product of the *Suppressor of Hairless (Su(H))* gene. The Su(H) protein is closely related to a mammalian DNA-binding protein called RBP-Jκ, which is necessary for immunoglobulin gene rearrangements[6] and expression of MHC class I genes[7], and to mediate the transactivation properties of the Epstein–Barr virus protein EBNA2 (refs 8–10). The DNA-binding specificity of RBP-Jκ has been established[11], and *E(spl)* and *HES-1* genes contain target sequences for RBP-Jκ and, by analogy, presumably Su(H), suggesting that Su(H) is the transcription-factor endpoint in the signal transduction pathway in response to Notch activation.

In an attempt to understand the Notch signalling pathway in mice, Jarriault *et al.*[1] studied the regulation of the *HES-1* gene. The authors show that expression of RBP-Jκ either alone or in the presence of full-length Notch cannot stimulate *HES-1* transcription. However, it has been previously shown that removal of the transmembrane domain of Notch leads to constitutive activation in *D. melanogaster* (reviewed in ref. 2). Equivalent truncations of mammalian forms of Notch can inhibit myogenesis[3,4], and are associated with several neoplasias[12,13]. These truncated forms localize to the nucleus, and in the case of myogenesis that event is essential for function[3].

When Jarriault *et al.* tested truncated forms of Notch they found that they strongly stimulated the *HES-1* promoter, in a manner that depended on the binding of RBP-Jκ. Activated Notch cannot directly bind to DNA, but forms a tertiary complex with RBP-Jκ and DNA through a stable interaction between the two proteins. So it seems the RBP-Jκ functions as a docking protein that directs the activated Notch to promoter targets, eliminating the need for intermediate factors (see figure). One possible mechanism for the activation of Notch invokes a conformational change induced by ligand binding that exposes the intracellular domain to a protease. What remains to be provided is unambiguous evidence that membrane-bound Notch is processed in response to ligand binding.

The simplicity of this signal transduction pathway suggests that it may be very ancient. This is supported by the pleiotropic nature of Notch function, and the conservation of the pathway components from flies to mammals. Although there are many examples of ligands that can freely diffuse into cells and directly activate transcription factors (steroids and their receptors for example), there are also some precedents for signal transduction pathways that lack intermediates between the membrane and target genes. Sterol regulatory element-binding protein 1 exists in membrane-bound form (albeit bound to the nuclear membrane and the endoplasmic reticulum) and yet can respond to depletion in sterols by undergoing proteolytic cleavage to yield a soluble product that can enter the nucleus and stimulate transcription from specific promoters[14]. Even more dramatically, lactoferrin released from secretory granules of neutrophils in response to infectious pathogens can cross the plasma membrane and migrate to the nucleus of nearby cells, thereby activating specific transcription[15].

It remains to be seen how common such simple pathways are. Although they suffer the disadvantage relative to the common protein kinase cascades of not being amplificative, they offer the advantage that they are not subject to cross-talk and interference. They might therefore offer the exquisite specificity that may be vital in some circumstances, particularly in early development. □

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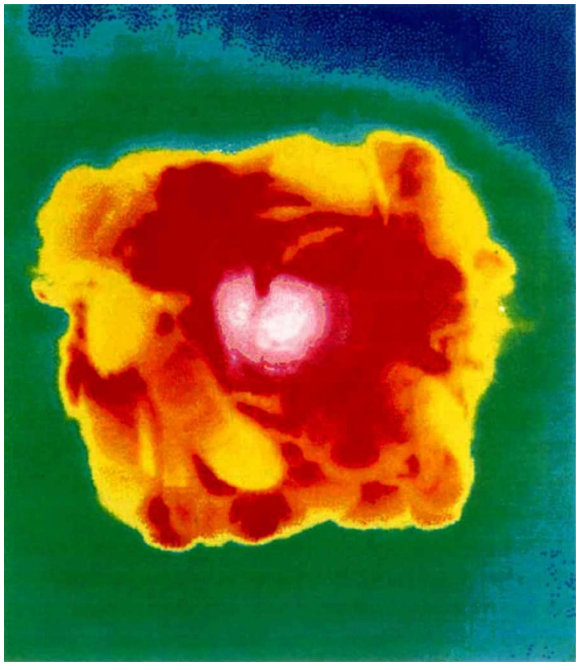
1. Jarriault, S. *et al. Nature* **377**, 355–358 (1995).
2. Artavanis-Tsakonas, S., Matsuno, K. & Fortini, M. *Science* **268**, 225–232 (1995).
3. Kopan, R., Nye, J. S. & Weintraub, H. *Development* **120**, 2385–2396 (1994).
4. Nye, J. S., Kopan, R. & Axel, R. *Development* **120**, 2421–2430 (1994).
5. Sasai, Y., Kageyama, R., Tagawa, Y., Shigemoto, R. & Nakanishi, S. *Genes Dev.* **6**, 2620–2634 (1992).
6. Furukawa, T. *et al. J. biol. Chem.* **266**, 23334–23340 (1991).
7. Brou, C. *et al. Genes Dev.* **8**, 2491–2503 (1994).
8. Zimber-Stobl, U. *et al. EMBO J.* **13**, 4973–4982 (1994).
9. Henkel, T., Ling, P. D., Hayward, D. & Peterson, M. G. *Science* **265**, 92–95 (1994).
10. Grossman, S. R., Johannsen, E., Tong, X., Yalamanchili, R. & Kieff, E. *Proc. natn. acad. Sci. U.S.A.* **91**, 7568–7572 (1994).
11. Tun, T. *et al. Nucleic Acids Res.* **22**, 965–971 (1994).
12. Ellisen, L. W. *et al. Cell* **66**, 649–661 (1991).
13. Jhappan, C. *et al. Genes Dev.* **6**, 345–355 (1992).
14. Wang, X., Saito, R., Brown, M. S., Hua, X. & Goldstein, J. L. *Cell* **77**, 53–62 (1994).
15. He, J. & Furmanski, P. *Nature* **373**, 721–724 (1995).

ANIMAL BEHAVIOUR

Neighbourhood watch



THIS picture illustrates one of the more spectacular weapons used in the unceasing war between Japanese giant hornets (*Vespa mandarinia japonica*) and honeybees (*Apis cerana japonica*), as graphically described by Masato Ono and colleagues of Tamagawa University on page 334 of this issue. It is a thermogram of a hornet being engulfed and baked to death by a ball of angry bees.

What has the hornet done to incur such displeasure? Japanese hornets are insatiable predators of smaller bees and wasps, raiding nests for larvae and pupae which they carry off to feed their own young. Ono and colleagues report that a raiding party of as few as 20 hornets can kill as many as 30,000 bees in three hours, laying waste to entire hives. The hornets can then occupy the hive at their leisure, picking off the defenceless larvae. Introduced European honeybees (*Apis mellifera*) are easy prey to this take-no-prisoners strategy, but native bees have evolved suitably drastic countermeasures.

Bees are alerted when hornets on reconnaissance missions stop at hives to mark them with a distinctive pheromone. Unlike European bees, Japanese bees have long been able to decrypt messages in hornets-only code, and lie in wait for the inevitable raid. Individual bees are no match for a hornet in single combat — a coordinated defence is required, and bees are masters at this kind of organization. On sighting a hornet, bee look-outs signal to their colleagues, who lie in wait just inside the entrance to the nest. Should the hornet try and enter, it rapidly disappears within a ball of some 500 bees. The temperature within the ball — as shown in the accompanying picture — rises to about 47 °C, which kills the hornet but leaves the more heat-tolerant bees unscathed.

Henry Gee