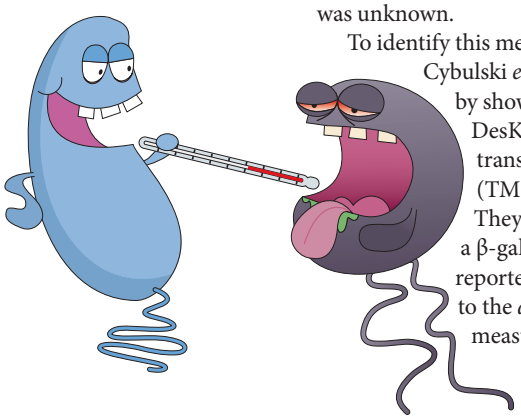
BACTERIAL PHYSIOLOGY

Bacillus takes the temperature

At low temperatures, the fatty acyl chains of the lipids in cell membranes shift from a fluid to a non-fluid arrangement, making the membrane thicker and more rigid. In *Bacillus subtilis*, autophosphorylation of the histidine kinase thermosensor DesK at low temperatures triggers expression of the acyl lipid desaturase Δ5-Des (encoded by *des*), which promotes membrane fluidity to overcome the cold-induced rigidity. However, the mechanism by which this regulator senses temperature was unknown.



To identify this mechanism, Cybulski *et al.* began by showing that DesK contains five transmembrane (TM) domains. They then used a β-galactosidase reporter gene fused to the *des* promoter to measure the kinase activities of DesK deletion variants expressed by *desK*$^-$ cells. They found that a deletion of the first TM domain, TM1, locked the protein into a 'kinase-on' state, causing higher levels of reporter expression than full length DesK at both 37 °C and 25 °C. This indicates that TM1 is vital for the regulation of DesK activity in response to temperature.

Next, the authors sought to clarify the method by which TM1 mediates this activity switch. Fusion proteins containing the kinase domain of DesK and either TM1 or TM5 did not exhibit temperature-dependent kinase activity, but a TM domain consisting of the first half of TM1 and the second half of TM5 (termed the minimal sensor (MS)) fused to the kinase domain restored thermal regulation.

The MS contains three hydrophilic residues near the lipid–water interface. The authors suggest that this motif is buried at lower temperatures, when the membrane is thicker, activating the DesK kinase activity, whereas at higher temperatures the motif is exposed, allowing it to be hydrated and stabilizing the protein in a 'kinase-off' state. Indeed, using the MS–kinase domain fusion incorporated into phosphatidylcholines with fatty acyl groups of differing lengths, the authors showed that a thicker membrane resulted in a higher DesK kinase activity.

This work has uncovered a 'ruler-like' mechanism for assessing temperature according to membrane thickness, which regulates the expression of proteins involved in temperature adaptation. Whether such a mechanisms is conserved in other bacteria remains to be determined.

Lucie Wootton

ORIGINAL RESEARCH PAPER Cybulski, L. E., Martín, M., Mansilla, M. C., Fernandez, A. & de Mendoza, D. Membrane thickness cue for cold sensing in a bacterium. *Curr. Biol.* **20**, 1–6 (2010)