SIGNAL TRANSDUCTION

Life in a cold climate

Whereas we respond to the cold by reaching out for our winter woolies to preserve our body temperature, plants and cold-blooded animals align their temperature to that of their environs. Such organisms avoid otherwise fatal injury from freezing temperatures by altering the fluidity of their cell membranes and by inducing molecular chaperones that protect proteins from denaturation. The network of that response to the cold is well studied in plants; however, many potential components of the cold signal-transduction pathway have so far only been identified by mutation, and their molecular basis remains unknown. By cloning one of these genes, *HOS1* (high expression in response to stress), in *Arabidopsis thaliana*, Lee *et al.* have now provided the first molecular characterization of a genetic locus that is involved in cold-regulated signalling in plants.

When the cold sets in, plants take two main courses of action: they raise tolerance to the cold (acclimation) and undergo vernalization — the accelerated flowering brought on by prolonged exposure to low temperatures. A clue to the function of *HOS1* came from looking at *hos1* mutant plants, which have an elevated temperature threshold for activating the cold response. Upon cold treatment, *hos1* plants enhance the induction of both the transcription factor CBF and the downstream cold-response genes that CBF induces; they also flower considerably earlier than wild-type plants, as if they were undergoing constitutive vernalization. Indeed, the expression of the *FLOWERING LOCUS C* gene, a crucial regulator of vernalization, almost disappears in *hos1* mutants. Because of its effects on more than one cold response, *HOS1* is probably quite high up in the signalling pathway that is activated by cold.

Lee *et al.* positionally cloned the *HOS1* gene, and showed that it encodes a novel protein with a variant of the RING-finger motif. This indicates that HOS1 might be involved in the protein ubiquitylation pathway, and the authors speculate that HOS1 might work by promoting the degradation of target proteins that positively regulate the cold response. The localization of the HOS1 protein is also intriguing — a tagged version of the protein is located in the cytoplasm, but accumulates in the nucleus after cold treatment.

All in all, *HOS1* encodes quite a unique molecule. It is the first protein of its type to be involved in cold signalling in any organism. Furthermore, its unique nucleocytoplasmic partitioning — never seen in proteins induced by low temperatures — indicates a simple and effective model for adapting to a changing environment.

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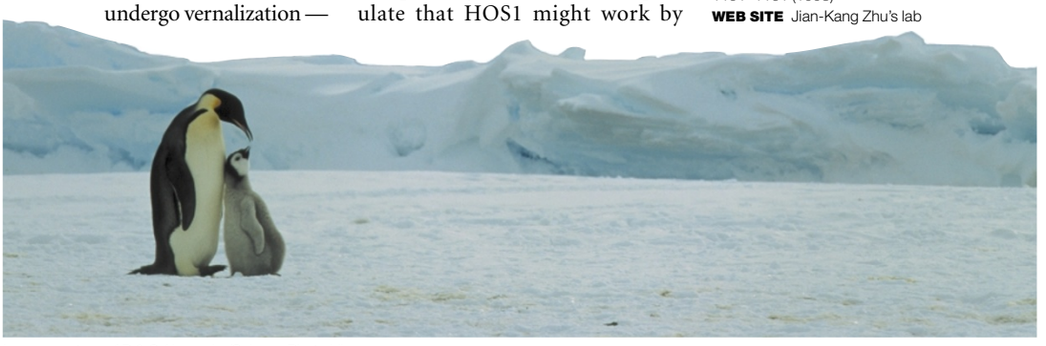

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References and links

ORIGINAL RESEARCH PAPER Lee, H. *et al.* The *Arabidopsis HOS1* gene negatively regulates cold signal transduction and encodes a RING finger protein that displays a cold-regulated nucleo-cytoplasmic partitioning. *Genes Dev.* **15**, 912–924 (2001)

FURTHER READING Ishitani, M. *et al. HOS1*, a genetic locus involved in cold responsive gene expression in *Arabidopsis thaliana*. *Plant Cell* **10**, 1151–1161 (1998)

WEB SITE Jian-Kang Zhu's lab