

## **Channelrhodopsin 1,2, a new class of ion channels: functional description and cellular applications**

Georg Nagel<sup>1</sup>, Peter Hegemann<sup>2</sup>, Suneel Kateriya<sup>2</sup> and Ernst Bamberg<sup>1</sup>, <sup>1</sup>Max-Planck-Institut für Biophysik, Frankfurt, Germany and <sup>2</sup>Institute of Biology, Humboldt University, Berlin, Germany.

Microbial-type rhodopsins are found in archaea, prokaryotes and eukaryotes. Some of them represent light activated ion pumps like the well known proton pump bacteriorhodopsin or they act as photosensors for phototactic behaviour in archaea. These proteins have in common the usual rhodopsin-like seven-transmembrane helices motif. By expressing microbial-type rhodopsins from the green alga *Chlamydomonas reinhardtii* in oocytes from *Xenopus laevis* or in HEK 293 cells we identified two light gated channels. Both channels open rapidly after light excitation and generate a large permeability for protons (ChR1) and for monovalent and divalent cations (ChR2), respectively. The action spectra give strong evidence for the participation of these light gated ion channels on the phototactic behaviour of the alga.

The predicted seven transmembrane  $\alpha$  helices structure of ChR1,2 is characteristic for G protein-coupled receptors but reflect a completely new motif for a cation-selective ion channel. Because of its unique properties as a light gated ion channel, which depolarizes cells directly without any delay, ChR2 offers the possibility to use it as a tool for manipulating the electrical properties excitable cells or Ca-dependent processes simply by light in a non-invasive manner.

Nagel, G., Ollig, D., Fuhrmann, M., Kateriya, S., Mustl, A.M., Bamberg, E. & Hegemann, P. (2002) *Science*, 296, 2395-2398.

Nagel, G., Szellas, T., Huhn, W., Kateriya, S., Adeishvili, N., Berthold, P., Ollig, D., Hegemann, P. & Bamberg, E. (2003) *Proceedings of the National Academy of Sciences of the United States of America*, 100, 13940-13945.

Boyden, E.S., Zhang, F., Bamberg, E., Nagel, G., & Deisseroth, V. (2005) *Nature Neurosciences* in press. -->