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A Novel Red-shifted ChannelRhodopsin - ChRmine

Researchers at Stanford have discovered a powerful new optogenetic actuator- a novel red-shifted opsin. Optogenetics is a technique used to study function and communication between cells. It involves the use of light-activated proteins to change the membrane voltage potential of neurons as well as other cells. In neurons, membrane depolarization creates action potentials which are the basis of neuronal excitation. Conversely, membrane hyperpolarization leads to the inhibition of such signals. To have even more control in optogenetic studies of the brain, more actuators are needed. To help meet this need the inventors have used microbial opsin crystal structure-based genome mining to identify a novel red-shifted opsin that they named ChRmine. This opsin has ideal properties for use in optogenetics. Its markedly improved light sensitivity, robustness to elicit action potentials, and red-shifted spectral properties make it an ideal tool for high level precision reading and writing of neuronal activities when combined with blue-light based activity reporters. This technology extends optogenetic capabilities.

Stage of research
This tool has been used in measuring naturally-occurring large-scale 3D ensemble activity patterns during visual experience, and then replaying these patterns at the level of many individually-specified cells.

Applications

- Optogenetics
    - Single-cell optical manipulations
    - Read and write from multiple cells
    - Non-invasive, deep tissue stimulation of central and peripheral nervous system

Advantages

- Red-shifted light sensitivity
- Extremely large photocurrents alongside millisecond spike-timing fidelity
- Effective tool to:
    - Excite cells with a low light power
    - Achieve non-invasive control either transcranially or transdermally
    - Combine with GECIs for real time calcium imaging and closed loop recording of cell activity
    - Combine with blue voltage indicators
- Better than other red-shifted opsins currently available
    - Improved light sensitivity
    - Improved robustness to elicit action potentials

Patents

- Published Application: WO2020150093
- Published Application: 20220118271
- Published Application: 20250303191
- Issued: 12,263,350 (USA)

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