sex-1 to see an effect in XX embryos. This could be used to argue that *sex-1* is not a critical gene in counting. Yet when *fox-1* function (which, by itself, has a very weak effect) is also removed from *sex-1* homozygous XX embryos, they all die. Therefore, *sex-1* is clearly important in the counting mechanism, although it is obviously not sufficient and requires *fox-1* plus at least one other gene. This makes the story confusing, but not surprising for those of us who work with mice and expect redundancy! Perhaps the other X-linked gene identified by the screen is another missing counting element, with a direct effect on *xol-1*.

The genetics argues that SEX-1 represses transcription of *xol-1*, but does it act directly? To answer this question, Carmi *et al.* devised an ingenious strategy involving transgenic worms, which allowed them to visualize the location of multicopy arrays of the *xol-1* promoter within the nucleus. Using an antibody to SEX-1 they showed that the endogenous protein specifically co-localized with these promoter arrays. These results indicate that SEX-1 associates with chromatin that contains *xol-1* DNA, consistent with a direct regulatory interaction.

The authors show that SEX-1 is mainly required zygotically, as predicted, to repress only the sex-specific transcription of *xol-1*, which occurs maximally during gastrulation in the early embryo. But how does SEX-1 act as a repressor? Some nuclear-hormone receptors repress transcription in a ligand-dependent manner³, but SEX-1 is unlikely to act in this way because its ligand-binding domain is predicted to fold differently from those of known ligand-dependent nuclear-hormone receptors. Perhaps it folds in such a way that it constitutively recruits co-repressors, thereby silencing transcription. Indeed, Rev-Erb, which is closely related to SEX-1, lacks the ligand-dependent transcriptional activation domain AF-2, and acts as a repressor — possibly by competing for DNA-binding sites and inhibiting activation by other nuclear-hormone receptors⁴. Some repressors show differences in the DNA-binding domain and may act by forming heterodimers with other, activating nuclear-hormone receptors, again preventing them from binding DNA. Alternatively, they may bind to these other nuclear-hormone receptors and recruit co-repressors to the site of transcription. It is interesting to speculate that *C. elegans* may have another activating nuclear-hormone receptor, present at the same time as SEX-1, that activates *xol-1* transcription and is antagonized by SEX-1.

But how does the *xol-1* promoter distinguish between one or two copies of X-chromosome counting elements such as SEX-1? Some transcription factors can work as either activators or repressors in a concentration-dependent manner. For example, the zinc-finger-type transcription factor Kruppel,

which is important for patterning of the early *Drosophila* embryo, is present in a concentration gradient. It represses target sequences at high concentrations, when it forms homodimers, yet activates those same sequences at lower concentrations when it is present as monomers⁵. However, this may be a special case and it is, perhaps, easier to imagine that SEX-1 competes against other transcription factors that work as activators. The autosomal mutations identified in the original screen could correspond to gain-of-function mutations in such genes, although it is more likely that these are recessive mutations in co-factors required for SEX-1 function.

Carmi *et al.*¹ comment on an intriguing parallel with mammalian sex determination, where a nuclear-hormone receptor, DAX1, represses male development in a dose-dependent manner⁶. The *Dax1* gene is also X-linked, but there is no evidence that it is involved in any X-chromosome counting mechanism (which is not linked to sex determination in eutherian mammals). In fact, *Dax1* is autosomal in marsupials, where some sexual characteristics — such as the choice between making a pouch or a scrotum — are determined by X-chromosome dosage⁷. DAX1 seems to work against the action of SF1, which is an activating nuclear-hormone receptor. However, it also behaves antagonistically to SRY, the product of the Y-linked testis-determining gene⁶. Presumably SRY and SF1 act in a complex, to promote the expression of critical secondary testis determinants, and high levels of DAX1 can interfere with this. So, to understand how SEX-1 functions in *C. elegans*, it is now especially important to define the other transcription factors that act on the *xol-1* promoter.

There is one other intriguing connection between SEX-1 and DAX1. Followers of *Star Trek* and its offshoot *Deep Space 9* will know that one of the characters is Commander Jadzia Dax, who represents a species called a Trill. She comprises the host body of a young woman, Jadzia, and a 300-year-old symbiont life form named Dax, which happens to be a worm. Obviously *C. elegans* with a compatible sex-determining mechanism. □

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1. Carmi, I., Kopczynski, J. B. & Meyer, B. *Nature* **396**, 168–173 (1998).
2. Nicoll, M., Akerib, C. C. & Meyer, B. *Nature* **388**, 200–204 (1997).
3. Forman, B. M. *et al.* *Nature* **395**, 612–615 (1998).
4. Harding, H. P. & Lazar, M. *Mol. Cell. Biol.* **15**, 4791–4802 (1995).
5. Sauer, F. & Jackle, H. *Nature* **361**, 454–457 (1993).
6. Swain, A. *et al.* *Nature* **391**, 761–767 (1998).
7. Pask, A. *et al.* *Genomics* **41**, 422–426 (1997).

Daedalus

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Modern information-storage systems are highly wonderful. But the most capacious of them (disks and tapes) still depend on mechanical scanning. Daedalus is dreaming up a read-only high-volume storage system with no moving parts.

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To read the fibre, Daedalus will simply send a short intense optical pulse down it. As the pulse passes each 'bit' of data, it will generate a fluorescent pulse, which will travel back along the fibre to a detection unit at the pulse-injector. The returning pattern of fluorescence pulses contains all the information in the fibre.

In this simple design, the loss of energy to fluorescence would rapidly damp out the most intense interrogation-pulse. But fibres these days can have optical gain. An erbium-doped fibre acts as a distributed laser; illuminated with a suitable pump radiation, it actively amplifies the pulses travelling along it. Indeed, the data-points in the new fibre might even be encoded as spots of erbium doping.

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David Jones