

2015 Siemens Competition
Regional Finals
Carnegie Mellon University Judges



Dr. Bruce Armitage, Lead Judge
Department of Chemistry

Bruce Armitage earned his BS in Chemistry from the University of Rochester in 1988 and his Ph.D from the University of Arizona in 1993, where he studied photochemical reactions in phospholipid membrane environments. He then spent four years doing postdoctoral research on the chemistry of natural and synthetic nucleic acids at the University of Illinois, Georgia Institute of Technology and University of Copenhagen before joining the faculty at Carnegie Mellon in 1997, where he is now Professor of Chemistry and Co-Director of the Center for Nucleic Acids Science and Technology. Dr. Armitage is also Senior Editor of the journal *Langmuir*, which publishes research in colloid and surface science.

Dr. Armitage's research focuses on the use of chemical methods and concepts to understand the molecular mechanisms of gene expression. His research group designs and synthesizes molecules that can bind to specific RNA and DNA targets. By optimizing the strength and selectivity of these binding interactions, these molecules will be useful for understanding the functions of genes and represent potential candidates for therapeutics for genetic diseases. In addition, Dr. Armitage's lab specializes in the use of nanotechnology to create functional DNA-based materials for biological imaging. Dr. Armitage teaches courses in organic chemistry and medicinal chemistry for undergraduate and graduate students at Carnegie Mellon.



Dr. Marcel Bruchez
Department of Chemistry and Biological Sciences

Marcel Bruchez develops and commercializes research tools for biological detection. As a graduate student, he modified quantum dots — nanometer-sized crystal particles — so that they could be used to tag proteins and label cells.

After graduate school, he founded Quantum Dot Corporation, which grew these materials into a significant and commercially successful tool

for single molecule biological detection and for multicolor analysis of cells, ultimately acquired by Invitrogen Corporation. At Carnegie Mellon University, Dr. Bruchez directs the Molecular Biosensors and Imaging Center, a national resource for biological probe development, and is applying these tools to the study of how protein synthesis, trafficking and degradation is coordinated and regulated in biological systems.

Dr. Bruchez holds 27 patents, has published 62 peer-reviewed papers and has received numerous recognitions for his work. Science recognized his development of quantum dots for biological detection as one of the Top Ten Scientific Innovations of 2003. In 2006, Dr. Bruchez received the Lord Rank Prize for Optoelectronics for "realization of quantum dot nanocrystals as biological labels."

Dr. Bruchez received a B.S. in chemistry from the Massachusetts Institute of Technology, and a Ph.D. in physical chemistry from the University of California at Berkeley.



Dr. Phil Campbell
Institute for Complex Engineered Systems (ICES)

Phil Campbell is a Research Professor within the Institute for Complex Engineered Systems at CMU's Carnegie Institute of Technology with appointments in Biomedical Engineering, Material Science and Engineering, Bone Tissue Engineering Center, Molecular Biosensor and Imaging Center, Biological Sciences and MERITS. He has over 25 years' experience conducting interdisciplinary biomedical engineering research involving endocrinology tissue engineering, bioimaging,

microimplantable biosensors, biological patterning with special interest in musculoskeletal repair and regeneration.

Dr. Campbell is actively involved with undergraduate, graduate and post-graduate education and also involved in outreach education from K-12 through to adults. He is a co-founder of the Pittsburgh regional middle/school teacher tissue engineering intern program. He regularly lectures and conducts hands-on tissue engineering laboratory experiences for such programs as the Pittsburgh Science Festival, the Pennsylvania Governor's School, the Pittsburgh Jewish Foundation, the Girl Scout Biotechnology Initiative, Academy for Lifelong Learning, and the Elderhausen Program. He is also co-founder and Chief Scientific Officer for Carmell, Inc. a Pittsburgh-based biotechnology company developing blood plasma-based plastics for biomedical applications.



Dr. Markus Deserno
Department of Physics

Markus Deserno received a diploma in Physics from the University of Erlangen/Nürnberg (Germany) in 1996 and a Ph.D. in Physics from the Max-Planck-Institute for Polymer Research (MPI-P) and the University of Mainz (Germany) in 2000. After three years as a postdoctoral researcher in the Department of Chemistry and Biochemistry at UCLA, he became a project leader at the MPI-P, where he also earned his "habilitation". In 2007, he joined the faculty at Carnegie Mellon as an Associate Professor in the Department of Physics, for which he also serves as the Associate

Department Head since 2013.

Dr. Deserno uses a wide variety of theoretical and computational tools to study problems in the field of Biological Physics. He is particularly interested in the question how proteins shape biological membranes. On the computational side, he uses and has developed coarse-grained models to study lipid membranes and proteins at length- and time-scales exceeding the capabilities of traditional atomistic molecular dynamics. On the theoretical side, Dr. Deserno applies tools such as continuum elasticity theory, differential geometry, and statistical field theory. He has taught graduate courses in Statistical Physics and Biological Physics, and has brought the undergraduate course "Physics for future Presidents" to CMU, which he co-taught between 2009 and 2013.



Dr. Shawn Litster
Department of Mechanical Engineering

Shawn Litster is an associate professor and the Russell V. Trader Faculty Fellow in the Department of Mechanical Engineering at Carnegie Mellon University. He also has a courtesy appointment in the Department of Materials Science and Engineering. He received his Ph.D. in mechanical engineering from Stanford University (2008) and his B.Eng. and M.A.Sc. degrees in mechanical engineering from the University of Victoria in Canada.

Dr. Litster's current research focus is micro- and nano-scale transport phenomena in energy conversion technologies where electrochemistry and electrokinetics play a dominant role, including fuel cells, batteries, and ultra-capacitors. His research interests also include multiphase flow in porous media and micro-channels, non-linear dynamics, catalytic gasification, and microfluidic pumping. He is also the director of Carnegie Mellon's X-ray

Computed Tomography Facility. He is a recipient of Carnegie Mellon's George Tallman Ladd Research Award, a National Science Foundation CAREER award, the University of Victoria's Lieutenant Governor's Silver Medal, and best paper/presentation awards from The Electrochemical Society and the American Society for Mechanical Engineers. He is an author of over 40 journal papers and three book chapters. He is also an inventor for three US patents on fuel cell design.

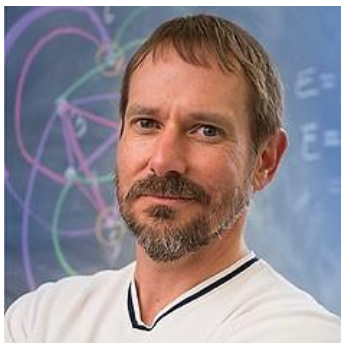


Dr. A. Javier Lopez
Department of Biological Sciences and Lane Center for Computational Biology

Javier Lopez earned his BA in Biology from Cornell University in 1979 and his Ph.D. in Biochemistry and Genetics from Duke University in 1985, where he studied the mechanisms of filamentous virus assembly at the bacterial cell membrane. He then pursued postdoctoral research at Stanford University, where he investigated the role of alternative pre-mRNA splicing in regulating gene expression and function during development in *Drosophila*. He joined the faculty of Carnegie Mellon in 1990, where he is now a member of the Department of Biological Sciences and the Lane Center for Computational Biology.

Dr. Lopez's research focuses on the mechanisms and biological functions of regulated alternative splicing and other RNA processing events. His work combines genetic, molecular, biochemical and computational approaches.

Current projects in his laboratory include fundamental studies in *Drosophila* and mammalian models, with a focus on the role of alternative splicing in aging and oxidative stress. Dr. Lopez teaches courses in genetics and genomics for undergraduate and graduate students at Carnegie Mellon.



Dr. John Mackey
Department of Mathematical Sciences

John Mackey earned his BS in Mathematics from Kent State University in 1987 and his Ph.D. from the University of Hawaii in 1994, where he studied extremal problems in combinatorics. He then spent four years at Dartmouth College, first as a visiting assistant professor and then as a John Wesley Young Research Instructor. During the following three years he was a Preceptor of Mathematics at Harvard University before coming to Carnegie Mellon University in 2003. He is now the Associate Department Head and Director of Undergraduate Studies in Mathematical

Sciences at Carnegie Mellon University.

Dr. Mackey's main fields of interest are combinatorics and graph theory, but he is also interested in ordered sets, lattices, and coding theory. A primary goal of his research is to better understand the nature of extremal results typified by the following theorem of Pal Turan: Any graph with $2k$ vertices and more than k^2 edges must contain a set of three mutually adjacent vertices. The only graph with $2k$ vertices and k^2 edges that does not have three mutually adjacent vertices is the complete bipartite graph with two groups of k vertices. By studying results of this type, Dr. Mackey hopes to better understand the nature and limits of randomness.



Dr. Brooke McCartney
Department of Biological Sciences

Brooke McCartney earned her bachelor's degree in Biological Sciences from Mount Holyoke College in 1992 and her Ph.D. in Cell and Developmental Biology from Duke University in 1997, where she studied the basic cellular functions of the Neurofibromatosis-2 tumor suppressor Merlin. She then spent five years doing postdoctoral research on the cytoskeletal and signaling functions of the colorectal cancer tumor suppressor Adenomatous polyposis coli (APC) at the University of North Carolina at Chapel Hill. Dr. McCartney joined the faculty at Carnegie Mellon in 2003, where she is now an Associate Professor of Biological Sciences.

Dr. McCartney's laboratory investigates the ways in which cells communicate with each other, and how those cellular signals influence cell fate and the organization of the cytoskeleton during development. Using the fruit fly *Drosophila melanogaster* as a model system, Dr. McCartney's laboratory is uncovering the mechanisms that control actin assembly and actin-microtubule crosstalk, and the regulation of cell signaling that influence both normal development and cancer development.

Dr. McCartney teaches an introductory level course for non-majors on the connections between fundamental biology and modern medical therapies, and an advanced course in developmental biology for the undergraduate and graduate students at Carnegie Mellon.



Dr. Kevin Noonan
Department of Chemistry

Kevin Noonan earned his B.Sc in Chemistry from Dalhousie University in 2003 and his Ph.D from the University of British

Columbia in 2008, where he studied controlled polymerization approaches to phosphorus-based polymers. He then moved to the United States and conducted postdoctoral research on alkaline membrane fuel cells at Cornell University under Geoffrey Coates as part of the Energy and Materials Center. He joined the faculty at Carnegie Mellon in 2011, where he is now an Assistant Professor of Chemistry.

Dr. Noonan's research focuses on the design and synthesis of polymer materials for transport applications. He has three main thrusts in his research group: semiconducting polymers for electron transport, gas separation membranes for CO₂ sequestration and phosphorus-based materials for anion exchange membranes. The phosphorus-based polymers are being developed as a solid support to be used in alkaline fuel cells. There is currently a great deal of interest in new chemistries for alkaline membranes to make materials with similar stability to Nafion. Dr. Noonan also teaches courses in organic and organometallic for undergraduate and graduate students at Carnegie Mellon.



Dr. Wesley Pegden
Department of Mathematical Sciences

Wes Pegden earned his B.A from the University of Chicago in 2004 and his Ph.D from Rutgers University in 2010. He was a NSF Postdoctoral Fellow at the Courant Institute from 2010-2013, before joining the Mathematics department of CMU as an assistant professor.

Dr. Pegden's research is in combinatorics and probabilistic methods. A major area of focus is the Abelian sandpile, a simple iterative process introduced by physicists in the 1987, which was observed to produce striking and mysterious fractal patterns. Dr. Pegden's work developed a mathematical framework to understand and predict fractal behavior in the sandpile, through methods which connect tilings of the Euclidean plane, circle packings, and "bounded curvature" quadratic forms.

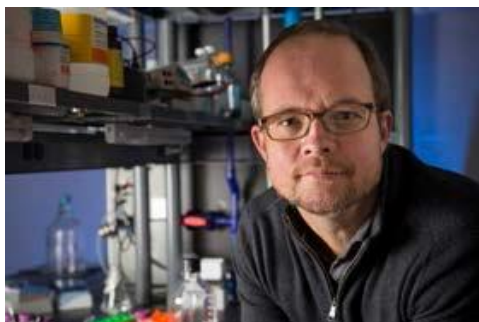


Dr. Matthew Walker
Department of Physics

Matthew Walker earned bachelor's degrees in physics and philosophy from Western Illinois University in 1999, and a Ph.D. in Astronomy and Astrophysics from the University of Michigan in 2007. He then spent three years as a postdoctoral researcher at the Institute of Astronomy at the University of Cambridge, followed by three years as a postdoctoral fellow at Harvard College Observatory. In 2013 he joined the faculty at Carnegie Mellon, where he is an assistant professor in

the physics department and the McWilliams Center for Cosmology.

Dr. Walker's research focuses on observational tests of the nature of dark matter. He uses large optical telescopes to acquire spectra from thousands of stars in the dwarf galaxies that orbit as satellites of our own Milky Way. His group analyzes the positions and motions of these stars in order to infer the amount and spatial distribution of dark matter, and then compares those results to theoretical predictions.

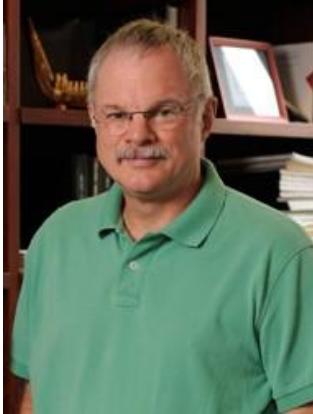


Dr. Newell Washburn
Department of Biomedical Engineering and Chemistry

Newell Washburn received a B.S. in Chemistry from University of Illinois at Urbana-Champaign in 1993 and a Ph.D. in Chemistry from the University of California, Berkeley in 1998. Following post-doctoral research at the University of Minnesota in the Department of Chemical Engineering and Materials Science, he moved to the Polymers Division at the National Institute of Standards and Technology, first as a National Research Council Post-Doctoral Fellow then as Leader of the Biomaterials Group. During this time he was also an Adjunct Professor at Johns Hopkins University in the Graduate Program in Biotechnology. He joined the faculty of Carnegie Mellon University in the Departments of Chemistry and Biomedical Engineering in 2004 and is Member Faculty at the McGowan Institute of Regenerative Medicine at the University of Pittsburgh. In 2011, he was promoted to Associate Professor at CMU.

Prof. Washburn's research interests involve development of immunologically active biomaterials and strategies for controlling the viscoelastic properties of biopolymers using the tools of chemistry and engineering.

The Washburn lab has developed gels for the localized delivery of antibodies against pro-inflammatory cytokines and performed extensive studies on the effects as burn treatments as well as numerous other applications based on direct delivery. Prof. Washburn teaches general chemistry, organic chemistry, and graduate-level courses in biomaterials.



Dr. John Woolford
Department of Biological Sciences

John Woolford earned his BA in Chemistry from Rice University in 1971, where he studied matrix isolation infrared spectroscopy. Woolford received his Ph.D. from Duke University in 1976, where he studied effects of assembly of bacteriophage f1 on phospholipid metabolism in *E. coli*.

Woolford was a postdoctoral fellow at the Rosenstiel Center and Department of Biology at Brandeis University, where he purified and characterized ribosomal protein genes in yeast. This led to the discovery of introns in these genes and the factors that regulate splicing of pre-mRNAs. In 1979, Woolford joined the faculty at Carnegie Mellon University, where he is now Professor of Biological Sciences and co-director of the Center for Nucleic Acids Science and Technology.

Dr. Woolford's research focuses on the mechanism of assembly of ribosomes in the yeast *Saccharomyces cerevisiae*. His group takes genetic and proteomic approaches to identify and characterize proteins necessary for maturation of assembly intermediates. They developed the first methods to purify ribosome assembly intermediates from cells. Recently the Woolford group has mapped the functions in assembly of all of the protein constituents of mature ribosome. Dr. Woolford teaches courses in Molecular Biology and Genetics to undergraduate and graduate students at Carnegie Mellon.