Optochemical Genetics

Dirk Trauner

Department of Chemistry, University of Munich
Butenandtstr. 5-13 (F4.086), 81377 Munich, Germany
E-mail: dirk.trauner@lmu.de

Transmembrane receptors allow a cell to communicate with its environment in response to a variety of input signals. These can be changes in the concentration of ligands (e.g. hormones or neurotransmitters), temperature, pressure (e.g. via acoustic waves or touch), transmembrane potential, or light intensity. Many important receptors have now been characterized in atomic detail and our understanding of their functional properties has markedly increased in recent years. As a consequence, these sophisticated molecular machines can be reprogrammed to respond to unnatural input signals. Arguably, the most useful of these signals is light. I will show how ligand-gated ion channels, G-protein coupled receptors, as well as voltage-gated ion channels, can be manipulated with synthetic photoswitches to become light-sensitive. The resulting hybrid photoreceptors can be used to optically control neurons with very high precision. They have been used to dissect neural networks and might find applications in the restoration of vision and the control of other sensations (such as pain). This combination of synthetic photoswitches and receptor proteins augments the field of Optogenetics and adds a new functional dimension to Chemical Genetics. As such, we propose to call it “Optochemical Genetics”.