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Six eminent scientists share the world's largest brain research prize

The Brain Prize - Denmark's 1 million euro brain research prize - is awarded to six leading scientists for the development of 'optogenetics', a revolutionary technique that advances our understanding of the brain and its disorders.

The names of the prize winners, Austrian Gero Miesenböck, Germans Ernst Bamberg, Peter Hegemann, and Georg Nagel, and Americans Ed Boyden and Karl Deisseroth, were announced on Monday 11 March 2013 in Copenhagen.

Together these scientists laid the foundations for a revolutionary technique - optogenetics - which will provide us with entirely new, fundamental knowledge of the complicated functions of the brain.

Optogenetics makes it easier to investigate diseases of the brain such as Parkinson's disease, Alzheimer's disease, epilepsy, pain disorders, schizophrenia, ADHD and addiction. It will play a significant role in the understanding of these disorders and, over time, in the development of a treatment for them.

The Brain Prize is awarded by the Grete Lundbeck European Brain Research Prize Foundation. British professor Colin Blakemore, chairman of the Foundation's selection committee, says:

"Optogenetic control of nerve cells is arguably the most important technical advance in neuroscience in the past 40 years. It offers a revolution in our understanding of the way in which circuits of neurons carry out complex functions, such as learning and controlling movement. And it could provide an entirely new approach to the restoration of function in blindness or brain degeneration, and to the treatment of a variety of other neurological and psychiatric disorders"

Breakthrough of the decade

Optogenetics, which has been called the breakthrough of the decade, involves the use of light to control neurons. Neurons can be genetically modified and made light-sensitive. Then, when these neurons are stimulated by specific wavelengths of light, they can be turned either on or off.

The four European scientists, Bamberg, Hegemann, Miesenböck and Nagel, made the fundamental observations and discoveries and developed light-sensitive molecules that can be introduced into specific types of neuron. The two Americans collaborated with the Europeans to develop the technique further and put it to work in living mammals.

Neuroscience provides an important understanding of both the function of the normal brain and the causes of brain disorders. It is estimated that more is spent on disorders of the brain and the nervous system than on cardiovascular disease and cancer combined. For instance, due to the growing size of the elderly population we will see a dramatic increase in the number of people with Alzheimer's.

And costs are expected to rise. There are 7 million people living with Alzheimer's and other forms of dementia in Europe alone. This figure is expected to double every 20 years and the cost of dealing with dementia, which currently amounts to 130 billion euros in Europe, will increase correspondingly.

Consolidating the research environment
The Brain Prize, which is the world's largest brain research prize, will be awarded for the third time this year. By augmenting the interaction between scientists in both Europe and the USA, the Prize contributes to the consolidation of the international brain research environment.

Chairman of the Foundation's board, Nils Axelsen, MD, says:

"The Prize can be awarded to scientists who have conducted research in Europe, or to scientists who have conducted research in collaboration with European scientists. Thus, the Prize stimulates international cooperation between the traditionally strong research environments in Europe and in the USA. However, it also inspires cooperation with other countries which are well on the way to developing solid research environments in the field of brain research."

The six scientists will all come to Denmark to receive the shared prize of 1 million euros at a ceremony on 2 May.

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Facts

- The Brain Prize of 1 million euros is awarded by the independent, charitable, non-profit Grete Lundbeck European Brain Research Prize Foundation.

- The Prize is awarded for the third consecutive year, and it is this year awarded for the development of optogenetics a revolutionary technique that advances our understanding of the brain and its disorders.

- The Brain Prize is a personal prize, awarded to one or more scientists who have distinguished themselves by an outstanding contribution to European brain research.

- The Prize is presented by HRH The Crown Prince on 2 May in Copenhagen

ABOUT OPTOGENETICS:

An implausible dream becomes reality

In 1999, Nobel Prize winner Francis Crick suggested that light could be used to control the activity of brain cells. Now, a good ten years later, this apparently implausible dream is not merely a reality; it has been developed into a versatile and powerful technique, proclaimed by the journal *Science* in 2010 to be the 'Breakthrough of the Decade'.

Optogenetics makes use of light-sensitive ion channels (Channelrhodopsin), which are found in, among other things, certain types of alga and in fruit flies. The light-sensitive ion channels are introduced into pre-determined types of neuron using a form of gene therapy. Two different types of light-sensitive ion channel are used; one that is able to switch on the activity in the neuron and one that can switch it off. By introducing both types of ion channel, and by stimulating the neurons with specific wavelengths of light, neurons can be turned either on or off.

The story of optogenetics began with the study of tiny, single-cell algae that move towards sources of light. In 1992, Hegemann and his colleagues discovered that illumination of the light-sensitive substance expressed by these algae, which is similar to the visual pigment rhodopsin found in photoreceptors, changes the permeability of the membrane to cations. Furthermore, entry of calcium activates movement of the flagellum.

Together with Nagel and Bamberg, Hegemann succeeded in transferring Rhodopsin from algae to the eggs of the African clawed frog, and he discovered that the Rhodopsin from the algae contained a channel that changes the ion permeability of the cell membrane when Rhodopsin is exposed to light. They called this molecule Channelrhodopsin.

In 2003, Nagel, Bamberg, Hegemann and colleagues described a variant of Channelrhodopsin (ChR2), which allowed more rapid light activation of the associated channel. They were able to express ChR2 in the surface membrane of isolated mammalian cells and to activate the cell quickly and reliably with light.

In 2002, a research group headed by Miesenböck described a slightly different strategy for optical activation of a genetically reconstructed molecule, including Rhodopsin from the fruit fly, Drosophila, and, in 2005, Miesenböck's group applied yet another optogenetic technique to modify flight behaviour in Drosophila.

This was the beginning of a ground-breaking cooperation. Nagel and Bamberg supplied ChR2 to the two young American scientists, Boyden and Deisseroth, who then successfully expressed ChR2 in mammalian neurons.

Between 2005 and 2007, Hegemann, Boyden, Bamberg, Nagel and Deisseroth worked to develop optogenetic methods for inhibiting and stimulating neurons. Since 2007, development has been rapid. Optogenetics is now being used in numerous laboratories all over the world, and it is the desire of many neuroscientists to master and apply the new method.

THE PRIZE WINNERS

Ernst Bamberg, Germany, Professor, is Head of the Dept. of Biophysical Chemistry and Director at the Max Planck Institute of Biophysics, Frankfurt am Main, Germany.

Ed Boyden, USA, is Associate Professor, MIT Media Lab and McGovern Institute, Departments of Biological Engineering and Brain and Cognitive Sciences, MIT, Cambridge, Massachusetts, USA.

Karl Deisseroth, USA, MD PhD, is the DH Chen Professor of Bioengineering and of Psychiatry and Behavioral Sciences at Stanford University, California, USA.

Peter Hegemann, Germany, Prof. Dr., Professor, is Head of experimental biophysics, Humboldt University, Berlin, Germany.

Gero Miesenböck, Austria, MD, is the Waynflete Professor of Physiology, Director, Centre for Neural Circuits and Behaviour, University of Oxford, United Kingdom.

Georg Nagel, Germany, Professor, Dr. phil., is full professor at University of Würzburg, Germany.