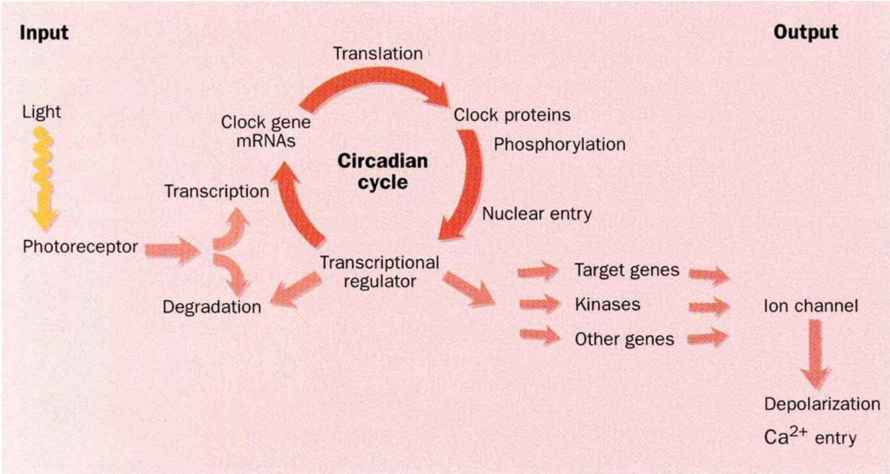

Possible control of the output of circadian rhythms by a transcription–translation loop oscillator — according to this proposal, output would be regulated by a circadian rhythm in expression of target genes such as those encoding kinases, ion channels and other regulatory elements.

stimulated adenylate cyclase activity at night. All of this suggests that the circadian clock machinery in chick pineal cells controls melatonin synthesis by regulating either cAMP levels or $[Ca^{2+}]_i$ on a circadian basis. How the chick pineal clock regulates these two second messengers remains an open question.

With D'Souza and Dryer's identification of I_{LOT}, one can imagine another scheme of events. Instead of directly regulating components of the cAMP or Ca^{2+} systems, the circadian clock would regulate the expression of I_{LOT} with a nocturnal profile (high at night, low in the day). Because I_{LOT} is a nonselective cation channel, pinealocytes would be more depolarized at night, and Ca^{2+} would enter the cell through both I_{LOT} and voltage-sensitive calcium channels. The elevation of $[Ca^{2+}]_i$ could then activate Ca^{2+}/calmodulin-stimulated adenylate cyclase (type I) and lead to an elevation in levels of intracellular cAMP. The joint increase in $[Ca^{2+}]_i$ and cAMP would then optimally stimulate NAT and melatonin synthesis at night. Such a rhythm of Ca^{2+} influx could provide one of the first examples of how the circadian oscillator mechanism can signal its output to the rest of the cell.

D'Souza and Dryer's results are of significance not only in providing a mechanism for circadian output in chick pineal cells in particular, but also in offering insight into a more general mechanism for other systems (especially neural circadian pacemakers such as the mammalian suprachiasmatic nucleus, retinal oscillators and invertebrate circadian systems). According to this view, the transcriptional regulation and expression of a channel on a circadian basis would provide an attractive mechanism for a transcription–translation loop oscillator to regulate the output of a neural circadian pacemaker cell by modulating either membrane voltage or excitability (see figure).

Obviously, the discovery of I_{LOT} creates the immediate opportunity for characterizing it at the molecular level and cloning it. In addition, the mechanism by which the activity of I_{LOT} is regulated by the clock mechanism will be of much interest. Is I_{LOT} activity regulated primarily by phosphorylation, or by its level of expression? If I_{LOT} expression is regulated, does the circadian transcription–translation loop oscillator system (hypothesized to exist in vertebrates as well as *Drosophila* and *Neurospora*) control the transcription of the I_{LOT} gene as a consequence of the negative autoregulatory feedback loop, or are other steps interposed? Whatever the answers, they should be interesting — there's clearly I_{LOT} to do! □

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DAEDALUS

Loaded crystal

THE traditional moderator for a nuclear reactor is graphite. Diamond, or even C_{60}, might be better, but are too expensive. But Daedalus likes the idea of exposing diamond to slow neutrons, for the free neutron is unstable. In a few minutes, it decays to a proton and an electron — a potential hydrogen atom. Now the diamond lattice is a web of carbon cages, each of three cyclohexane 'chairs' back to back, and enclosing a cavity about 0.5 nm across. A hydrogen atom would be a snug fit in such a cavity. So Daedalus reckons that in a flux of lethargically slow neutrons, a diamond would gradually fill up with hydrogen atoms. Each would be trapped in its carbon cage and unable to get at its neighbours.

The product, hydrogen-intercalated diamond (or 'Hidi'), would be a most intriguing substance. For a start, it would probably be the most rigid material known — superior even to diamond itself. The close-fitting hydrogen atoms would stiffen its lattice dramatically. Its refractive index would also exceed that of diamond. But as a gemstone it would have a serious drawback: it would be highly explosive. For atomic hydrogen is the most energetic substance known; its chemical energy is some 40 times that of TNT. If roughly handled, Hidi would explode to methane and amorphous carbon with appalling violence.

With luck, the trapped hydrogen atoms might be induced to combine peacefully. Gentle heat treatment might allow them gradually to 'hold hands' through their carbon cages, going to stable dihydrogen molecules. Dihydrogen-intercalated diamond, Dihidi, would be quite stable.

Hidi might also be stabilized by a magnetic field. The unpaired electron on each trapped hydrogen would give Hidi an unprecedented paramagnetic spin density. By aligning all their spins, the field would prevent the electrons from bonding. Indeed, they would generate a field strong enough to keep themselves aligned without further aid. So Hidi could be magnetized to a transparent and amazingly strong permanent magnet, still capable of exploding, but far more stable.

Hidi will be vastly expensive. But Daedalus recalls that hydrocarbon vapour passed over a suitable hot surface can deposit thin-film diamond. The film always contains hydrogen; indeed, atomic hydrogen is a crucial catalyst in the reaction. Could the process be tweaked to deposit Hidi? If so, it might become cheap enough to employ in magneto-optic modulators, micro-motors, thin-film inductors and magnetic limpet mines. Dihidi would be ideal for jewellery, lenses and ultra-high-strength reinforced laminates.

David Jones