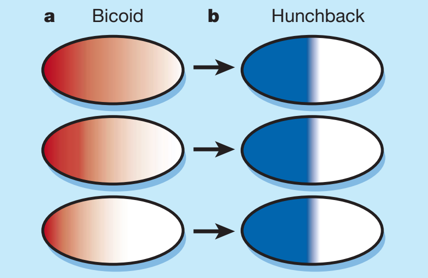

Figure 1 **Filtering out noise in development.** a, **Houchmandzadeh *et al.*[1] find that, within a group of wild-type fruitfly embryos, the profile of the Bicoid gradient (red) can vary significantly (exaggerated somewhat here).** b, **However, the profile of Hunchback expression (blue) is relatively precise and constant, even though Bicoid regulates Hunchback expression. In fact, the addition of extra copies of the Bicoid gene does lead to shifts in the Hunchback pattern[3] (not shown). But Houchmandzadeh *et al.* find that these shifts are not as great as might be expected if the Hunchback pattern depended solely on Bicoid concentration.**

embryos, Houchmandzadeh *et al.*[1] found that the Hunchback boundary — at the level of both mRNA and protein — is very precise, showing far less variation than the Bicoid gradient (Fig. 1). Normalizing for egg length, about two-thirds of the embryos showed a precise Hunchback boundary in a range that spanned only about 1% of the total egg length, a precision equivalent to the width of a single nucleus. Furthermore, unlike the Bicoid gradient, the Hunchback boundary position directly correlates with egg length, suggesting that information about proportion is included in the Hunchback expression pattern.

This observation, that the precision of the wild-type Hunchback boundary is unaffected by variations in the Bicoid gradient, seems to be at odds with the finding[3] that increasing the number of maternal Bicoid transgenes leads to posterior shifts in the Hunchback boundary. However, when Houchmandzadeh *et al.* repeated the transgene experiments they found that the shift in Hunchback expression was clear, but smaller than expected. When they raised embryos at different temperatures they found that, although the Bicoid protein profile at equivalent developmental stages is significantly altered by temperature changes, the position of the Hunchback boundary is almost unaffected. The implication is that this boundary is subject to correction mechanisms that filter out variability in the Bicoid gradient, as well as a mechanism that imparts scaling information.

Houchmandzadeh *et al.* conclude that the precision of the Hunchback boundary is independent of Bicoid. So what does regulate the Hunchback boundary? The most obvious candidates are other embryonic gap genes. The authors show, however, that eliminating any one of these genes has little or no effect on the absolute position of the Hunchback boundary and, more importantly, has no effect on the boundary's precision. The authors screened 80% of the fruitfly genome by eliminating entire chromosomes, and still found no embryonically expressed gene that disrupts the precision of the Hunchback boundary.

The most obvious maternally derived candidates — the posteriorly focused gradient of Nanos protein, and maternal Hunchback — affect the position of the embryonic Hunchback boundary but not its precision[1]. But Houchmandzadeh *et al.* identified specific mutant forms of the maternal Staufen gene that did affect this precision. Staufen is known to affect the localization of maternally derived mRNAs at both embryonic poles[4], but Houchmandzadeh *et al.* show that the effect of Staufen on the Hunchback boundary appears to be independent of an effect on Bicoid localization.

These results have several implications. First, the obvious embryonic candidates for regulating the Hunchback boundary are not solely responsible for its precision. So theories proposing that interactions between gap genes are responsible for generating precise expression boundaries may be missing a crucial component. The identification of mutant forms of the Staufen gene that affect precision might provide the key to unravelling the mechanism.

Second, it is thought that the Bicoid gene evolved relatively recently, within the Dipterans (the large group of insects that includes *Drosophila*). But evolutionarily distant insects such as grasshoppers also show anterior domains of Hunchback expression[5] that are presumably wholly independent of Bicoid. So maybe the genetic system that produces precise Hunchback boundaries in *Drosophila* will give us clues to the regulation of Hunchback in these other insects.

Finally, the phenomenon of noise filtration may be a general property of morphogenetic systems, made necessary by their inherent susceptibility to perturbations. Indeed, studies[6] of the morphogen Dpp in the *Drosophila* wing disc indicate that the concentration gradient of Dpp can differ from its 'activity' gradient (its output). So mechanisms that correct and modulate morphogen gradients may be common to, and required for, the precise, robust and elaborate patterning of different developmental fields. ■

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Daedalus

Fresh flavours

Our past as hunters and gatherers has left us with distinctive taste in food. We like it fresh. An animal or vegetable that was living and growing only a few minutes ago has quite a different taste to one that has been stored. Many foods, from sprouts to fish, lose their pleasant flavour very quickly. Even the British diet would be delightful if it were fresh. But in bulk farming, a large amount of food is harvested at the same time and is then stored. This is clearly at variance with our animal nature. But this type of farming is highly efficient, and so has sadly become a fact of life.

While an animal or vegetable is alive, its immune system protects its evanescent compounds or regenerates them. When it dies, all this stops. Bacterial attack, crosslinking and decomposition all start at once. Freezing, that brutal attempt to stop the clock, seems to work best with the bulk components. One food-processing company claims to freeze its vegetable product within 2 hours of picking it, hoping to trap the brief trace compounds of freshness while they last. Daedalus also recalls how the makers of instant coffee put a key flavour volatile in the space at the top of each jar, so the illusion of the real thing survives at least for a moment. DREADCO biochemists are now studying the trace compounds present in fresh foodstuffs.

This delicate and tricky work must be done quickly, using food picked or killed and transported to the lab with equal rapidity. For each foodstuff, Daedalus hopes to identify or synthesize just those elusive volatiles that restore the illusion of freshness to the long-stored product. Farming, that dreary but efficient business, will at last be matched to our instinctive nature.

Standard condiments, such as salt, pepper or monosodium glutamate, are 'amplifiers': they exaggerate whatever taste the food has at the time. By contrast, each DREADCO 'elixir of freshness' will restore the food's own character, so it tastes fresh again. Like pepper, it will be added at the table rather than in the pot. It may take the form of an inert tasteless powder with an added volatile, or a spray-can of liquid or vapour. Daedalus cannot guess how many will be needed. In the worst case, every foodstuff will need its own elixir. But with luck, only a few elixirs will be needed to revive that elusive sense of freshness — one for meat, say, and one for vegetables. Even calorie-counting, vegetarianism and other dietary extremes will gain new pleasure and respectability.

David Jones