

PRESS RELEASE | JAN 30, 2019

## Rumford Prize Awarded for the Invention and Refinement of Optogenetics

### **Science Prize Awarded to Ernst Bamberg, Ed Boyden, Karl Deisseroth, Peter Hegemann, Gero Miesenböck, and Georg Nagel**

A storied science prize that was awarded to Thomas Edison in 1895 for his work in electric lighting; Edwin Land in 1945 for his applications in polarized light and photography; Enrico Fermi in 1953 for his studies of radiation theory and nuclear energy; and Federico Capasso and Alfred Cho in 2015 for their contributions to the field of laser technology will next be awarded to Ernst Bamberg, Ed Boyden, Karl Deisseroth, Peter Hegemann, Gero Miesenböck, and Georg Nagel in recognition of their extraordinary contributions related to the invention and refinement of optogenetics.

First awarded in 1839, the Rumford Prize given by the American Academy of Arts and Sciences recognizes contributions to the fields of heat and light. The Rumford Prize will next be presented during the **Academy's Annual Awards Ceremony on April 11, 2019** (**/events/annual-awards-ceremony**), at the Academy's headquarters in Cambridge, Massachusetts.

Named "Breakthrough of the Decade" in 2010 by the journal *Science*, the field of optogenetics has furthered the fundamental scientific understanding of how specific cell types contribute to the function of biological tissues. On the clinical side, optogenetics-driven research has led to insights into Parkinson's disease and other neurological and psychiatric disorders, as well as autism, schizophrenia, drug abuse, anxiety, and depression.

As Lucia Rothman-Denes, a member of the Academy's Prize Committee and the A. J. Carlson Professor of Molecular Genetics and Cell Biology at the University of Chicago, stated, "Optogenetics has revolutionized the field of neuroscience," and

added “the work undertaken by these scientists has had a profound impact on cell biology and, most recently, microbiology in ways that advance our understanding of science and of health.”

“On behalf of the American Academy, I am pleased to present the Rumford Prize to Professors Bamberg, Boyden, Deisseroth, Hegemann, Miesenböck, and Nagel for their achievements,” said **David W. Oxtoby**, President of the American Academy of Arts and Sciences. “Along with Alexander Graham Bell, Albert Einstein, Niels Bohr, and others, they are part of a distinguished lineage of scientists who have been honored by the Academy.”

The American Academy of Arts and Sciences, founded in 1780, honors excellence and brings together members and other leaders across disciplines, fields, and professions to pursue nonpartisan research and provide critical insight on issues of profound importance to the nation and the world. Areas of focus include the arts and humanities, democracy, education, global affairs, and science policy.

The 2018 Rumford Prize recipients:

*Ernst Bamberg* is Professor and Director of the Department of Biophysical Chemistry at the Max-Planck Institute of Biophysics in Frankfurt, Germany. In 1995, Bamberg and Nagel were the first to demonstrate the functional expression of a light-driven proton pump, bacteriorhodopsin, in vertebrate cells which in 2002/2003 led to a cooperation with Hegemann, the discovery of rhodopsins as light-gated ion channels, and demonstration of light-induced membrane depolarization in human cells. Bamberg’s current research focuses on the search and functional and structural analysis of microbial rhodopsins with biophysical methods for a deeper understanding of the molecular mechanism of these proteins. Improved tools are developed with respect to light sensitivity, speed, and ion selectivity in order to make them more applicable to the brain. In different collaborations the “new” rhodopsins are used for the recovery of hearing and of vision on deaf or blind animals respectively, providing a biomedical perspective. Bamberg is the recipient of the Boris Rajewsky Prize for Biophysics (1987), the Prize of the Stifterverband für die deutsche Wissenschaft (2009), the Wiley Prize in Biomedical Sciences (2010), the Karl Heinz Beckurts-Preis (2010), the K. J. Zülch-Prize (2012), and the Grete Lundbeck Brain Prize (2013). He is a member of the German Academy of Sciences Leopoldina.

*Edward Boyden* is the Y. Eva Tan Professor of Neurotechnology, Associate Professor of Biological Engineering and Brain and Cognitive Sciences at MIT's Media Lab and McGovern Institute for Brain Research, and Co-Director of the MIT Center for Neurobiological Engineering. In 2018, he was selected to be an Investigator of the Howard Hughes Medical Institute. While a PhD student at Stanford, he discovered that the molecular mechanisms used to store a memory are determined by the content to be learned. In parallel, he co-invented optogenetic control of neurons. In particular, he and co-winner Karl Deisseroth brainstormed about how microbial opsins could be used to mediate optical control of neural activity while both were students in the year 2000. Together the two of them collaborated to demonstrate the first optical control of neural activity using microbial opsins in summer 2004, with Karl, then a postdoc, and Ed, then a graduate student, performing the gene transfection and the optical stimulation respectively. His lab at MIT pioneered optogenetic neural silencing, and further developed the optogenetic toolset towards the neuroscience-driven goals of powerful, noninvasive, high-speed, multiplexed, and single-cell targeted optical control of neural activity. Dr. Boyden has received the Harvey Prize (2011), the Perl-UNC Neuroscience Prize (2011), the Grete Lundbeck Brain Prize (2013), the Jacob Heskell Gabbay Award (2013), the Carnegie Prize in Mind and Brain Sciences (2015), the BBVA Foundation Frontiers of Knowledge Award (2015), the Breakthrough Prize in Life Sciences (2016), and the Canada Gairdner International Award (2018). He is a member of the American Academy of Arts and Sciences, the National Academy of Inventors, and the American Institute for Medical and Biological Engineering.

*Karl Deisseroth* is the D. H. Chen Professor of Bioengineering and of Psychiatry and Behavioral Sciences at Stanford University, and HHMI Investigator. In July 2004, while a principal investigator at Stanford, he carried out and quantified the initial microbial opsin-based optical activation of neurons, that he had transduced with a channelrhodopsin. In 2005, his laboratory published the first demonstration of the use of microbial opsin genes to achieve optogenetic control of neurons (together with graduate students Ed Boyden and Feng Zhang), allowing for the reliable control of action potentials with light at millisecond precision. He named this field "optogenetics" in 2006 and followed up with pioneering full development of optogenetic technology, as well as leading fundamental understanding of channelrhodopsin structure and function through obtaining the key crystal structures, and leading

many applications of optogenetics including to psychiatry and neurology. Dr. Deisseroth is the recipient of the NIH Pioneer Award (2005), the HFSP Nakasone Award (2010), the Koetser Award (2010), the W. Alden Spencer Award (2011), the Perl-UNC Neuroscience Prize (2012), the Goldman-Rakic Prize for Cognitive Neuroscience Research from the Brain & Behavior Research Foundation (2013), the Richard Lounsbery Award (2013), the Jacob Heskell Gabbay Award (2013), the Grete Lundbeck Brain Prize (2013), the Keio Prize in Medicine (2014), the Lurie Prize in Biomedical Sciences (2015), the Breakthrough Prize in Life Sciences (2016), the Harvey Prize (2016), the Massry Prize (2016), the Canada Gairdner International Award (2018), the Leibinger Prize (2018), and the Kyoto Prize (2018). He is a member of the National Academy of Sciences and the National Academy of Medicine.

*Peter Hegemann* is Professor and Head of the Department for Biophysics at the Humboldt University of Berlin, Germany. He is credited with the discovery and characterization of channelrhodopsins, a family of directly light-gated ion channels. Hegemann's research focused almost entirely on the characterization of natural sensory photoreceptors, mainly from microalgae. Hegemann has characterized behavioral and photoelectric responses of the unicellular alga *Chlamydomonas*, a work that culminated in the claim that the photoreceptors for these responses are rhodopsins that unify the sensor and ion channel in one protein. He has finally proven this concept with Georg Nagel by identifying the light-gated channel channelrhodopsin, and its functionality in animal cells. His group characterized these proteins in molecular detail by a wide range of biophysical techniques, and the many mutants he generated in close collaboration with Karl Deisseroth led to the deciphering of the ion channel mechanism, including gating and ion selection. This work was the basis for the discovery of Optogenetics, a technology where light-activated proteins – first of all channelrhodopsin – allow to control selected cells of large networks as the animal brain with unprecedented precision in space and time just by application of light. Currently the Hegemann group also works on light-activated enzymes as the light-activated nucleotide-cyclases which further expand the optogenetic applications to important biochemical pathways. Dr. Hegemann is the recipient of the Wiley Prize in Biomedical Sciences (2010), the Karl Heinz Beckurts Prize (2010), the Zülch Prize (2012), the Gottfried Wilhelm Leibniz Prize, awarded by the German Research Foundation (2013), the Grete Lundbeck Brain

Prize (2013), the Harvey Prize (2016), the Massry Prize (2016), and the Gairdner Foundation International Award (2018). He is a member of the German Academy of Sciences Leopoldina.

*Gero Miesenböck* is Waynflete Professor of Physiology and Director of the Center for Neural Circuits and Behavior at the University of Oxford, and a Fellow of Magdalen College, Oxford. He invented optogenetic control in 2002, by demonstrating that opsins could be used to activate normally light-insensitive neurons. In 2005, he was the first to use optogenetics to control animal behavior. His subsequent applications of optogenetic technology have led to fundamental insights into the nature of reinforcement, the control of sexually dimorphic behavior, and the regulation and function of sleep. Dr. Miesenböck is the recipient of the Inbev-Baillet Latour Health Prize (2012), the Grete Lundbeck Brain Prize (2013), the Jacob Heskell Gabbay Award (2013), the Heinrich Wieland Prize (2015), the BBVA Foundation Frontiers of Knowledge Award in Biomedicine (2016), and the Massry Prize (2016). He is a member of the Austrian Academy of Sciences, the German Academy of Sciences Leopoldina, and a Fellow of the Royal Society.

*Georg Nagel* is Professor at the University of Würzburg (Bavaria). At the Max-Planck-Institute of Biophysics, Nagel and Bamberg were 1995 the first to demonstrate the functional expression of bacteriorhodopsin in vertebrate cells, demonstrating light-induced membrane currents. They characterized the first light-gated ion channel in a collaboration with Hegemann in 2002. In 2003 Nagel demonstrated the light-induced depolarization of human cells in which he expressed channelrhodopsin-2 and started collaborations with neuroscientists. His current research focuses on rhodopsins and light-activated adenylyl cyclases. His team cooperates with physiologists who use these photoreceptors as tools to modulate cellular function by visible light (optogenetics). He is currently working on generating channelrhodopsin- or flavoprotein-expressing plants to study signaling in plant cells (“green optogenetics”). Dr. Nagel is the recipient of the Karl-Heinz-Beckurts-Preis (2010), the Wiley Prize in Biomedical Sciences (2010), the Klaus Joachim Zülch-Preis (2012), the Prix Louis-Jeantet (2013), and the Grete Lundbeck Brain Prize (2013). In 2015 he was elected as an EMBO member.

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FEATURING: Ashton Carter, Ernest J. Moniz, Lucia B. Rothman-Denes, and Edward S. Boyden III  
Cambridge, MA

BULLETIN | AUG 2019

[The Rumford Prize: Acceptance Remarks by Edward Boyden](#)  
([/news/rumford-prize-acceptance-remarks-edward-boyden](#)).