

Nobel Prize in Medicine awarded for optogenetics, a light switch for the brain

Benjamin Mateus
11 October 2026

More than three decades ago, a biophysicist asked a simple question: how does a single-celled green alga sense light and swim toward it? The curiosity to pursue that question, carried from one laboratory to another, has produced one of the most powerful tools in modern brain science. On Oct. 5, the Nobel Assembly at Karolinska Institutet awarded the 2026 Nobel Prize in Physiology or Medicine to the three scientists who followed it from pond water to the living brain, “for their discoveries concerning light-gated ion channels and optogenetics.”

Peter Hegemann, 71, of Humboldt University of Berlin, and Georg Nagel, 73, of the University of Würzburg, both biophysicists, identified the light-sensitive protein in the alga and proved that it was itself a channel, a pore that opens when struck by light and lets electrically charged particles into the cell, relaying the signal that steers the alga toward its source.

Karl Deisseroth, 54, a bioengineer at Stanford University and the Howard Hughes Medical Institute who also practices psychiatry, treating patients with treatment-resistant depression and autism, put the gene for that protein into nerve cells, which then built the channel themselves and began responding to light like the alga. The result was a method using light to switch specific cells in a living brain on and off. For the first time, researchers could make a chosen set of nerve cells fire and watch what happened next. What those cells do could now be observed directly, where before it could only be inferred.

A neuron is a nerve cell. Neurons signal to one another with brief electrical pulses lasting about a thousandth of a second, produced when ion channels in the cell’s outer membrane open and charged particles rush in. Optogenetics delivers the gene for a light-sensitive channel found in an alga, called channelrhodopsin, usually inside a harmless modified virus, into one chosen type of neuron. Light shone into the brain then switches on only those cells that possess the light-driven protein channel.

As the Nobel committee’s scientific background recounts, Hegemann trained under Dieter Oesterhelt at the Max Planck Institute of Biochemistry, where Oesterhelt had discovered the first light-driven pump found in a microbe. Studying the alga *Chlamydomonas* from around 1990, Hegemann found that its electrical response to light began within millionths of a second, too fast for the chain of chemical steps by which animal eyes turn light into a signal. He proposed that in the alga a single protein did both jobs, sensing the light and opening to let the current through.

Nagel had trained in Ernst Bamberg’s department at the Max

Planck Institute of Biophysics in Frankfurt, where he first met Hegemann. Hegemann, by then at the University of Regensburg, supplied candidate genes from the alga, and Nagel and Bamberg inserted them into frog eggs, a standard way of testing what a protein does. In 2002 they showed that light alone opened the channel, with no chemical relay in between, confirming Hegemann’s thesis. In 2003 they showed that a second, closely related protein, channelrhodopsin-2, worked just as well in human cells grown in the laboratory, and wrote that it could be used to excite cells “simply by illumination.”

Nagel sent the gene to Deisseroth at Stanford. In rat nerve cells carrying it, pulses of blue light triggered nerve impulses on command with millisecond precision, Deisseroth’s group reported in *Nature Neuroscience* in August 2005. His laboratory in turn sent its engineered genes freely to laboratories around the world. By 2007 his group was guiding light through thin optical fibers into the brains of living mice, and his group and Edward Boyden’s at MIT had adapted a light-driven pump from a salt-loving microbe to switch neurons off. Researchers now had a two-way switch: they could trigger a chosen group of cells or silence them, and watch what followed either way.

Nobel rules allow no more than three laureates, though many scientists contributed, among them Bamberg; Boyden, who as a Stanford graduate student was first author of the 2005 paper; Gero Miesenböck, whose laboratory first made neurons light-sensitive by genetic means; and Zhuo-Hua Pan, whose work opened the path to the vision trials.

The prize extends a line of Nobel-recognized work on the nervous system that spans 120 years. It runs from Camillo Golgi and Santiago Ramón y Cajal, who made the neuron visible in 1906, through Alan Hodgkin and Andrew Huxley, who explained its electrical pulse in 1963, to Erwin Neher and Bert Sakmann, who recorded the currents through its single channels in 1991.

Recording, imaging, brain injuries and drugs could show which activity accompanies a behavior, but not which cells cause it. Francis Crick argued in 1979 that neuroscience needed a way to control one type of neuron while leaving the rest undisturbed, and he later suggested light, an idea he called “rather far-fetched.” With optogenetics, a far more precise tool now exists for the study of these complex neuronal pathways.

Switching on a small group of neurons in a region that governs sleep made sleeping mice more likely to wake. Neighboring dopamine neurons, cells involved in motivation, drove reward or

aversion depending on which brain regions fed into them, and separate pathways out of the amygdala, a center of emotion, raised or lowered anxiety. In Susumu Tonegawa's laboratory, reactivating the cells that held a fear memory made mice freeze in a safe place, and researchers later implanted a false memory, fear of a place where nothing had ever happened to them. Emotions, behaviors and memories proved to be built from specific, separable circuits, and experience was shown to leave its physical mark on particular cells.

The false memory also shows the method's limit. Light can drive a circuit to produce a state the animal never lived through, so showing that a circuit *can* cause a behavior does not by itself show that the brain normally produces it that way. That is why such experiments are paired with recordings of what the same cells do in ordinary life.

Engels wrote in 1886 that consciousness and thinking, "however supra-sensuous they may seem," are the product of a material, bodily organ, the brain, and that "mind itself is merely the highest product of matter." The brain is itself the outcome of the long development of the material world, and the mind develops through the social life of human beings. Experiments that trace fear, reward, sleep and memory to identifiable circuits give the Marxist, materialist understanding of the mind a concrete causal foundation and leave ever less room for the idealist conception of a mind or spirit standing apart from the body.

The clinical promise remains modest, as Nagel himself said. The obstacles are real: delivering genes safely into the human brain and bringing light to tissue deep inside it remain unsolved problems. How quickly they are overcome, however, depends on how research and its applications are organized and funded, as the fate of the one treatment to reach patients shows.

In an interview with Nobel Prize Outreach on Oct. 5, Nagel said he knew of only one patient "who profited from optogenetics" and had thought it too early for a prize in medicine. That patient, described in *Nature Medicine* in 2021, was a man blinded by retinitis pigmentosa, an inherited disease that destroys the eye's light-sensing cells. After a light-sensitive protein was delivered to his surviving retinal cells, he could locate, count and touch objects on a table while wearing special goggles.

On Oct. 8, the *New England Journal of Medicine* published fuller results from the same trial of GenSight Biologics' treatment: six of 10 patients improved in light sensitivity, though the study was designed to test safety. GenSight, whose main program is a different gene therapy, reported only €700,000 in cash at the end of September and warned of "a material uncertainty" about its ability to continue as a going concern. The only human treatment built on the prize-winning work depends on whether a small company can find investors. A treatment that has let a blind man find objects on a table is thus left to the calculations of private capital, the subordination of human need to profit in its most direct form.

In a 1932 letter quoted in the Nobel committee's background, Virginia Woolf called her own brain "the most unaccountable of machinery." For as long as people have thought about thinking, they have been trying to wrap their heads around the brain: what a memory is, how a feeling arises, how the brain governs the body.

That investigation has immense cultural and social value, above all for the 23.4 percent of U.S. adults, about 61.5 million people, who had a mental illness in 2024, according to the Substance Abuse and Mental Health Services Administration, and the more than 1 billion people worldwide living with mental health conditions, according to the World Health Organization. Understanding why these illnesses arise, and offering people real ways to address them, is the direction the whole health system should be taking. Yet the population this research should serve is the same population whose care is now being stripped away, even as the science itself comes under attack.

Discoveries like this rest on patient public funding with no promised payoff. Hegemann and Nagel worked in publicly funded German institutes, and Deisseroth's early program was supported by a 2005 National Institutes of Health (NIH) Director's Pioneer Award. That foundation is under attack.

The Trump administration has terminated thousands of NIH grants, proposed a \$5 billion cut to the agency for 2027 and is drafting an order to give an outside committee veto power over NIH awards on political grounds. Trump and Health and Human Services Secretary Robert F. Kennedy, Jr. have recast autism as an "epidemic" with a culprit to be found, reviving eugenic conceptions of the very people this science seeks to understand. The Democrats share responsibility; the NIH's BRAIN Initiative, which Deisseroth helped propose, lost about 40 percent of its funding in fiscal 2024, when Congress and the Biden administration declined to make up a scheduled drop in temporary money from the 2016 21st Century Cures Act. Some 5 million Medicare enrollees are being forced to switch private plans, Medicaid work requirements are set to strip coverage from millions, and the White House is seeking \$1.5 trillion for the military.

Work of the kind honored in the Nobel Prize for Medicine depends on the open, cooperative exchange of materials, methods and ideas across laboratories and national borders, as does all productive human labor. A discovery produced by decades of publicly funded, international and collaborative work wins an honor, while the class which rules society cuts research, strips coverage from the old and the poor, expands war and revives eugenic ideas about the people the research could help, expressing the barbarism of a capitalist order in decline.

Socialists and workers have always taken a deep interest in scientific discovery and understand the social value it holds. At Marx's graveside in 1883, Engels compared Marx's discovery of the law of development of human history to Darwin's discovery of the law of development of organic nature. In times like these, the preservation of scientific thought and discovery has assumed revolutionary significance, and it falls to the working class to defend it.



To contact the WSWWS and the
Socialist Equality Party visit:

wsws.org/contact