

Comparative success: the rising number of sequenced genomes is bringing evolutionary insights.

Analyses of this type are particularly informative if they include both near and far evolutionary relatives — as was illustrated by reports that identified potential regulatory elements in the human genome by comparing chunks of our sequence with those of vertebrates as diverse as other primates, the platypus, chickens and fish^{3–5}.

Comparisons between species have also revised estimates of the total number of genes possessed by important lab organisms. The tally for the baker's yeast *Saccharomyces cerevisiae*, for instance, has been reduced by 500 genes, following the analysis of three related yeast species¹. Meanwhile, the nematode *Caenorhabditis elegans* has gained 1,300 or so genes from comparisons with its cousin *C. briggsae*⁶. Our own gene tally, as recorded on the Ensembl genome-browser website, has slipped this year from about 31,000 to just under 25,000, following comparisons with various other vertebrate sequences.

Comparative analysis has also taught us a thing or two about genome evolution. Over the eons, genomes have been flipped and flopped, added to and chopped, to give rise to new genes and entire gene families. Through cross-species comparisons, it is possible to determine when these changes arose. Comparing various bits of human sequences with those of other primates^{4,7}, for instance, has revealed events that have sculpted our genome throughout evolution. The Y chromosome⁸, for example, seems to have a neat trick for copying important male-specific genes to protect them from being lost as the chromosome degrades down the generations.

Researchers now want to devise experiments to explore the predictions made by comparative genomics. For instance, Mark Johnston of the Washington University School of Medicine in St Louis, Missouri, is putting the proposed regulatory elements identified in yeast² to the test in various ways. One assay involves throwing them onto 'chips' carrying proteins known to bind to regulatory regions of DNA, to see if any of them take the bait.

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Cosmology

Welcome to the real world

t has often been easy for cynics to dismiss cosmologists as whimsical purveyors of 'just-so' stories. But 2003 will go down as the year in which cosmology became a precise observational science — and for that we can thank NASA's Wilkinson Microwave Anisotropy Probe (WMAP), a satellite launched in 2001 that has been studying the faint afterglow of the Big Bang.

In February, WMAP produced an all-sky map, with unprecedented resolution, of the ancient microwaves that fill the Universe. By combining WMAP data with measurements from ground-based microwave telescopes, researchers have pinned down the Universe's age to a relatively sprightly 13.7 billion years,

give or take about 200 million. They have also verified that the cosmos is overwhelmingly made up of two shadowy constituents: dark matter and dark energy. Dark matter, invisible mass whose gravitational pull helps to shape galaxies, seems to make up about a quarter of the Universe, whereas dark energy, which accounts for almost everything else, is a mysterious phenomenon that pushes matter apart at the largest scales. That leaves only about 4% for the visible stuff such as stars, planets and clouds of interstellar gas¹.

WMAP's microwave picture agreed with other results obtained this year, such as measurements of distant, exploding stars². "The degree of cosmic consistency is really heartening," says Charles Bennett, lead scientist on the WMAP project at NASA's Goddard Space Flight Center in Greenbelt, Maryland.

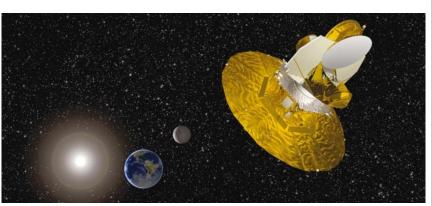
But the data did contain a few surprises. Most notably, fluctuations in the temperature and polarization of the microwaves detected by WMAP showed that the first generation of stars and galaxies appeared just 200 million years after the Big Bang¹—hundreds of millions of years earlier than most theorists had thought.

Measurements of microwaves from disparate points of the sky also present something of a mystery, according to John Carlstrom, an astronomer at the University of Chicago. The temperature differences between these points match poorly with standard theories, he says. This has led to some new ideas about the shape of the Universe: it could, for example, be dodecahedral, rather like a soccer ball³.

That will give the theorists some thinking to do, as their favourite hypothesis has been that the Universe is flat and infinite. Happily, the shape of the Universe can be probed by future data on the microwave background—from WMAP, ground-based telescopes and the European Space Agency's Planck satellite, which will carry instruments of even greater precision and is set to launch in 2007.

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Glowing report: the WMAP spacecraft has helped to quantify the composition of the Universe.

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