may not disrupt the process.

Now, however, Godt and Tepass and González-Reyes and St Johnston have the long-sought in vivo evidence. Both groups studied follicles of the fruitfly (Drosophila melanogaster) ovary, which contain two types of germline cell, the oocyte and its attendant nurse cells. These form a compact package, surrounded by a single layer of epithelial follicle cells. The oocyte is nestled next to the follicle cells at the posterior pole of the follicle, and proper positioning is a key step in setting up anterior–posterior polarity of both the egg and the embryo that develops from it. Thus, we have a small-scale model of morphogenesis—how does the oocyte know to move to the posterior pole?

The solution started with a simple observation. Although all germline and follicle cells express E-cadherin, the oocyte and the posterior follicle cells express higher levels of it than the nurse cells and other follicle cells. This suggested that, as Steinberg and Takeichi observed in cultured cells, the oocyte might assume a posterior position to maximize its association with the follicle cells that express the highest levels of E-cadherin. (The anterior follicle cells also express increased levels of E-cadherin, but the oocyte may normally never come into contact with them.)

Godt and Tepass, and González-Reyes and St Johnston, manipulated E-cadherin levels to test this hypothesis. First, building on observations by others, both groups found that when E-cadherin was removed from the oocyte and nurse cells, the oocyte was no longer invariably posterior. Instead, it was positioned more or less randomly. They also found that the oocyte adopted a random position if expression of E-cadherin was lost specifically in the follicle cells. Thus, adhesion between germline and follicle cells is essential for positioning. By itself, this did not prove that cadherins are instructive, so both groups generated ‘mosaic’ follicles, in which some follicle cells express cadherin and others do not. In almost all cases, the oocyte moved to be in contact with cadherin-expressing follicle cells (Fig. 1). Even more strikingly, Godt and Tepass found that when the follicle cells expressed different levels of cadherin, the oocyte preferentially moved next to those cells that expressed the highest levels.

The new data provide a direct and dramatic confirmation of Steinberg’s theory: first, that morphogenetic movements in vivo can be driven by differences in cell adhesion; and second, that differences in the level of a single cell-adhesion molecule are enough to mediate cell sorting in an intact tissue. It is time to rewrite the textbooks, and for cell and developmental biologists to have a party to celebrate the confirmation, in vivo, of a venerable theory.

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**Isotope astrophysics**

**Sorting stardust**

Sara S. Russell

Certain meteorites, called primitive chondrites, contain microscopic diamonds (Fig. 1, overleaf). These diamonds are of astrophysical as well as mineralogical interest, because they are thought to have formed before the Solar System condensed. In a new experiment — whose results were reported at a meeting in Dublin in July — two classes of pre-solar diamond have been distinguished, implying that they come from at least two different environments.

We believe that these diamonds may be pre-solar because of their peculiar isotopic composition. The anomalous isotope ratios of trace elements in the crystals imply that they cannot have formed from the well-mixed material that makes up the bulk of the Solar System. Instead, at least some of the diamonds must have formed around other stars. They survived collisions and bombardment by cosmic rays in the interstellar medium and in the contracting disk of the early Solar System, and remain preserved in some chondrites. Those that fall to Earth and are collected provide an opportunity to study stardust in the laboratory.

So where exactly do the diamonds form? Two possible places are the atmospheres of red-giant stars, and the remnants of supernova explosions. The isotopic composition and chemistry of a given diamond grain should hold clues to the formation site, but because of the tiny size of the diamond crystals (their average diameter is only 1.6 nm), they cannot be isotopically analysed one by one — only their bulk properties can be determined. In this respect, they differ from other identified pre-solar crystals, such as graphite, silicon carbide and corundum, which are large enough to analyse individually, and whose origins are consequently better understood.

For these reasons, little progress has been made in divining the origins of the diamonds. It is not known how many sources contributed to the diamond population, or
form such material, but two together could: the lighter xenon isotopes are formed during the 'p' process, and the heavier during the 'r' process, two types of nuclear reaction that are known to happen in supernovae.

The two processes occur in different layers of the exploding star, so in theory heavy-and light-xenon-bearing material should be separable in the laboratory. Nevertheless, more than 20 years of analysis has not allowed us to untwine these two signatures, indicating either that these diamonds are a single population that formed from isotopically homogeneous xenon, or that the different populations are very well mixed.

The experiment reported in Dublin finally appears to have succeeded in separating the two components (A. Meshik and colleagues, Washington Univ., St Louis). A laser was fired at a collection of diamonds spread out thinly on sapphire plates, and the evolved gases were collected. This technique may owe its success to the fact that some diamonds contain more nitrogen than others. Nitrogen-enriched diamonds tend to be coloured, and so these crystals will absorb more laser light, heat up, and emit their noble gases more efficiently than clear, nitrogen-poor diamonds.

The gases evolved in the latest experiment, presumably mostly from nitrogen-rich diamonds, contained less of the lighter xenon isotopes than bulk diamonds. This result implies that heavier xenon is preferentially located in nitrogen-rich grains and lighter in nitrogen-poor grains, suggesting the existence of two populations of supernova diamonds. These data confirm our understanding of nucleosynthetic processes occurring in supernovae, and suggest that the expanding shells of the supernovae involved did not mix well, at least until they had cooled enough to allow solid material to condense.

If the result is confirmed, isotopic and chemical analyses of elements other than xenon will be required to investigate the characteristics of the separated components thoroughly. This will constrain the nucleosynthetic processes occurring in specific regions of the supernovae responsible. One outstanding issue that may be resolved by these future experiments is the formation of the heavy-xenon-enriched component.

The isotope abundances of this component appear to require condensation of solids just hours after the explosion, contradicting observations that dust only begins to form about a year after the supernova burst.

The new result is grounds for hope that these questions can be answered. Meteoritic diamonds may be forever, but the mysteries surrounding their origins might not last quite so long.

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**Behavioural genetics**

Worming out social secrets

Some species of the nematode worm (*Caenorhabditis elegans*) are sociable diners, clumping together to share a meal, yet others are more solitary. Why? According to a report by de Bono and Bargmann (Cell 94, 679–689; 1998), these differences can be explained by a change of just one amino acid in a putative neuropeptide receptor.

The authors analysed mutations that cause solitary worm strains to form social aggregates. Solitary worms browse alone on bacterial lawns, forming clumps only when food is scarce. But the mutants always swarm together and show other behavioural differences, such as a tendency to burrow into the agar medium.

All of the mutations that caused worms to turn — from solitary to sociable — mapped to the gene for NPR-1, a seven-transmembrane-domain receptor. The NPR-1 protein closely resembles neuropeptide-Y receptors, which, in humans, are found throughout the brain. Indeed, de Bono and Bargmann detected *C. elegans* NPR-1 in neurons of the head, ventral cord and preanal ganglion (pictured).

The authors next studied the np-1 gene in 15 wild strains of *C. elegans*. Whereas the solitary worms had a valine residue at position 215 of the NPR-1 chain, their sociable counterparts used phenylalanine. This residue is thought to affect the specificity of NPR-1 signalling through guanine-nucleotide-binding (G) proteins, so it may help to transduce the signals that drive the worms to clump.

Could changes in neuropeptide pathways be a widespread mechanism for altering nematode behaviour? Another study by Nelson *et al.* (Science 281, 1686–1690; 1998) suggests that they could. These authors disrupted fpr-1, a member of the FMRFamide-related neuropeptide gene family in *C. elegans*, and found behavioural defects in the worms, including a lack of coordination and hyperactivity.

Nematodes probably aggregate because of a mutually attractive stimulus, an as-yet-unknown neuropeptide, that acts through the NPR-1 receptor. Because the worms clump only on bacterial lawns, food is likely to regulate secretion of the neuropeptide — in other words, for worms, as for humans, food is important in social behaviour.

Alison Mitchell