Research Roundup

Transcribed in synchronicity

The brain’s clock is actually an assembly of individually cycling cells, according to results from Shun Yamaguchi, Hitoshi Okamura (Kobe University, Kobe, Japan), and colleagues. But the discrete clocks can work as one because they are synchronized by electrical impulses.

Our internal clock, which controls circadian behaviors and physiology, is a circuitry of many thousands of neurons in the brain called the suprachiasmatic nucleus (SCN). The Kobe group looked at communication within this circuitry in cultured brain slices of transgenic mice using a fluorescent reporter of transcription of a central clock gene, Period (mPer1). They found that mPer1 transcription cycled in nearly every neuron in the SCN. Transcription occurs independently in each cell, and yet in all cells the transcriptional peaks were synchronized: mPer1 levels were high in the day and low at night. The only variation was a dorsal-to-ventral wave, with dorsal regions peaking a few hours earlier. The function of the wave is unclear but may relate to the fact that portions of the SCN talk to different areas of brain.

The synchronized gene oscillation is controlled by neuronal activity. Blocking Na⁺-dependent action potentials desynchronized the SCN, thus producing some cells with day and some with night mPer1 peaks. But synchronization reasserted itself automatically in the neurons—resumption of action potentials returned the organized oscillations to the SCN.

The results mean that the SCN must be reading out as a sum of its parts to “announce circadian time to the rest of the organism,” says Okamura. In the future, he would like to define the circuits that mediate both coordination within the SCN and communication with peripheral clocks.

Reference: Yamaguchi, S., et al. 2003. Science. 302:1408–1412.

Auxin auxin everywhere

Unlike we mammals, plants develop new organs throughout their lifetime. In the face of environmental change, this ability is important for their survival, as plants must “adapt developmentally rather than grow legs and run away,” according to Jirí Friml (Universität Tübingen, Germany). To adapt, plants take advantage of cells that can change their fate. If nutrient content in the soil is favorable, for example, growth of the main root slows, and some of its cells proliferate and differentiate into the multiple cell types that make up lateral roots. At the tip of shoots, groups of plant stem cells called meristems initiate leaves or shoots depending on environmental conditions. Reproductive organs are also formed postembryonically.

Now, Friml, Eva Benková, and colleagues show that initiation of all of these varied organs is due to the same plant hormone. “We’re now starting to understand how auxin can do all these things,” says Friml. “You can get a flower or a leaf or a root with the same auxin and the same transport system.”

The authors show that auxin concentrates at sites where these new organs will form. The auxin gradient is established by a family of polarly localized proteins, known as PINs, that are involved in cell-to-cell auxin transport. Auxin is normally transported from the tip of a plant to its roots to maintain the apical–basal growth axis. But the authors see that, during organ formation, the polarity of PIN localization changes to redirect some of the auxin flow. And where new auxin pools accumulate, new organs form. PIN mutants that disturb auxin flow are deficient in organ initiation.

What the totipotent cells become in response to auxin is influenced by the regulatory genes they express before auxin arrives. Thus, the developmental or environmental cues need only change PIN localization to spur whatever growth or adaptive response is needed.

Reference: Benková, E., et al. 2003. Cell. 115:591–602.