic channels that generate some of the sodium and calcium currents responsible for the electrophysiological properties of neurons and their distribution in different cell types. Dr. Llinas also looks at the role of calcium conductance in synaptic transmissions, the concept of calcium microdomains, examines the cerebellar control of movement and thalamocortical connectivity, and mapping the human brain using noninvasive magnetoencephalography. He received his M.D. from the Universidad Javeriana in Bogotá, Columbia, and his Ph.D. in neuroscience from the Australian National University in Canberra. He served on the NRC's U.S. National Committee for the International Brain Research Organization and on the steering group for a Workshop on Bionics and Space Exploration.

Kathryn V. Logan

Member

KATHRYN V. LOGAN is the director of the Center for Multifunctional Aerospace Materials, and the Samuel P. Langley Professor in the Department of Materials Science and Engineering at the Virginia Polytechnic Institute and State University. Her research interests are advanced synthesis and processing, design high temperature solid state diffusion, refractory material development, analytical materials characterization, and mechanical properties of materials. At the Center, Dr. Logan is responsible for high-performance, multi-function aerospace materials research, and has overseen the development of a variety of new materials and structures. Dr. Logan is interested in creating unique materials that help in human exploration of space. In addition to her materials work, she is working to develop a large radio-frequency induction press that will be capable of forming large surface-area materials for space-exploration programs. Once complete, this device will produce unique components and structures not yet possible using standard techniques. Dr. Logan is a fellow of the American Ceramic Society and the National Institute of Ceramic Engineers, and is on the external advisory board for Clemson University's Department of Materials Science and Engineering. She has served on the NRC's Board on Army Science Technology.

Philippa Marrack

Member

PHILIPPA MARRACK, NAS, IOM, is an investigator at the Howard Hughes Medical Institute, senior faculty member in the Integrated Department of Immunology at National Jewish Health, and professor in the Departments of Biochemistry and Molecular Biology and Immunology and Medicine at the University of Colorado Health Sciences Center in Denver. Dr. Marrack's research interests include the creation, specificity, survival, and activation of T cells; cellular and molecular immunology; microbial pathogenesis; mammalian development; cell biology; and pathogenicity. She did much of the pioneering research on T cells, including the discovery that T cells have receptors to distinguish between dangerous microbes and a molecule called MHC. Dr. Marrack's current research focuses on how the body realizes that it has been injected with alum, a precipitate of aluminum salts. Her work is partially supported by funds from NIH and by fellowships from the Leukemia and Lymphoma Society. Dr. Marrack earned her B.A. in biochemistry and her Ph.D. in biological sciences from Cambridge University. In addition her NAS and IOM membership, she is a member of the Royal Society of the United Kingdom, the American Academy of Arts and Sciences, the American Association of Immunology, and the British Society for Immunology.

Gabor A. Somorjai

Member

GABOR SOMORJAI, NAS, is a professor in the Department of Chemistry at the University of California, Berkeley, a faculty senior scientist in the Materials Sciences Division, and a group leader of the Surface Science and Catalysis Program at the Lawrence Berkeley National Laboratory. Dr. Somorjai's research interests are in the field of surface science. His group is studying the structure, bonding, and reactivity at solid surfaces on the molecular scale. This knowledge is then utilized to understand macroscopic surface phenomena, adsorption, heterogeneous catalysis, and biocompatibility on the molecular level. To this end, he also develops instruments for nanoscale characterization of surfaces, including sum frequency generation surface vibrational spectroscopy, high-pressure scanning tunneling microscopy, and high-pressure x-ray photoelectron spectroscopy. Dr. Somorjai received his Ph.D. in chemistry from the University of California, Berkeley.

Charles M. Tipton

Member

CHARLES M. TIPTON is professor emeritus of physiology at the University of Arizona. He has held many professorships in various departments and disciplines, including physical education, physiology, kinesiology, biomedical engineering, biophysics, exercise and sports science, surgery, biological sciences, orthopaedic surgery, thermal and mountain medicine, and was a visiting senior scientist at NASA Ames Research Center. Dr. Tipton has received recognition awards from the American College of Sports Medicine, the American Physiological Society, and the American Society for Space Gravitation Biology Research. He has been Chair and a member of NIH Study Sections and served as a reviewer on numerous panels, including the NASA Review Panel on Space Medicine and Countermeasures, the NASA-IDI Cardiopulmonary Physiology Review Panel, and the NASA Bion-Biospecimens Peer Review Panel, and is a current member of the External Advisory Committee to the National Space Biomedical Research Institute. Dr. Tipton has received numerous awards, including the Orr Reynolds Award from the American Physiological Society and the Founders Award from the American Society for Space Gravitation Biology Research. Dr. Tipton is currently an associate editor for *Advances in Physiology Education*, and is the chair of the Gisolfi Lecture Advisory Committee of the American College of Sports Medicine. He received a B.S. in physical education from Springfield College, and an M.S. in physical education and a Ph.D. in physiology (with minors in biochemistry and anatomy) from the University of Illinois. He has no prior NRC experience.

Jose L. Torero

Member

JOSE L. TORERO is the chair of the Building Research Establishment/Royal Academy of Engineering Centre for Fire Safety Engineering at the University of Edinburgh, Scotland. Prior to taking the helm of the Centre, Dr. Torero was an associate professor of fire protection engineering and an affiliate associate professor in the Department of Aerospace Engineering at the University of Maryland. He has also served as a consultant to numerous organizations around the world, including the National Institute of Standards and Technology, the University of Texas at Austin, and the University of California at Berkeley. His research is primarily in the areas of fire dynamics, smoke detection and management, protection and suppression systems, fire induced skin burns, and the behavior of structures in the event of a fire—in particular, fire behavior in complex environments like the ISS. Dr. Torero is a member of numerous organizations, including the Board of the International Association for Fire Safety Science, the American Institute of Aeronautics and Astronautics 's (AIAA's) Microgravity and Space Processes Technical Committee, and NASA's Mars or Bust and Fire Safety committees. He has received a M.Sc. and a Ph.D. from the University of California at Berkeley. Dr. Torero has no prior NRC experience.

Robert Wegeng

Member

ROBERT WEGENG is a Chief Engineer at Battelle's Pacific Northwest National Laboratory's Energy and Efficiency Division. During his more than two decades of employment with Battelle, Mr. Wegeng has contributed as an engineer and project manager for projects supported by the Federal government, for DARPA, DOD, DOE, and NASA, and by commercial organizations in the energy, aerospace, and chemical process industries. He was previously Vice Chair of the 2nd and 4th International Conferences on Microreaction Technology, a joint conference between Battelle, the Institute of Microtechnology, the German Society for Chemical Apparatus, Chemical Engineering and Biotechnology, and the American Institute for Chemical Engineers. Mr. Wegeng has been involved in numerous projects over the years dealing with alternative energy, and human exploration architecture, including in-situ resource utilization (ISRU). In the latter vein, he has written on the matter, outlining microchemical and thermal systems for ISRU, and on a microchannel in-situ propellant system as an enabling technology for Mars architecture concepts. Mr. Wegeng's experience in solar thermochemical fuel production demonstrates a strong foundation in chemistry, which he applies to his technical papers on ISRU. In collaboration with researchers at NASA, he has developed a means to keep robotic systems warm enough to operate in harsh extraterrestrial environments. Mr. Wegeng is the co-reipient of two R&D 100 Awards and 88 patents (USA and foreign) and has no prior NRC experience.

Gayle E. Woloschak

Member

GAYLE E. WOLOSCHAK is a professor in the Department of Radiology and Department of Cell and Molecular Biology at Northwestern University School of Medicine. Her research is focused on nanocomposites and genes controlling radiosensitivity and motor neuron dysfunction. Dr. Woloschak's work is oriented toward function use of nanocomposites for intracellular manipulation, imaging, and gene silencing. Her work on motor neuron disease is design to understand the molecular basis for the combined abnormalities from a molecular-cellular perspective. She received her Ph.D. in medical sciences (microbiology) from the Medical College of Ohio. Dr. Woloschak has previously served on the NRC Committee on Evaluation of Radiation Shielding for Space Exploration and the Committee to Assess Potential Health Effects from Exposures to PAVE PAWS Low-level Phased-array Radiofrequency Energy.