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Singapore designs new genetic tool to investigate brain function and psychiatric disorders

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Developing a new light-controlled ‘off switch’ for brain cells

Researchers from Duke-NUS Medical School in Singapore have found that a new class of light-sensitive proteins are capable of turning off brain cells with light, offering scientists an unprecedentedly effective tool to investigate brain function.

The study opens new opportunities to apply optogenetics to investigate the brain activity underlying neurodegenerative and psychiatric disorders such as Parkinson’s disease and depression.

The team showed that specific potassium channels, known as kalium channelrhodopsins, can serve as effective instruments for regulating brain-cell activity in three critical experimental animals: fish, worms, and flies.

Potassium ions are essential to normal electrical function in all human cells. Potassium channels are specialised proteins present in cell membranes that allow the flow of potassium ions. They regulate the flow of potassium ions across the cell membrane to maintain various cellular processes, and are critical to nerve-impulse transmission, muscle contraction, and cellular-fluid balance maintenance.

When triggered by light, the new kalium channelrhodopsins let potassium ions leave a neuron, changing the electrical gradient across the membrane. This change, known as hyperpolarisation, makes it difficult for the neuron to generate the electrical signal known as an action potential. Without action potentials, a neuron’s communication with other cells is greatly suppressed or even silenced.

The ability to silence brain cells using light-triggered potassium channels opens avenues for studying the intricate interactions between different brain regions. It also offers a promising approach for exploring the pathological mechanisms underlying neurodegenerative, neurodevelopmental, and psychiatric disorders.