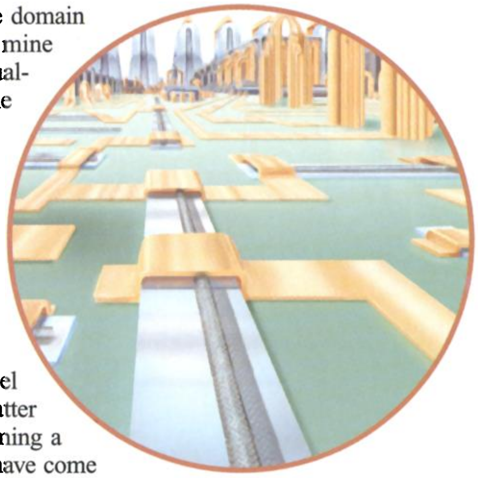
Breakthrough of the Year

Each year, *Science*'s editors gather to consider nominations for Breakthrough of the Year. It is always challenging to approach an assortment of new discoveries, but this year we had an especially difficult task: to find a science act exciting enough to follow the sequencing of the genomes of *Drosophila* and a growing list of other organisms. Not only did that work sweep last year's Breakthrough award, it led to a rich array of successor projects, not least the publication of the draft sequence of the human genome.

Those follow-on successes are one entry in this year's scientific treasure trove, which turns out to be as well stocked as last year's. The list of nominees, as imposing as last year's cabinet of wonders, also includes exhibits that range from nanotechnology to climate history, and from axonal guidance to superconductivity. Some of the excitement is in the domain of molecular structure and function. A biochemistry professor of mine once remarked that as science progressed, biochemistry would eventually become anatomy; when function becomes sufficiently reduced, he said, it's really about structure. Well, we've arrived. Among the exciting advances on this year's list is an intimate view of how the architecture of RNA polymerase permits it to admit the DNA template and express the newly synthesized RNA from the same pore. Another explores the structure of the spliceosome. It demonstrates that, as we have also learned about the ribosome, it is RNA itself and not the accompanying protein that acts as the enzyme, improving the odds that an RNA world may have preceded the DNA world we have come to know and love.



Some of the dramatic revelations of structure at the molecular level have come not from biology but from the domain of condensed-matter physics and materials science, in contributing to and eventually forming a new discipline now famously called nanotechnology. The advances have come in several different fields: scanning probe microscopes, technologies for producing carbon nanotubes and nanowires made of various materials, and new organic materials that lend themselves to conducting assemblies. Together, these ways of creating and working with molecular-scale structures have combined to give us the Breakthrough of the Year. However, the Breakthrough is not for the devices themselves, although the work that has produced them deserves high praise. It is for the extraordinary accomplishment of arranging them into circuits that can actually perform logical operations: amplify signals, invert current flows, and even perform simple computing tasks.

The possibilities are remarkable, because the scale is thousands of times smaller than that embodied in the very best contemporary computer chips. Naturally, there is a vision of a new generation of powerful tiny computers. Getting from here to there is apt to be a long and bumpy road, because production scales and economic costs are likely to be formidable. Indeed, we have no idea what a fabrication facility in a post-silicon nanoworld might look like! But in the tiny yet functional molecular circuits scientists have generated during this year, there is something like proof of principle, and that is indeed a breakthrough.

What's next? Each year we try to pick some winners, and then, in the year following, we have the humbling task of seeing how we did. This year's retrospection of last year's crystal ball exercise yielded a mixed result. For example, we got it right on RNA interference, because the year turned out to be chock-full of diced-up RNAs. Given the public health concerns that arose after the September 11 attack, it was doubly disappointing that the scientific yield on the major diseases and on vaccine development was so meager. As to the crystal ball for this year's U.S. science budget, we couldn't even see into it, because when this issue went to press, Congress still hadn't come up with the final numbers.

How will we do this year? You can bet your own favorites. My colleagues like optical clocks and predict a big year for telescopes, real and virtual. They are also very keen on proteomics, but it will be hard to find your way up to the teller's window; everyone likes this area, which looks to be the darling of the biotech industry. The handicappers favor stem cells, but mostly in corporate or overseas races. The real question for next year, though, concerns the dark horses: What will turn up that we couldn't foresee? Count on the extraordinary vigor of the scientific community to give us, once again, an exciting stable of unexpected entries.

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