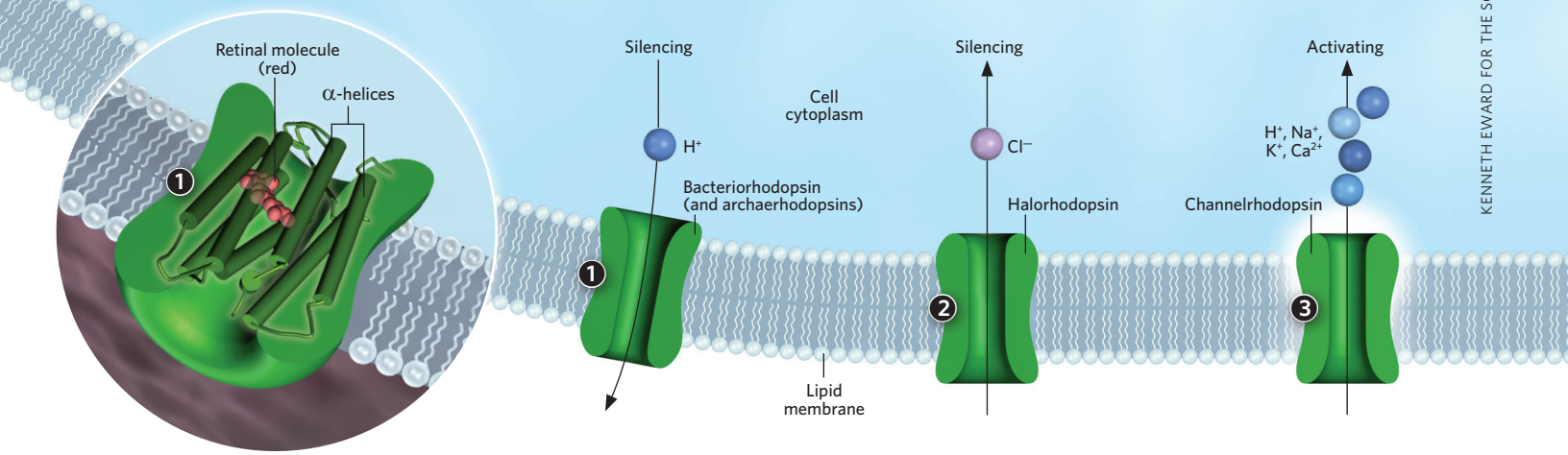
OPSINS: TOOLS OF THE TRADE

The optogenetic toolset is composed of genetically encoded molecules that, when targeted to specific neurons in the brain, enable the electrical activity of those neurons to be driven or silenced by light. When these opsins are expressed in the lipid membranes of specific neurons and subsequently illuminated, the resulting ion transport changes the electrical potential of the neurons, and results in the targeted neurons being either activated or silenced in response to light, depending upon the identity of the ion being transported.

LIGHT-ACTIVATED ION CHANNELS

Bacteriorhodopsin, discovered in the early 1970s in the archaeon *Halobacterium salinarum*, pumps protons out of cells in response to green light, supporting energy production in this organism ❶. In the late 1970s, the related molecule halorhodopsin, an orange-light-driven inward chloride pump ❷, was discovered in the same organism. And in the early 2000s, the opsins that drive phototaxis in the green alga *Chlamydomonas reinhardtii*, channelrhodopsins, were found to be light-gated cation channels that, when illuminated, let positively charged ions (such as H+ and Na+) pass into cells ❸. When heterologously expressed in neurons, light-driven outward proton pumps and light-driven chloride pumps enable optical silencing of neural electrical activity, and light-driven cation channels enable optical activation of neural activity—just what is needed to achieve precision control, using light, of the electrical activity of specific neurons.



KENNETH EWARD FOR THE SCIENTIST, JULY 2011