Breakthrough of the Year

Each year the editorial and news staffs of *Science* gather to debate and decide which, among the discoveries of the preceding year, deserves the Breakthrough trophy. There's a natural polarity in the discussion: The physical science types have entries to which they are understandably loyal; the biologists counter, knowing that they have a slight advantage in volume. Last year, the physical folks won with nanocircuits. This year it is the biologists' turn, but notice that they stole a leaf from last year's book. Not only does this year's award recognize a group of papers rather than a single contribution, it also resembles last year's in honoring little things.

Indeed, the fascinating family of small RNAs could almost be called nanoRNAs! Attention to the class was first directed at small temporal RNAs [now called micro-RNAs (miRNAs)], which have been shown to control gene expression either by repressing translation or by degrading the targeted messenger RNAs. Other work focused on the phenomenon of gene silencing and showed that small RNAs were also involved here; these interfering RNAs (RNAi's), unlike miRNAs, which are encoded by correspondingly micro genes, are produced from aberrant (probably double-stranded) RNAs by an enzyme called Dicer. But the big surprise has been the demonstration that RNAi's can modify the structure of chromatin so as to alter gene expression and even the genome itself. Thus, small RNAs of both varieties impose a whole new layer of regulation on the genome, producing a paradigm shift in our view of genetic and epigenetic control.

The physical scientists made a strong case for honoring the neutrino: the nearly massless particle that has earned a special status, like the dog that didn't bark in the Sherlock Holmes story *Silver Blaze*. Although the nuclear reactions taking place in the Sun were expected to produce a special class of neutrino—"electron neutrinos"—they weren't there. That paradox has now been solved with the discovery that the Sun has been emitting neutrinos all right, but they were changing identities on the trip.

The neutrino breakthrough had been foretold in last year's runner-up list, and so had the success of the hunt for small RNAs. What about the other runners-up in last year's Breakthrough contest? Genomes got a lot of attention a year ago. They're back, but the emphasis has shifted somewhat, to genomes that matter in the developing world. Those for rice and for the malaria vector *Anopheles gambiae* were described in papers published here during the past year.

Last year's news editors also mentioned some things to watch, and now we can evaluate their crystal ball. They foresaw that stem cell research might progress abroad or in federally unfunded laboratories. The result has been more controversy than progress; what's clear is that the cell lines approved in August of 2001 are disappointing. Bright futures were predicted for proteomics and for bigger and better telescopes. Sure enough, new telescopes, especially those with "adaptive optics," are featured among this year's runners-up. As for proteomics, the money flow is there all right, but the jury is out on productivity.

Of course we must recognize Breakdowns as well as Breakthroughs. Last year, the big breakdown was the delay in science appointments by the Bush administration. To be fair, those folks now get credit for a belated comeback: The promising appointments of Elias Zerhouni as director of the National Institutes of Health and of Mark McClellan as commissioner of the Food and Drug Administration take that breakdown off the list. Alas, it must be replaced by the research misconduct episode involving more than a dozen papers from Bell Labs, all published in leading peer-reviewed journals. An expert visiting committee found the work to have been contaminated by fraud on the part of Jan Hendrik Schön. We published several of the papers ourselves, so we're not very happy about this Breakdown of the Year.

Unabashed, we wipe the egg off our face and turn to the task of prediction. Next year, my colleagues say, watch out! Budgets for science, as for other items in the "domestic discretionary" pigeonhole, will be shrinking. And the climate? Glaciers are melting even faster than university endowments, but the administration thinks the global warming issue still needs more study! From this quarter, it looks as if this may become the Breakdown of the Year for 2003, so stay tuned.

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