Protein involved in temperature entrainment of brain for circadian clock in fruit fly identified

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Fruit fly. Credit: John Tann/Wikipedia

(Phys.org)—A team of researchers from institutions in the U.K. and Switzerland has identified a protein that is heavily involved in entrainment in fruit fly brains as part of coordinating the circadian clock. In their paper published in the journal *Nature*, the team describes how they engineered mutant flies to express differing amounts of the protein Ionotropic Receptor 25a, aka, IR25a and then tested the ability of the flies to adjust to light and temperature fluctuations. François Rouyer and Abhishek Chatterjee with Institut des Neurosciences Université Paris-Sud, offer a News & Views piece on the work done by the team in a companion piece published in the same journal edition.

As most are aware, the circadian clock allows organisms to adjust their biological processes to the day-night cycle. Prior research has shown, as Rouyer and Chatterjee point out, that the clock is most heavily influenced by changes in light and temperature, but just how this occurs is still not well understood. To learn more, the researchers looked at the fruit fly, because of its simpler biology. Prior research with the tiny flies has shown that their circadian clock works in two ways—their outer organs respond directly to changes in light and temperature and their brains respond indirectly. The researchers set out to learn more about the indirect means by which the brain is caused to adjust, a process known as entrainment.

Scientists have known for some time that IR25a plays a role in odor reception in fruit flies, and because it interacts with the Nocte protein (the expression of which is known to be involved in the development of organs that respond to light and temperature), the researchers suspected it may play a role in brain entrainment as well. To find out they engineered fruit flies that lacked the protein and then subjected them (and non-mutant control groups) to tests that involved both large and small light and temperature fluctuations. Their results showed that the mutant flies were still able to modify their clocks when the variations of either were large, but not when the temperature variations were small, suggesting that IR25a was necessary for adapting to such changes. The team also looked at the oscillations of the proteins that are known to make up the circadian clock in the mutant flies and found that they had become defective during small variation temperature changes.

The findings by the team suggest that IR25a plays a key role in entrainment in the brains of fruit flies for small temperature fluctuations.

More information: Chenghao Chen et al. Drosophila Ionotropic Receptor 25a mediates circadian clock resetting by temperature, *Nature* (2015). DOI: 10.1038/nature16148

Abstract

Circadian clocks are endogenous timers adjusting behaviour and physiology with the solar day. Synchronized circadian clocks improve fitness and are crucial for our physical and mental well-being3. Visual and non-visual photoreceptors are responsible for synchronizing circadian clocks to light, but clock-resetting is also achieved by alternating day and night temperatures with only 2–4 °C difference. This temperature sensitivity is remarkable considering that the circadian clock period (~24 h) is largely independent of surrounding ambient temperatures. Here we show that Drosophila Ionotropic Receptor 25a (IR25a) is required for behavioural synchronization to low-amplitude temperature cycles. This channel is expressed in sensory neurons of internal stretch receptors previously implicated in temperature synchronization of the circadian clock9. IR25a is required for temperature-synchronized clock protein oscillations in subsets of central clock neurons. Extracellular leg nerve recordings reveal temperature- and IR25a-dependent sensory responses, and IR25a misexpression confers temperature-dependent firing of heterologous neurons. We propose that IR25a is part of an input pathway to the circadian clock that detects small temperature differences. This pathway operates in the absence of known 'hot' and 'cold' sensors in the Drosophila antenna, revealing the existence of novel periphery-to-brain temperature signalling channels.