the neck leads from the neck linker to the coiled stalk. The binding of ATP induces a series of conformational changes that position the stepping head forwards[11]; in particular, ATP-driven docking of the neck linker onto the core of the attached head has been suggested to influence the direction of movement and processivity[9,12]. Other models for kinesin stepping include a role for partial unwinding and subsequent recoiling of the neck or coiled stalks.

What about the *N. crassa* conventional kinesin (NcKin)? This is the Ferrari of the kinesin motor family, so its structure and mechanisms might be expected to differ somewhat from its more sluggish relatives. Kallipolitou *et al.*[2] and Song *et al.*[3] provide, respectively, biochemical and structural clues to NcKin's souped-up performance.

One obvious structural feature[3], which contrasts markedly with available structures of rat[13,14] and human[15] conventional kinesins, is that NcKin's neck linker/neck domain appears as a random coil, implying that it is highly mobile (Fig. 1). Furthermore, Kallipolitou *et al.*'s biochemical analyses[2] reveal that artificial NcKin motors that include the catalytic core, the neck linker and the neck fail to dimerize, in contrast to similar constructs of fruitfly kinesin. The neck linker, neck and part of the adjacent hinge domain are all required for NcKin's dimerization, rapid motility and processivity[2]. It seems, then, that NcKin's neck domain has unusual properties. So, too, does its head domain.

Kinesins, myosins and molecular switches known as G proteins, although unrelated in amino-acid sequence, share remarkable structural similarity in their nucleotide-binding pockets, suggesting that they have a similar mechanism of nucleotide hydrolysis[10,12]. The nucleotide-sensing regions are formed by three structural elements, known as the P-loop, switch I and switch II. During nucleotide binding and hydrolysis, the switch regions are mobile, and small movements trigger a cascade of structural alterations in the rest of the protein. As Song *et al.*[3] find, the biggest differences between the *N. crassa* and rat conventional kinesins are in regions implicated in these structural changes — that is, in switch I, switch II and the microtubule-binding surface.

These differences mean that NcKin has a nucleotide-binding pocket that is much more open than that of other conventional kinesins. In particular, loop 9 in the switch I region bends out, making the pocket very wide. Moreover, the nucleotide-dependent displacement of switch I resembles what happens when the G protein Ras binds a factor that accelerates its nucleotide exchange. This suggests that microtubules — which activate ADP release in kinesins — might further accelerate the exchange of ADP for ATP in NcKin. Comparison of NcKin with several other kinesins reveals a direct correlation between the rate of ATP turnover, the speed of the motor, and the openness of the nucleotide-binding pocket[2,3]. The structure of this pocket in NcKin suggests that this motor's fast movement is due in part to rapid ATP turnover, including accelerated ADP/ATP exchange.

NcKin has another unique structural feature that might affect the rate of ATP turnover[3]: it has contacts with the microtubule surface that are not seen in other kinesin structures (Fig. 1). Microtubules consist of long chains of alternating α-tubulin and β-tubulin subunits, and most of the contacts with a conventional kinesin involve β-tubulin's carboxy-terminal part and three structural features of kinesin's switch II region[16]. In NcKin[3], a further structural feature from switch II — loop 11 — also contacts α-tubulin. Loop 11 is also part of the switch II region that forms the nucleotide-binding pocket, so its interaction with α-tubulin probably affects ATP hydrolysis.

Part of NcKin's mobile neck also interacts with microtubules[3], in a way that could explain the increase in processivity seen[17] when extra positive charge is added to the neck, increasing its interaction with tubulin's negatively charged carboxy terminus. Kallipolitou *et al.* suggest[2] that the mobile neck of NcKin may enhance both processivity and rate of movement.

It seems, then, that the high performance of NcKin stems from its unusually wide ATP-binding pocket, its mobile neck and its extra interactions with microtubules. These interpretations will no doubt trigger some dissent. But they should lead researchers to test the effect of a more flexible neck and more open nucleotide-binding pocket on processivity, the rate of ATP turnover and the speed of these splendid molecular machines. ■

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1. http://www.blocks.fhcrc.org/~kinesin
2. Kallipolitou, A. *et al. EMBO J.* 20, 6226–6235 (2001).
3. Song, Y.-H. *et al. EMBO J.* 20, 6213–6225 (2001).
4. Schnitzer, M. J. & Block, S. M. *Nature* 388, 386–390 (1997).
5. Hua, W. *et al. Nature* 388, 390–393 (1997).
6. Hackney, D. D. *Proc. Natl Acad. Sci. USA* 91, 6865–6869 (1994).
7. Ma, Y. Z. & Taylor, E. W. *J. Biol. Chem.* 272, 724–730 (1997).
8. Gilbert, S. P., Moyer, M. L. & Johnson, K. A. *Biochemistry* 37, 792–799 (1998).
9. Rice, S. *et al. Nature* 402, 778–784 (1999).
10. Vale, R. D. & Milligan, R. A. *Science* 288, 88–95 (2000).
11. Schnitzer, M. J., Visscher, K. & Block, S. M. *Nature Cell Biol.* 2, 718–723 (2000).
12. Kikkawa, M. *et al. Nature* 411, 439–445 (2001).
13. Sack, S. *et al. Biochemistry* 36, 16155–16165 (1997).
14. Kozielski, F. *et al. Cell* 91, 985–994 (1997).
15. Kull, F. J. *et al. Nature* 380, 550–555 (1996).
16. Hoenger, A. *et al. J. Mol. Biol.* 297, 1087–1103 (2000).
17. Thorn, K. S., Ubersax, J. A. & Vale, R. D. *J. Cell Biol.* 151, 1093–1100 (2000).
18. http://www.mpasmb-hamburg.mpg.de/ktdock
19. Nogales, E. *et al. Cell* 96, 79–88 (1999).

Daedalus

Extra security

Airline security is something we must all face. Many engineers are making clever scanners and sniffers to check our luggage. But Daedalus wants to reduce the amount of stuff we take in the first place. One proposed scheme reduces the nonsense of 'duty free' purchases. Payment at the departure airport leads to delivery at the destination. Airlines no longer have to carry (and scan) a vast amount of impure alcohol in 'duty free' flight bags. So Daedalus is extending this idea. DREADCO security guards are now examining the bulk luggage to spot common objects that can easily be specified and replicated at the other end.

The main problem is clothing. Casually dressed flyers often carry a smart suit or outfit in their luggage. In principle, the details could be faxed to the other end. The clothing industry has largely perfected the reduction of any suit to a set of numbers, but fashion sadly complicates the choice. Colour, pattern, cut and other subtle variables greatly multiply the items that would need to be held at the receiving airport. DREADCO does not want to take on the fashion industry, but he hopes to nudge it in a socially useful direction. Casual flightwear might be challenged: with luck a standard 'airline suit' would identify the frequent flier to fashionable advantage. A flight-resistant suit or outfit in some old 'wonder fibre' could be revived for this job. Casual flight-creased clothes might become fashionable themselves, but Daedalus admits this is out of his hands.

Another item studied by the security guards is the laptop computer. Many flyers would be glad not to carry this heavy and expensive toy. Even the most ardent key-basher is unlikely to fill a memory insert during a flight. With a standard aircraft computer (including a power supply, like the standard audio system), patrons could insert their memory device for the flight, do their work, and rely on the digital environment at the other end. Indeed, the next generation of portable computers should be designed so that changeable memory can be divorced from keyboard, screen and such standard items. Laptop owners would be pleased to take a mere memory everywhere, and use it to update their machine when they get home.

Other items frequently carried include pens, paper, calculators, cosmetics and toiletries. A standard 'travel pack' could be provided at the destination airport. The saving on security, scanners, and needless carriage should reduce the unavoidable costs of air travel.

David Jones