March 2003

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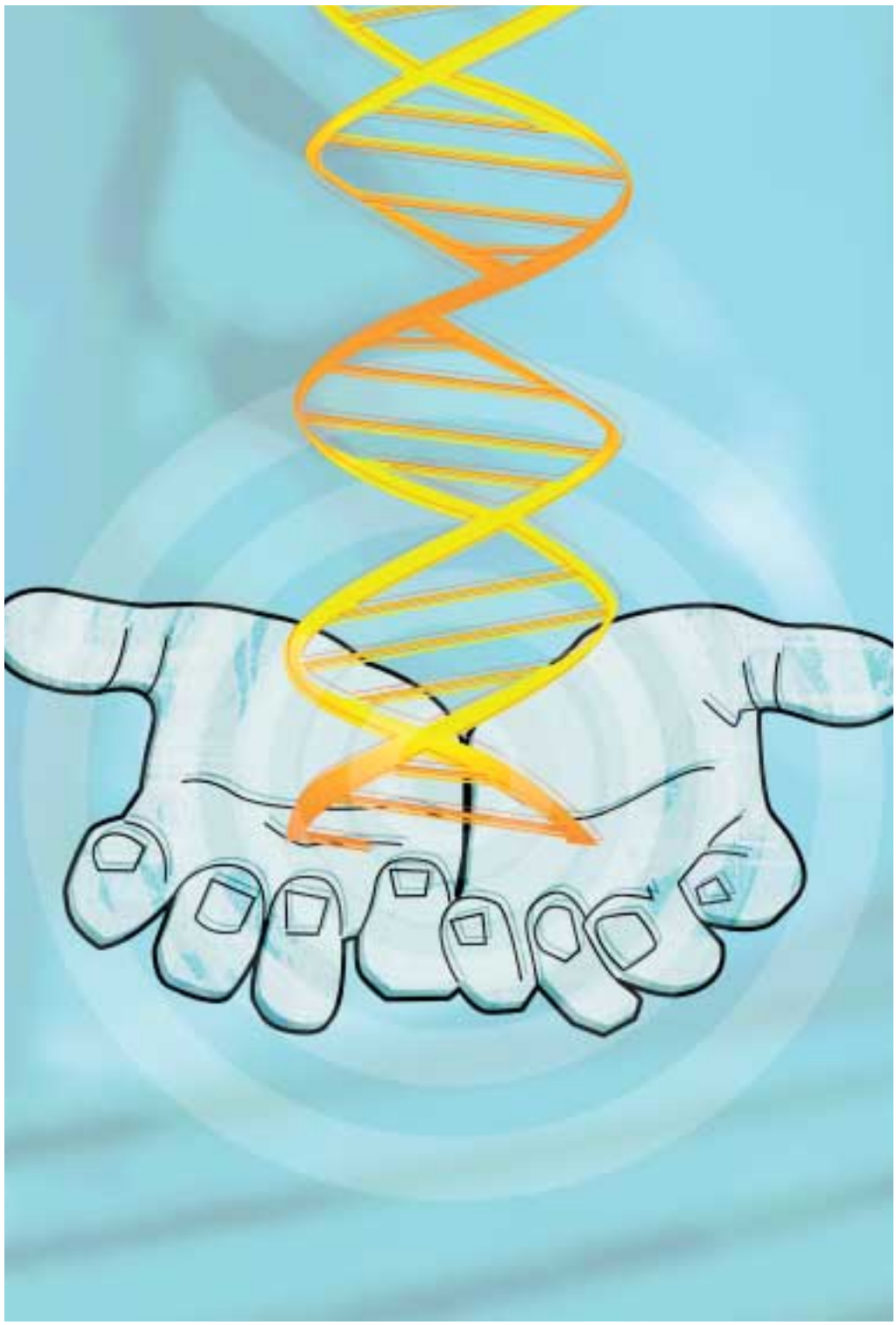
# Science & Public Affairs

50th anniversary of the discovery of the structure of DNA

DNA families

Genetics and human behaviour



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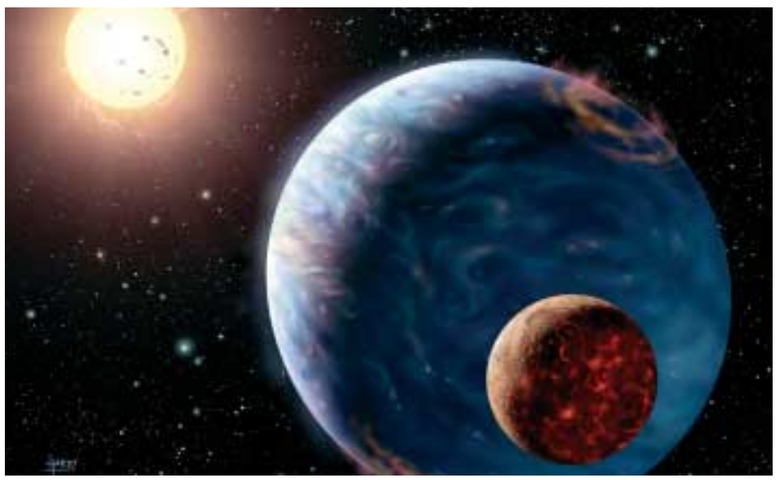




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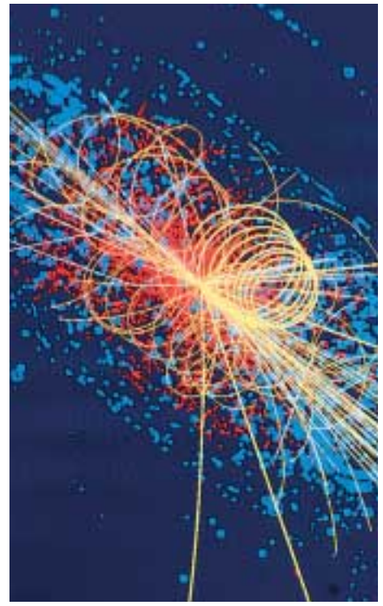
# *Features*





**Erratum**
We apologise to Jerry Ravetz for misprinting his email address in the October 2002 issue. His correct address is **jerry_ravetz@lineone.net**

# *The legacy of the double helix*

*SPL*

**This famous picture of James Watson and Francis Crick, looking very pleased with themselves and their model of DNA, heralds the 50th anniversary of their publication of its structure. Much of this issue of S&PA celebrates the occasion.**

**The two young collaborators at the Cavendish Laboratory finally solved the puzzle of the structure on 28 February 1953, and published their paper in *Nature* on 25 April the same year. Their discovery, more than any other, underlies the most important issues that science raises in public policy today. For example: in the case of UK Biobank (an attempt to investigate the links between genetic and environmental factors contributing to common, serious diseases), does the potential for good outweigh the potential for ill? The Spat (page four) reflects opposing views.**

**On page six, we ourselves jump forward fifty years and, looking back to the present, celebrate current developments that leaders in different fields predict will be especially significant.**

**In a range of articles on the way genetics increasingly affects our lives, Martin Richards (page 12) considers whether it may change the ways we think about family connections. Is parentage a matter of shared DNA sequence, as the Child Support Act has redefined it? Some of the new questions DNA raises, pose ethical dilemmas. On page 14, Bob Hepple examines the ethical dimension of a particularly complex and controversial aspect of genetics: how our genes influence our behaviour. Might abortion, or pre-implantation genetic diagnosis, be acceptable to avoid giving birth to a baby with certain behavioural traits?**

**The latest twist in the GM crop saga is debated on pages 16 and 17, with Tony Gilland and Robin Grove-White disagreeing over the importance of the farm-scale trial results for the public debate.**

**But it's not all DNA. We also explore energy (pages 18 and 20); women in science (pages 8 and 30); regulating science (page 9), weaponry (page 22) and privacy (page 24); and provide a megaphone for some strongly-held convictions (pages 26 and 29).**

**Wendy Barnaby, Editor**
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# *UK Biobank: in the public interest?*

Helen Wallace and Robert Terry beg to differ

Healthy volunteers aged 45-69 will be asked to give a blood sample (for DNA) and complete a lifestyle questionnaire, which will be combined with medical records. © *Wellcome Trust*

**UK Biobank aims to collect genetic and lifestyle profiles of half a million people between the ages of 45 and 69. It is proposed that the resulting database will be used by researchers to investigate the links between genetic and environmental factors contributing to diseases such as cancer, heart disease, diabetes and Alzheimer's. The project is funded by the Medical Research Council, the Wellcome Trust and the Department of Health. Recruitment is expected to start in 2004, following piloting.**

*Dear **Robert**,*
UK Biobank's aims are controversial, its science is questionable and the data in it will be open to misuse.

- A good health priority? Targeting medicines at those identified as 'genetically susceptible' to common diseases could vastly expand the market for medicines for healthy people. This is likely to be wasteful, costly and unsafe.
- Meaningful results? The study's scientific limitations mean there is a real danger that spurious links are found between genes and diseases.
- Will commercial access be in the public interest? UK Biobank will not contribute directly to the development of new medicines, but commercial companies will be allowed to patent gene sequences that they find in it. This means that they could gain excessive monopolies over future treatments. Conflicts of interest could also arise – should tobacco companies be sold access to the data on smokers, for example?
- Legal safeguards? There are no laws to prevent insurers or employers refusing someone insurance or a job because of their genetic make-up. The basis on which the police might be given access to the biobank is unclear.

Biobanks can be useful in medical research, but UK Biobank should not go ahead until the controversies surrounding it have been democratically debated and resolved.
Regards, **Helen**

*Dear **Helen**,*
The UK Biobank will be a resource for scientists to study links between genes, lifestyle and the environment for major debilitating conditions such as cancer, diabetes and heart disease. The development of tailored medicines is only one potential outcome of the project; just as important are public health interventions and improved diagnoses.

The draft scientific protocol for the UK Biobank was developed by a panel of experts and reviewed by an independent body of international scientists, who agreed it was scientifically sound and represented good value for money. It will be refined further as the project develops.

The aims of the project have been supported not only in public consultations, but also by the House of Lords recent review of human genetic databases and the Human Genetics Commission. We always welcome further debates on this and other population-based databases, in Parliament and elsewhere.

Participation in the project will be entirely voluntary and individuals' data will be encrypted, anonymised and subject to existing legal protections. All research using the UK Biobank resource, whether conducted by academics or companies, will be assessed by research ethics committees. A separate oversight body, accountable to the public, will monitor the activities of the project's co-ordinating centre, such as how samples and information relating to them are kept and used.
Regards, **Robert**

**The UK Biobank will be a resource for scientists to study links between genes, lifestyle and the environment for major debilitating conditions such as cancer, diabetes and heart disease. The development of tailored medicines is only one potential outcome of the project; just as important are public health interventions and improved diagnoses.**

*Dear **Robert**,*
The Biobank aims to identify people who are 'genetically susceptible' to chemicals in their diet, cigarettes or workplace that might cause common illnesses. Genes are poor predictors of most illnesses – so what will it mean to target medicines or health advice at these individuals?

Does the Wellcome Trust believe that people identified as 'genetically susceptible' to a hazardous chemical should be excluded from some jobs? Or do you agree that employers should be banned from using genetic test results and clean up workplaces instead?

What if the manufacturers of this chemical applied to use the Biobank to develop this type of genetic test? Would the Trust agree?

Do you accept that increasing healthy eating and exercise and cutting smoking and pollution are important for everyone not just a 'genetically susceptible' minority? Why is there only an in-house assessment of the Biobank's likely value-for-money?

Links made between genes and diseases are often spurious. Will you produce a detailed response to those scientists who say that the study will be 'a poor vehicle for study of cardiovascular and metabolic disease'? Will you publish your peer reviewers' comments and allow a truly independent, externally-managed peer review process?
Regards, **Helen**

*Dear **Helen**,*
The UK Biobank aims to generate a unique database as a research tool that can be combined with information from existing or new disease-specific studies to better understand the link between genes, lifestyle, diet and health. This is why the project has the support of a number of leading charities including the British Heart Foundation and the Juvenile Diabetes Research Foundation.

As already explained, the draft protocol was reviewed by an international group of scientists wholly external to, and independent of, all the funders.

GeneWatch has concerns over the potential discriminatory uses of genetic information by employers or insurers and the notion that genes are spurious, poor predictors of disease. Both these points, the funders believe, are good arguments in support of the necessity for such research to ensure that policy decisions, when made, are evidence-based.

One role for the proposed independent oversight body will be to ensure appropriate use of the data for research in the public interest. A company or employer wanting to use the information for a potentially-discriminatory test would most certainly not pass such an examination. It should be noted that the Trust strongly supports the current moratorium on the use of genetic tests by insurers.
Regards, **Robert**

*Dear **Robert**,*
Wellcome's claims that genetic tests developed in the Biobank 'could be used to predict the likelihood that an individual would develop disease, so that medicines could be used to prevent the onset of disease' are not good science, but a dangerous marketing strategy. This suits companies that wish to sell genetic tests, and sell more medicines to healthy people, but it won't help prevent disease. In essence it means selling diet pills to those supposedly 'genetically susceptible' to being overweight, instead of tackling diets and exercise for everyone.

Pretending that the Biobank will provide the evidence for reliable 'genetic horoscopes' is highly misleading, and increases the likelihood of genetic discrimination by insurers and employers. Only one paragraph in the protocol refers to the complexities and errors inherent in this type of study.

This doesn't mean that studies of genes, disease and environmental factors are always useless, just that they need to be designed with different aims in mind, explicit recognition of uncertainties, and with proper legal safeguards. What a pity that the Wellcome Trust has chosen to make a deeply misleading sales pitch instead. Sadly, such a poorly thought through project can only further undermine public trust in genetic science.
Regards, **Helen**

**Pretending that the Biobank will provide the evidence for reliable 'genetic horoscopes' is highly misleading, and increases the likelihood of genetic discrimination by insurers and employers.**

*Dear **Helen***
Unfortunately it appears GeneWatch has deliberately misinterpreted the aims of the project in order to use it as a vehicle to raise their own concerns as a pressure group about the impact of genetics on society.

The UK Biobank is not designed as a commercial entity; all the funders are not-for-profit organisations with a track record of funding research to benefit society. As you acknowledge, biobanks are necessary if we are to gain any understanding of what the real links between genes, diseases and environmental factors are. The UK Biobank will not be prescriptive about potential relationships, but rather will look at the evidence. GeneWatch, on the other hand, is prejudging the results.

By saying that these issues shouldn't even be studied, GeneWatch is attempting to close the door on potentially massive leaps in biomedical research, when we surely have a duty to explore these issues in a rigorous and comprehensive way. GeneWatch feels free to throw out any number of questions without the same burden of investing in a similar level of public dialogue. I wonder which approach is doing more to undermine public confidence in science, and who GeneWatch feel they actually represent?
Regards, **Helen**

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**is Senior Policy Adviser**
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# *Fifty years hence...*

**April 2003 marks the 50th anniversary of the discovery of the structure of DNA. What current developments will we be celebrating in 50 years' time?**

**IT: no-stop shop**

In another 50 years, we may shop with one of the most significant developments in IT today. These are radio-frequency identity tags: chips less than a millimetre across, connected to an aerial. Radio energy from a detector's aerial briefly powers the chip on the tag, which then sends back its identification. That's all it does. This is significant because it allows computer data, positioning information and network functionality to be associated with any object to which the tag is attached. By sticking this simple tag on an object, the object is effectively connected to the network, and open to the full capability of the network.

Shoppers may look at goods and immediately see their prices, allergy compatibility, recipe options (when combined with other goods in their trolley or at home), how many calories they contain, where and when they were made, and the special offers associated with them, depending on their personal loyalty scheme profile. They can then walk out of the shop without needing to stop at a checkout, since the tags can be interrogated automatically at the door, along with the identity tag on the customer's loyalty and charge cards.

***Ian Pearson, BT Exact Technology's futurologist***
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**Underpinning bioethics with philosophy**

We can expect bioethics to follow in the wake of advances in medicine and biotechnology. But the interesting advances would develop better arguments, on which philosophy depends.

We might hope to have improved accounts of collective and corporate action; of the ascription of obligations and responsibilities to non-individual actors. Without this we won't reach more than a gestural account of the obligations of companies and other institutions.

We might hope to gain a better understanding of the limits of informatic metaphors in human genetics. Without this we probably can't develop a convincing account of individual privacy, or an adequate ethical framework for regulating uses of genetic data in public health or pharmacogenetics.

We might hope for accounts of human freedom that are realistically linked to developments in neurology and cognitive science, and to sharpen our grasp of the limits of individual responsibility, including criminal responsibility.

***Onora O'Neill, Principal of Newnham College, Cambridge*** *os01000@cam.ac.uk*

**Architecture of the mind**

In cognitive science, which pictures the mind/brain in computational terms, questions about the computational architecture of the mind as a whole will probably dominate.

What are the various virtual machines, the sub-mechanisms and layers of control, that underlie thought and behaviour – and how are they integrated? Which psychological phenomena arise fairly directly from a given mechanism, and which emerge from interactions between mechanisms? How does a basically parallel-processing system generate sequential and hierarchical processes?

Different species have different mental architectures, generating different capacities for perception, inference, language, self-reflection, emotion, motives, motor skills, and bodily reflexes. Besides those examples we know about, what others could have evolved? And what types of mind could be produced by artificial intelligence? Such questions require a general theory of computational architectures, defining the space of all possible minds.

As for the many meanings of 'consciousness', we shan't have all the answers within 50 years. The nature and architectural origin of 'pure' experience remains the $64,000 question. To understand that, we'll need significant advance in the computational philosophy of mind. Neuroscience isn't enough.

***Margaret A. Boden, Research Professor of Cognitive Science at the University of Sussex***
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**Predictive biology**

In the next 50 years it would be amazing if important advances did not arise from the seismic shift now occurring at the interface between biosciences and disciplines such as mathematics, computing, engineering, chemistry and physics.

Biology is becoming more predictive and more integrative. Experimental data for biologists is growing exponentially. In addition to successful genome programmes, more and more data are accumulating about what genes are expressed under particular sets of conditions, which proteins are produced and what metabolites are present in animals, plants and microbes.

Increasingly we will be able to model *in silico* not just molecules or parts of pathways but entire systems and processes. This will bring unprecedented opportunities to predict outcomes and to intervene to direct them – for example, in drug design, alternatives to animal experimentation and for developing sustainable systems of land use and manufacture. An early step – a virtual reality 'minimal' cell – should soon be possible. Could it be the icon we will recall when looking back and considering the applications derived from today's bioscience?

***Paul Burrows, Head of Science Strategy, BBSRC***
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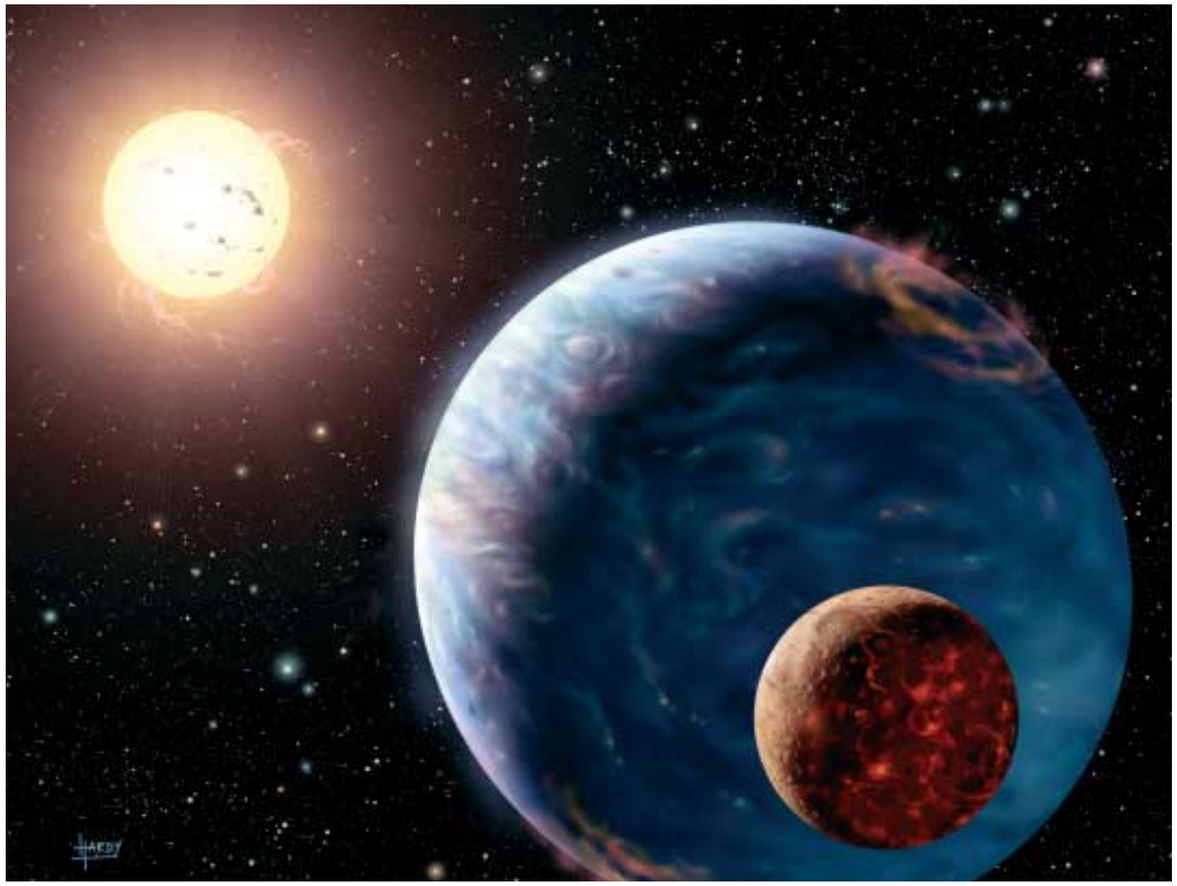
**New materials**

Fifty years hence, we may well be celebrating the progeny of the current collision of research into two types of large molecules. One is DNA; the other, synthetic polymers: huge strings of atoms shaped like stars, chains and trees, which flow and bounce like a child's slime toy when they're melted, then form many of the materials we use every day.

We are now applying our understanding of polymers to DNA itself. What emerges is a quantitative glimpse of the complex structures DNA forms inside cells, the way viruses steal and transplant it, and the wonder of the disentangling enzymes that allow DNA chains to pass through each other unaltered. Polymer dynamics is also one of the skeleton keys being applied to the locked mystery of protein folding – how do these exquisitely-designed bio-polymers fold themselves into the precise structures that allow them to function?







**Based on scientific data, an artist's impression of 'The Millennium Planet'. It depicts a planet of the star tau Boötis – a huge, bluish gas giant, bigger than Jupiter. The moon in the foreground is imaginary, but it is possible that the planet might have a moon.** ***David A. Hardy, astroart.org © Particle Physics and Astronomy Research Council***

The progeny of this collision of disciplines may well include entirely new routes to tackle diseases, new biologically-based materials and the vital tools we need for a sustainable world.

There will be plenty to celebrate – if there's time, that is...

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**DNA Ark**

Looking back 50 years from our mid-21st century vantage point, it is tragic to realise how much of the world's ecosystem has been destroyed in a mere half-century. Apart from the very visible larger mammals that many of us remember seeing when we were children, we are still struggling to draw up some estimate of the total number of species becoming extinct each year, invertebrate as well as vertebrate.

But it was just 50 years ago that biologists started fully to appreciate the great benefits of preserving a DNA sample of all endangered species. With the primitive methods of DNA sequencing then in use, they cannot have realised how quick and easy it would be for us to convert those DNA samples into DNA sequences. Now, we can reconstruct in considerable detail what all those extinct animals were like. We also have a much more solid basis for elucidating the evolutionary relationships of the entire animal kingdom.

It is surprising how many of the reconstructed proteins of those extinct animals are turning out to be of value for biomedicine, agriculture or the food industry. Let us remember with gratitude the builders of the DNA Ark.

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**Other Earths?**

Fifty years from now, the night sky will seem far more interesting. Nearby stars will no longer just be twinkling dots – we'll think of each one as the 'Sun' of another solar system. We'll know the orbits of each star's retinue of planets, and the sizes (and even some topographic details) of the bigger ones.

We'll be especially interested in possible 'twins' of our Earth – planets the same size as ours, orbiting other Sun-like stars, and with climates where water neither boils nor stays frozen. By analysing such a planet's faint light, we could infer whether it might have a biosphere.

Could some of these planets, orbiting other stars, harbour life-forms far more interesting and exotic than anything we might find on Mars? I think biologists will understand enough about life's origins to be able to tell us whether it is a fluke, or whether it is near-inevitable in the kind of initial 'soup' expected on a young planet. They might even have answered the harder question: what are the odds against it evolving into something that we would recognise as intelligent?

***Sir Martin Rees, FRS, is the Astronomer Royal***
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# Women in physics

## Julia King wants less stereotyping

**We are all guilty of stereotyping. It can be an arresting way to get a point across, but it also has more sinister effects. Take, for example, the recognition we give to women in physics.**

**Against the norm: Dr Yasmin Robson, Daphne Jackson Fellow in Physics at Oxford University**
***Daphne Jackson Trust***

At 84 per cent, the Institute of Physics' membership is predominantly male. Amongst members over 40, 13 per cent of the male membership have achieved the grade of Fellow – recognising significant contribution to physics in their sector, whether it be research, teaching, industry or public service. Of our already small percentage of female members in this age group, only 2 per cent are Fellows. So does this mean that women are less good, less achieving, lesser contributors? Or are they less prone to put themselves forward (and less likely to be encouraged to put themselves forward) because they do not think they make the grade? Has this societal stereotype been subsumed into their self-image? Then we are *all* guilty.

**Less pushy**

There seems to be no shortage of evidence that women are not as inclined to push themselves forward as men. With 2003 marking the 50th anniversary of the elucidation of the structure of DNA, Rosalind Franklin is an obvious example. But there are others – such as Hertha Ayrton, the first woman to read a paper in person to The Royal Society, yet denied a Fellowship because she was a married woman, and Lise Meitner, the Austrian physicist who explained nuclear fission yet saw her junior, Otto Hahn, awarded the 1944 physics Nobel Prize. There are many others whose names we have not heard.

In science as in politics. When Estelle Morris resigned from the Cabinet last year, *The Guardian* pointed out that the ex-Education Secretary was the victim of a political culture that patronises and stereotypes women as not robust enough to cope with high office; as being obsessed with details and trivia; or as obedient followers – not sharp enough to think for themselves.

When a survey published by *Good Housekeeping Magazine* tells us that a quarter of women admitted to telling their daughters, 'never mind, I was never any good at science or maths at school either' - and that one in five women with daughters admits that they don't do enough to encourage them to be interested in scientific subjects – is it any wonder that most girls regard progress in a science or engineering-based career as against the norm?

**Steps at the IOP**

It is not enough to shrug and say we would appoint women if they came forward, but they are not there and so, well, we tried. We must look harder, in a different way and in different places to find female candidates for jobs, honours, prizes and promotion. This isn't positive discrimination, just a rational recognition that, when dealing with different characteristics, somewhat different approaches are necessary.

We haven't got there yet at the Institute. However, we are making a new senior appointment to catalyse our programme to recognise, promote and support women in physics, including implementing key recommendations from the Roberts and Greenfield reports[1] as well as those from the International Union of Pure and Applied Physics (IUPAP) women in physics conference.[2] In addition to ensuring that all of the Institute's materials, processes and behaviours encourage women's participation, we intend to develop a range of innovative services to support both universities and industry. These will include reverse mentoring of senior staff by female employees – where young women staff provide feedback on an organisation's culture and how it is perceived by female employees – and diversity audits.

In the near future, if we do not make proper use of women's talents, we could be very short of talent indeed. The Institute for Employment Studies predicts that, by 2011, just 20 per cent of the workforce will be white, male, able-bodied and under 45, and 80 per cent of workforce growth will be among women. Perhaps that will change our stereotypes.

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   *Baroness Susan Greenfield,* SET Fair. *A report for the DTI, tackling the gender gap in science, engineering and technology. November 2002 www.set4women.gov.uk*
2. *See http://groups.iop.org/WP/H2.html#rec*

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# Regulating ourselves

## Robert May argues for citizen scientists

**Scientists do not work, and never have worked, in a moral and ethical vacuum.**

Like all responsible citizens, they comply with implicit and explicit codes that set the bounds of acceptable behaviour in the workplace. But there is growing concern that scientists do not discuss enough, among themselves and with the rest of society, the moral and ethical implications of their work and how these affect the way that the results of research are obtained and applied.

**Public confidence**

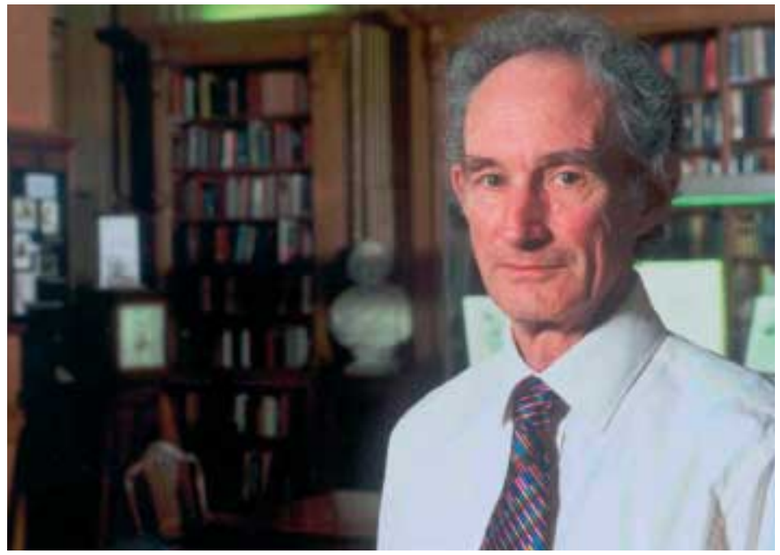
Such concern can threaten public confidence in scientists and their work. It also tempts law-makers to introduce draconian regulations, impeding the free flow of information between researchers that is so crucial to pushing back the frontiers.

A significant proportion of the population believe that scientific advances are outpacing the evolution of regulatory frameworks to control them. This worry arises partly because much of the public is unaware of the extent to which scientists regulate themselves, creating the impression that some are free to do anything they want in the name of research, no matter how weird or wicked the outcome.

The popular image of the mad scientist, often based on Shelley's portrayal of Doctor Frankenstein, has persisted for generations. The portrayal of mythical scientists conducting their work unfettered and outside the bounds of civil society reflects unease about what real scientists get up to. It is important for scientists to appreciate why these perceptions exist.

**What sort of regulation?**

Scientists accept, and indeed often initiate, formal regulation of their work, particularly in those areas where the dangers are perceived to be greatest (such as research on contagious diseases) or the ethical and moral constraints most obvious (such as research involving human embryos). A notable example is the moratorium on gene-splicing (a technique for cutting up and re-combining different pieces of DNA) put in place by the scientific community itself during the 1970s. Following the landmark Asilomar meeting at Pacific Grove, California, in 1975, the work of molecular biologists across the world went ahead under a set of self-imposed and precautionary guidelines.



**Lord May**
***Royal Society***

Formal legislation, however, can often be a blunt tool. We need to be especially careful in how we limit free speech and academic freedom, lest we inflict greater damage on society than that which we aim to prevent. Most scientists fully recognise the need for the kinds of restrictions dealt with, for example, in the Export Control Bill debated in Parliament earlier this year. (This included measures to prevent the transfer from the UK of materials and technologies that could be used to produce weapons of mass destruction.) But the exceptional circumstances in which academic freedom may be curtailed need to be spelled out clearly and carefully, and not in sweepingly general terms.

**Codes of conduct**

Some have proposed a formal code of conduct for scientists, perhaps along the lines of the Hippocratic Oath, which was once, but is no longer, the solemn pledge of the medical profession. Codes of practice may be worth considering for certain areas of research involving, for instance, dangerous pathogens, particularly if they are linked to well-established international treaties such as the Biological and Toxin Weapons Convention.

But it is difficult to see how a single code or oath could be devised, and enforced, for the full spectrum of science. Nor could any such oaths stop wrongdoing. However, these calls for more formal codes and rules will continue if we as scientists do not devote enough time and effort to engaging in wide-ranging debate about how we regulate ourselves, and demonstrating that we recognise and respect the ethical and moral bounds determined by the rest of society. As suggested by Neil Lane, President Clinton's science advisor, we need to adopt and embrace the notion of the 'citizen scientist'.

**Lord May**
**is President of the Royal Society**
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# Shorts

## HE strategy separating research and teaching

The Government's white paper, *The Future of Higher Education,* has caused a stir – not only by giving the go-ahead for top-up fees, but also by deciding that research should be concentrated in the best universities and most of the rest should focus on teaching.

The reform is designed to boost the UK's international research standing by channelling the extra funding set out in last year's spending review into the most promising research departments, in order to improve the quality of research and the way it is managed.

The strategy addresses four issues: rewarding research-intensive institutions adequately; protecting isolated pockets of high quality research in institutions which are not themselves research intensive; encouraging and developing emerging areas of research; and steering non-research-intensive institutions towards 'other parts of their mission'. The primary 'other part' is, of course, teaching, and the paper makes it clear that all universities will be judged by their teaching achievement as much as by their research attainment, promising resources in order to help achieve this.

Better infrastructure and better opportunities for interdisciplinary research would result from concentrating research into the most effective departments, says the paper, and to do this the very best of the RAE-rated 5* departments that have a critical mass of researchers will be identified and given a new '6*' rating to qualify them for an 'uplift' in funding over the next three years.

Non-research-intensive universities – those which attained an RAE rating of 4 or lower – will be encouraged to develop new technologies in conjunction with the commercial sector and to focus on knowledge transfer, rather than engage in basic research work.

The report is at www.dfes.gov.uk/highereducation/hestrategy

- The British Medical Association (BMA) (www.bma.org.uk) has warned that the Government's strategy threatens the future supply of doctors, saying that the prospect of huge debts on graduation will discourage school-leavers from considering medicine as a career.

**Nanotechnology: new regulation? Nanorobot repairing DNA: a taster for this year's Visions of Science Photographic Awards. For how to enter, visit www.visions-of-science.co.uk. There are 5 entry categories including a special DNA Award to mark the 50th anniversary of DNA.** ***Victor Habbick Visions/SPL***

## New model for research regulation

The Better Regulation Task Force (BRTF), an independent Government advisory body, has proposed a new regulatory approach to three areas of scientific research: GM seed and plant breeding, embryonic stem cell research and nanotechnology.

While calling for action in all areas, the BRTF's report points out that a regulatory environment like the one we have for stem cell research is more constructive than is the existing situation for GM research. It suggests that the emerging field of nanotechnology needs a similarly precise approach, but which also enables the public to consider the risks for themselves and takes a strong lead over the handling of risk issues.

Save British Science welcomed the report, emphasising its observation that academic research is currently controlled via funding mechanisms rather than through a more desirable, transparent process. However Professor Paul O'Brien, nanotechnology expert at Manchester University, said: 'I see no reason why special regulations are needed for nanotechnology.'

The Government has agreed to respond to the report (at www.brtf.gov.uk) within 60 days.

## Assessing science communication

The BA has reported to the Office of Science and Technology on (OST) a process to assess whether science communication activities across the UK are meeting the interests and needs of the public.

The report recommends that a detailed mapping exercise of science in society activities should be undertaken in parallel with a national survey of the public, and that a range of these activities should be evaluated to explore which are the most engaging. It proposes that the OST should support an annual conference for stakeholders and provide a fund to facilitate year-round networking.

The study is at www.the-ba.net/the-ba/ost_study

**Communicating science @Bristol © *Brian Harris***





## Cash boost to keep women in science

The Royal Society has successfully secured an extra £1.35m from the Government's 2002 Spending Review to expand its schemes to keep women in science. This will support, among other things, the new Relocation Fellowships scheme to help excellent scientists move to a new post to follow a spouse or partner's workplace move.

The funding, and this scheme, follow on from the Greenfield report on women in science, SET Fair, which indicates that women scientists are more likely to follow their partners to a new location to the detriment of their own careers.

- A new report shows that despite a growing number of women science and engineering graduates in Europe, they constitute just 15 per cent of industrial researchers in the EU. The report makes recommendations for corrective action (http://europa.eu.int/comm/research/wir).

## Lords inspect regional science

The House of Lords Science and Technology Committee is undertaking an inquiry into Science and the Regional Development Agencies (RDAs).

Lord Patel, chairman of the sub-committee undertaking the inquiry, said:

'The nine English RDAs have public funds of over £1.5 billion a year and mobilise substantial other resources for regional development ... we want to see what models for gathering and applying scientific, engineering and technological expertise have been the most successful so that best practice can be spread.' The inquiry will also make comparisons with practice in the Devolved Administrations and in other countries. Follow the 'Committees' link from www.parliament.uk/about_lords/about_lords.cfm

## UK climate law needs rethink

An EU Directive on carbon trading, the EU Emissions Trading Scheme – agreed in principle and likely to be approved and in force by January 2005 – will have a significant impact on all elements of the UK Climate Programme (UKCP), says a new report from the Science and Technology Policy Research Unit at the University of Sussex. The report says that as a result, the core of the UKCP may have to be changed.

In particular, the Climate Change Levy and the Climate Change Agreements will need to be modified, and the UK Emissions Trading Scheme abandoned. 'The UK government does not appear to have fully acknowledged this,' says the report, at www.sussex.ac.uk/spru/.

## PPARC: doing well but watch CERN

A report from the House of Commons Select Committee on Science and Technology on the performance of the Particle Physics and Astronomy Research Council (PPARC) notes that the Council has performed well generally, but asks for greater vigilance regarding fund management at the particle physics research laboratory CERN in Switzerland.

'We remain concerned that a body which receives £65 million a year of UK taxpayers' money appears to have been so appallingly managed,' it states, referring to the increased cost to completion of the Large Hadron Collider. Peter Barratt of PPARC agreed that CERN 'should have been more stringent in monitoring costs and advising... of any predicted overspend.'

However he believes that CERN is now 'back on track'.

PPARC has also been tasked with reviewing its policies on contract researchers. See: http:// www.parliament.uk/commons/selcom/s&thome.htm

## GM news

- Research published in the Royal Society's *Philosophical Transactions B*, which concludes: 'creative use of GM crops could bring back increasing numbers of endangered wildlife and birds such as skylarks and finches' (www.royalsociety.org) has been disputed by NGOs. Friends of the Earth (www.foe.org.uk) cites weaknesses in the study, while the Soil Association (www.soilassociation.org.uk) says: 'This research ... fails to take into account the year-on-year effects on wildlife,' pointing out that the research was funded by Monsanto and was previously publicised in 1999.

- The British Medical Association (BMA) in Scotland has welcomed the conclusions of a Scottish Parliament Health and Community Care Committee's report that current GM crop risk assessment is 'flawed', saying: 'there is insufficient evidence to show whether or not there are potential health risks from exposure to GMOs'. See http://www.bma.org.uk/ap.nsf/Content/gmcrops

- Advice issued by the Government's GM scientific advisory committee is in conflict with the findings of a government-commissioned report on GM oilseed rape pollination, says Friends of the Earth (www.foe.org.uk). The report (www.defra.gov.uk/environment/gm/research/epg-1-5-84.htm) on GM cross pollination of oilseed rape crops with wild plants puts the early commercialisation of GM oilseed rape in question, revealing significant contamination. But the Advisory Committee on Releases to the Environment (ACRE)'s advice (www.defra.gov.uk/environment/acre/advice/advice21.htm) plays down the findings, saying contamination was expected.

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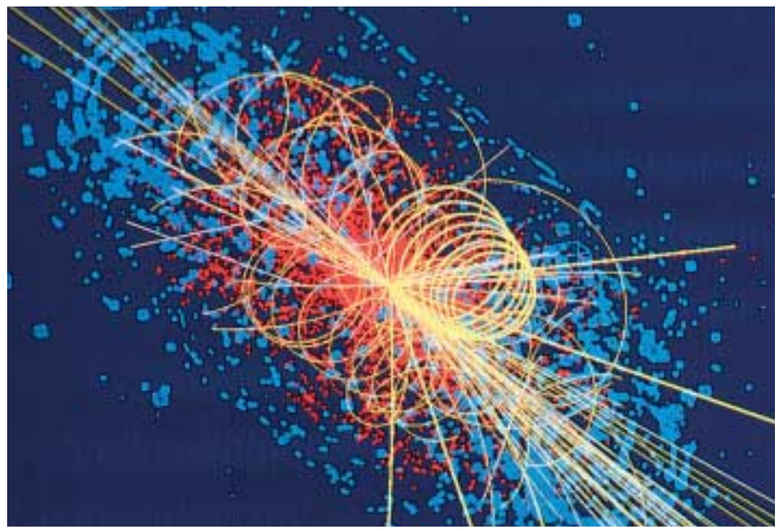

**CERN: on track** ***CERN***

# *DNA families*

## Genetics may change family relationships, says Martin Richards

**Genetics is a family affair. It has been suggested that knowledge of DNA and the 'new genetics' is changing the ways we think about family connections. There is not a lot of evidence to support that view, as yet. However, the Child Support Act has redefined parentage as shared DNA sequence, and that may well be a sign of the times and of things to come.**

Is parentage simply a matter of shared DNA sequence?

**Family histories**

New DNA techniques have provided genealogists with new tools which can sometimes solve old problems. There have long been claims that the American President, Thomas Jefferson, fathered a child with his slave Sally Hemings. Using a technique which involves mapping polymorphisms on Y chrosomosomes, DNA from modern Hemings and Jefferson descendants provides very strong evidence to support the suspicions.[1] This method is restricted to tracing male lines.

A similar approach can be used, involving mitochondrial DNA (passed on in eggs and not sperm), for females. An example here was the identification of remains of the Tsarina, Alexandra, who had been executed in the Russian Revolution. Her maternal grandmother was Queen Victoria, who was also a direct ancestor of the Duke of Edinburgh. He supplied the mitochondria that clinched the identification.

Of course, sharing DNA sequences is neither necessary nor sufficient to create family relationships. Hemings have not overnight become Jeffersons, though of course, perceptions of family history have changed on both sides. Nor, as Archers fans well understand, has the recent birth in Ambridge provided an addition to the Aldridge family. However, there are situations where DNA testing can make a material difference to family relationships, and its growing use may be changing our perceptions of the essence of kinship.

**Paternity testing**

About 10,000 paternity (and other close blood relative) tests are done in the UK each year. They are based on techniques that compare some of the more variable stretches of DNA sequence in the genome. Unlike the earlier generation of tests, these provide near certain results. Most of the tests in Britain are carried out by the state, to determine liability to pay for child support, or eligibility to receive an immigration visa (where family membership may be an issue).

Some men have received repayment of child support after a negative test result showed they were not the fathers. Many other men's denials about paternity have been proved to be in vain. However, the social and family consequences of these results may be rather different. In the first situation, the net result of testing may be that a child loses a social father and does not gain contact with his biological father, while in the second nothing much may change except the men's liability to pay child support has been established.[2]

There are tight guidelines in the UK governing the practice of paternity testing which set both laboratory standards for companies and for the obtaining of consent from relevant parties. This is important because it is very easy to obtain DNA samples surreptitiously and without consent – hairs on a collar, cells from a toothbrush for example – and DNA is very stable, so can persist in biological materials long after death (as in the case of the Romanovs).

While we have guidelines in the UK, these do not cover overseas companies that trade on the web, some of which use the lack of regulation as a selling point ('consent requirements minimised'). For this reason, the Human Genetic Commission has recently recommended that there should be a new criminal offence of the non-consensual or deceitful obtaining or use of personal genetic information. This may provide some protection against the non-consensual use of offshore testing.[3]

**Genetic testing for disease**

The other major use of DNA testing which affects family life is testing for the rare Mendelian, single gene, diseases. The dominantly inherited diseases, such as Huntington's disease, generally develop in middle age. But a DNA test for the mutation will predict the eventual development of the disease with a very high degree of accuracy: all those with the mutation will eventually develop the disease, unless they die of something else first. But would you want to know your fate?

Most of those in affected families are only too aware of what the disease means: a relentless degeneration of the central nervous system, which results in a progressive loss of control of movements and of the mind, with death following about a decade after the first obvious symptoms. And there are no cures.

Before testing became available, it was widely believed that most of those at risk would prefer to take the test. This might, of course, bring good news, and even if bad, would at least allow planning for the inevitable future and the avoidance of passing on the trait to children. But human nature does not always follow clinician expectations. Most of those at risk have decided that hope and uncertainty are better than certain knowledge, and have chosen not to take the test.

A common feature of all genetic tests for Mendelian diseases is that an individual's test result usually has implications for other family members. If a parent at risk of Huntington's disease takes a test and the result is positive, their children are at 50 per cent risk. If it's negative, they are in the clear. But suppose a young person learning of their grandparents' diagnosis of the disease, decides to be tested; that test may then reveal the status of their parent. If the result is positive, the relevant parent must also carry the mutation. What if the parent does not want to know? Genetic testing has brought new social and moral dilemmas for families who carry this devastating disease.[4]

**Social innovations**

In recessively inherited Mendelian diseases (and these are generally diseases of early onset), children are only affected if they inherit the relevant gene mutation from both parents. The parents who have only a single copy of the gene with mutations are normal (in fact, may be 'supernormal', having resistance to certain diseases which accounts for the high carrier frequency in some populations). Some of these recessive diseases provide some socially creative examples of dealing with these inherited conditions.

Thalassaemia (a blood disorder which even with extensive treatment may result in death in early adulthood) was common in Cyprus. About one in five adults are normal carriers of the gene mutation (and have resistance to malaria). Couples are now screened before marriage – it's a condition for a church wedding. If both are carriers, they then can use prenatal testing and abortion of affected foetuses. Once, caring for the brief and painful lives of children with thalassaemia was a major commitment for the island's health services. Now, births of affected children have been almost completely eliminated. But is this effective public health or a new form of eugenics?

Tay Sach's disease causes rapid degeneration of the nervous system after birth with death in early infancy. It is particularly common in populations of Ashkenazi Jews. Orthodox communities reject abortion. In some of these, marriages are arranged by matchmakers. Young people are tested and their carrier status is made known to the matchmakers who match accordingly. Not telling the young people their carrier status avoids damage to their self-esteem and their marriage prospects, which might follow a positive test result.[5]

I mentioned that uptake of testing for Huntington's disease was low. This contrasts with very high uptake of testing in some rare, inherited cancer syndromes. Or we might contrast what has happened in Cyprus with thalassaemia with the situation in Britain where, despite the availability of testing, there has been a relatively small impact on births of children with cystic fibrosis.

Genetic testing raises new questions and dilemmas for families. There is a growing body of research on the social and family consequences of testing for genetic disease. The results underline a diversity of responses, depending on both the social context and the nature of the disease.

**What if the parent does not want to know? Genetic testing has brought new social and moral dilemmas for families**

### *@ a glance...*

The new genetics may change the ways we think about family connections

Perceptions of family history change with accurate genealogy

Paternity testing may result in a child losing a social father without gaining contact with his biological father

Genetic testing raises new questions and dilemmas for families, for example for those who carry Huntington's disease

Testing for thalassaemia and Tay Sach's have given rise to new social arrangements amongst affected communities


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# *Genetics and human behaviour*

**Bob Hepple examines the ethical context**

**Human behaviour is influenced both by the genes that we inherit and the environment in which we live. Some researchers are attempting to locate specific genes – or groups of genes – associated with behavioural traits, and to understand the complex relationship between these genes and the environment.**

Investigating how our genes influence our behaviour is particularly complex and controversial. As yet, there are no practical applications of research in behavioural genetics, but it is not too early to start thinking about possible future developments and the issues they may raise. The Nuffield Council on Bioethics has recently published a report, *Genetics and human behaviour: the ethical context*, which looks at ethical, legal and social issues raised by this research.

The report examines behaviour within the normal range of variation (rather than those thought of as diseases or disorders, such as depression, which have been considered by previous reports). Behavioural traits considered included intelligence, antisocial behaviour, personality traits such as novelty-seeking or anxiety, and sexual orientation.

## Behavioural genetics

Behavioural genetics is still at an early stage. The connection between genes and diseases is far from straightforward, but the relationship between genes and behaviour is even more complicated. Despite a number of highly publicised claims (see Box 1), no individual gene has yet been shown conclusively to influence antisocial behaviour, anxiety or intelligence in the normal range, or sexual orientation.

It is common to hear of research that claims to identify a 'gene for aggression' or a 'gene for homosexuality'. However, the term a 'gene for X' is misleading. It is unlikely that variation in just one gene contributes to a trait. Many genes, each having a very small effect, are likely to be involved, and the environment also plays an important role. The predictive power of genes should not be over-estimated: the effects of genes are not inevitable.

Behavioural genetics is an extremely sensitive, and potentially explosive, area of research, not least because it takes place in the shadow of eugenics. One of the first questions the Nuffield Working Party asked was whether the research should be carried out at all. We concluded that it can be justified because it has the potential to advance our understanding of human behaviour. However, it is important to create safeguards to protect against its misuse.

## Treatment

In the future it may become possible to make predictions, albeit limited ones, about behaviour based on genetic information.

One possibility would be to use genetic information to modify or change behaviour, by developing a range of approaches or treatment. These approaches could be medical, genetic or environmental, for example using social policies such as changes in diet or education.

There are concerns that such interventions could increase medicalisation and stigma. When considering whether an approach should be acceptable, we identified five criteria: the effectiveness, safety and reversibility of the intervention, the extent to which one can make choices about its use, and its implications for individuality.

Taking gene therapy as an example, there are significant concerns about its safety. In view of this, the report recommends that considerable caution should be exercised before contemplating its application to traits that do not have serious implications for health. In the context of behavioural variation within the normal range, we cannot envisage any circumstances in which germline gene therapy (the modification of the human germline) would be justifiable.

## Prenatal selection

A different type of intervention might affect the traits of individuals, not by altering them but by selecting them in advance. One such intervention would be prenatal testing, which has been practised on clinical grounds for thirty years in the UK to detect pregnancies affected by diseases such as Down's syndrome and spina bifida. The Working Party took the view that the use of selective termination following prenatal diagnosis to abort a foetus merely on the basis of information about behavioural traits in the normal range is morally unacceptable.


**Could a genetic explanation for antisocial behaviour be used to excuse an offender?**

A second possible intervention would be the use of pre-implantation genetic diagnosis (PGD), which enables embryos created by *in vitro* fertilisation programmes tested for genetic disorders before they are implanted. Currently, the selection of embryos using this method is restricted to serious diseases. The report recommends that the use of PGD should not be extended to include behavioural traits in the normal range.

## Legal issues

Information about genetic influences on behaviour may also have implications for the criminal justice system. Could a genetic explanation for antisocial behaviour be used to excuse an offender? The Working Party concluded that genetic information about behaviours within the normal range does not absolve an individual from responsibility for an offence. However, the information could be taken into account by judges when sentencing, in the same way that environmental factors, such as an abusive childhood, may be considered. If the information is to be used in this way, it is vital that the genetic link is convincing, and that the tests are accurate and reliable.

It is unlikely that genetic information will be accurate enough to justify using it on its own to predict antisocial behaviour. Where a person has not yet committed a crime, the Working Party did not feel that it is justifiable to try to predict behaviour with a view to detaining that individual. This applies equally whether the information is based on genetic or non-genetic influences.

## Policy issues

The report also discusses the use of genetic information about behaviour in the contexts of employment, education and insurance. Would someone with a predisposition for anxiety be unsuitable as a pilot? In the future, employers might want to use genetic tests for intelligence or for behavioural traits like aggression or anxiety, to help choose appropriate employees or to veto unsuitable applicants. The Working Party recommended that employees should be selected and promoted on the basis of their ability to meet the requirements of a job. However, employers should not demand that an individual take a genetic test for a behavioural trait as a condition of employment.

We believe that this is the first report of its kind to give advice and make policy recommendations in this controversial area of research. We hope that it will stimulate debate between government, scientists and the public about the ethical and legal implications of behavioural genetics. It is important that the debate is well-informed and that policy-makers should begin to think now about how to monitor and regulate the applications of research in behavioural genetics.

**The report, *Genetics and human behaviour: the ethical context*, is available to download from the Council's website: www.nuffieldbioethics.org/behaviouralgenetics**



### Homosexuality

In 1995, Dean Hamer of the National Institutes of Health, Bethesda, USA, announced that he had found a region of the X chromosome that appeared to be linked to homosexuality in males. The X chromosome is one of the sex chromosomes; females having two X chromosomes, males having an X and a Y. Hamer studied 40 pairs of homosexual brothers. In 33 of these pairs, he found that the brothers had similar genetic variants in the same region of the X chromosome. This was a higher proportion of the brothers than would be expected by chance.

No independent laboratory has yet published confirmation of this finding. Moreover, there are approximately 100 genes in this region. The research does not yet provide any information about which gene or genes might influence male sexual orientation or how they might function.

### 'Smart mice'?

In 1999, scientists at Princeton University and MIT created the 'Doogie mouse', a mouse that seemed to have a better memory. These mice were genetically modified to over- produce a receptor found in nerve cells of the brain's memory region. Compared to unmodified mice, Doogie learned more quickly, remembered what it had learnt, and preferred novel situations.

Claims appeared in the papers of 'a gene for intelligence'. However, the research should be treated with caution. The learning effects only lasted for a few hours or days. More recently it has been discovered that these mice are more susceptible to persistent pain (an illustration of the fact that a gene might affect more than one trait).

### *@ a glance...*

The Nuffield Council on Bioethics has published a report on the ethical, legal and social questions raised by behavioural genetics: how our genes influence our behaviour

The report rejects germline gene therapy and recommends considerable caution in contemplating gene therapy for traits that do not have serious implications for health

It argues that abortion, or pre-implantation genetic diagnosis, to avoid giving birth to a baby with behavioural traits in the normal range would be morally unacceptable

Genetic information about behaviours within the normal range does not absolve an individual from responsibility for an offence

Employers should not demand that an individual take a genetic test for a behavioural trait as a condition of employment

Although there are currently no practical applications of research in behavioural genetics, there should be a well-informed public debate and policy-makers should begin to think now about how to monitor and regulate the applications of the research

**Professor Bob Hepple**
**chaired the Working Party on *Genetics and human behaviour: the ethical context*. He has succeeded Professor Sir Ian Kennedy as Chairman of the Nuffield Council on Bioethics**
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→ Feature

# *Farm-scale politics?*

**The results of the current GM crop trials will not emerge until after the government-funded public debate on GM. Does it matter? No, argues Tony Gilland (below). Yes, insists Robin Grove-White (opposite).**

## It's about politics, not science, says Tony Gilland

**When the Agriculture and Environment Biotechnology Commission (AEBC) published its *Crops on Trial* review in 2001, it warned the Government against exaggerating the significance of the trials.**

According to the AEBC, their restricted scope means they should not be crucial in any decision about moving forward with the commercialisation of GM technology in the UK.

However, it would seem that the Government has taken the AEBC's advice too much to heart for GM's critics.

Margaret Beckett, Secretary of State for Environment, Food and Rural Affairs, has asked for the results of the public debate on GM being organised by the AEBC and funded by government, and the results of a separate scientific review of the safety and usefulness of GM crops, to be delivered by June 2003, before the farm scale trials are completed.

**Timing: irrelevant**

Conspiracy theories abound as to what Margaret Beckett and the Government are up to. Some suspect that they are trying to stage-manage the whole process to ensure that commercialisation of GM goes ahead, regardless of the results of the farm-scale trials. But it should be remembered that the primary purpose of the farm-scale trials was always more political than scientific. They represented the Government's lack of resolve in pushing ahead with the commercialisation of GM crops, and its desire to take the heat out of the debate by appeasing the concerns of GM's critics.

They also reflected an exaggerated and unnecessarily negative interpretation of the relationship between modern farming and wildlife. If the media debate about GM crops had not spun out of control, it is unlikely that the farm-scale trials would ever have been initiated. Therefore, the timing of the results are irrelevant to the debate and the political decision that needs to be taken about GM crops.

**Origin of the trials**

The trials were introduced at a time when numerous unfounded GM scare stories were making the headlines, from 'super weeds' to 'poisonous potatoes'. The specific motivation for the trials, back in 1999, was a concern about the plight of Britain's 'farmland' birds: an issue highlighted by the Royal Society for the Protection of Birds (RSPB) and English Nature, to the joy of a media only too eager to publish yet another story criticising modern farming and warning of the dangers of GM. But this story, too, was based on a great deal of prejudice.

While the Government's index of 'farmland' birds, compiled by the RSPB and the British Trust for Ornithology, showed that they had declined by 30 percent since 1970, a date that coincides with the intensification of some farming practices, few bothered examining the facts. The index focuses on a narrow group of 20 birds: other birds frequently found on farmland, but excluded from the index, have fared far better. An index that included all the birds found on farmland would show no overall change in the abundance of bird life over the same period.

**Key issue**

It is to be hoped that the farm-scale trials will be of some scientific interest. After all, they have been funded by £5 million of public money. But the key issue for the forthcoming debate about the future of GM technology in this country is not the results of the trials, but whether government, industry and scientists have learned the lessons of what went wrong last time. The public was treated to a one-sided debate, which allowed exaggerated risks to be passed off as likely outcomes. The Government lacked the political will to ensure that such concerns were kept in perspective, and a clearly-stated motivation for experimenting with this technology.

What the Government now needs is the confidence to win the argument with the public about GM commercialisation being the right policy, rather than kow-towing to self-appointed arbiters of public opinion. Unfortunately, given its continued prevarication and defensiveness about this issue, its success is by no means assured.

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GM maize: science or politics?

## The Government's good faith is in question, alleges Robin Grove-White

**The Government is unwise to insist that the results of the current GM crop trials should be sealed off from the wider public GM debate now under way. To some of us, such a separation smacks of bad faith.**

Why should this be so? After all, seen in their own restricted terms, the trials have much to commend them. They will contribute fresh understanding of a modest range of environmental impacts of specific GM crops. For the first time, a controversial new farming technology is being field-tested in advance for potentially adverse biodiversity consequences, before decisions are taken about full commercialisation. This is an important precedent.

But the trials already have a bad name in many parts of the country. Introduced with a minimum of consultation, they have served as a condensation point for wider public unease about GM crops – in particular, concerns about the increasing industrialisation of food production and potentially irreversible contamination of non-GM agriculture and countryside. Yet the Government has now arranged things so that the trials' findings cannot be scrutinised within the wider review of GM science in the current public debate.

Such an exclusion sends a mistaken message on an issue of great public sensitivity.

**Lack of public trust**

A key factor in the recent GM crop controversies has been the manifest lack of public trust in official oversight of what is a novel and powerful technology. Survey after survey suggests that people suspect the Government and its scientists of unacknowledged collusion with powerful economic interests standing to benefit directly from introduction of the technology. There is limited confidence in the even-handedness of the official regulatory framework. And there are concerns that possible long-term 'surprises' are being neglected in official risk assessments – as happened in past cases such as CFCs, fossil fuels and climate change, BSE, and other recent food scares.

When, last July, Margaret Beckett announced her intention to encourage an independently organised public debate – acting on advice from the Agriculture and Environment Biotechnology Commission (AEBC) – it seemed this message was being taken to heart. No decisions on commercialisation would be taken, said the Secretary of State, until there had been fuller public discussion, including a comprehensive and open review of the state of GM science. Yet, contrary to AEBC's advice, the crop trial findings have been explicitly excluded.

At the time, this caused little comment. However, it is now increasingly clear that many issues relevant to the merits of the trials will form part of the science review – not simply specific concerns like geneflow and soil contamination, but also wider generic matters such as the confidence limits and boundaries of present overall scientific understanding.

Whilst it may still be possible in principle to assess the findings from the trials against the conclusions of the science review at a later stage, many GM sceptics smell a rat. They argue that, once the debate is safely out of the way, the firewall between debate and trials will be used to give latter a political significance they do not merit.

**Extend the debate**

There are sound grounds for such suspicions. A year ago, in a report on the trials, the AEBC criticised Ministers for repeatedly exaggerating the scope and importance of the trials, in the process playing down the political and ethical tensions reflected in public concerns. Such concerns have been reinforced by the way in which selective representations of 'science' have been used officially to patronise and belittle wider disagreements.

In such circumstances, the Government's good faith is again in question. Surely it would be wiser to extend the time allowed for the GM debate and science review beyond the present deadline of 30 June, so as to ensure that the trials' findings are treated even-handedly as matters of public discussion?

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# *Britain needs nuclear power... ... right now!*

**insists Adrian Bull**

**Climate change is perhaps the greatest environmental threat of this century, its global effects being particularly felt in developing countries. Nuclear energy offers the only credible, clean, reliable and efficient way of generating electricity with almost no greenhouse gas emissions.**

However, with current market conditions biased against investment in the new nuclear capacity needed to replace the UK's existing nuclear stations, the 25 per cent contribution that nuclear energy currently makes to the UK's generation mix will be allowed to disappear over the next 20 years unless urgent action is taken.

BNFL hopes that the Government will establish in the 2003 Energy White Paper a clear policy supporting a future role for nuclear power and remove the obstacles to its implementation.

## UK's energy future

The UK faces a future of increasing energy and electricity demand where:

- By 2020, 70-80 per cent of the nation's electricity will be derived from gas, almost all of which will be imported, primarily from Russia, via long pipelines crossing many national borders
- Electricity prices may rise sharply to mirror global oil and gas prices, which themselves may be increasingly volatile
- $CO_2$ emissions will be rising, in the face of a need for substantial cuts, as first the Magnox and then the AGR nuclear power stations close, removing a major source of carbon-free electricity generation. Although renewable sources will be added, this will not be enough to offset the closure of nuclear capacity
- Electricity supplies may be disrupted at times of peak demand.

Faced with this scenario, it is vital that the nation adopts a long-term energy policy, where *all* low-carbon alternatives – primarily nuclear and renewables – are retained and encouraged, and where significant obstacles to their deployment are removed.

## Cutting $CO_2$ emissions

To date, the UK has led the way internationally with $CO_2$ cuts. These have not come through strong policy leadership, but as a by-product of the 'dash for gas' which has seen coal-fired power stations replaced with cheaper gas-fired units, which only produce half as much $CO_2$ for each unit of electricity generated. However, the benefits of switching coal for gas can only be taken once, and already more than half of the UK's coal-fired generation has been shut down in this way.

Renewable energy is part of the solution but, because most renewable systems are driven by intermittent phenomena such as sunshine, wind and waves, they cannot always be relied upon to generate power whenever it is demanded. How often do we see a period of several cold, dark, windless days during a typical UK winter?

**Artist's impression of the AP1000 Reactor**
***BNFL***

## Security and safety

In terms of security of supply, nuclear offers a range of attractive features. The raw uranium feedstock comes from a number of politically stable countries, such as Canada and Australia. A strategic stock (enough to keep all the nation's nuclear reactors fuelled for two or three years) can readily be maintained in only as much space as a typical house, whereas huge storage facilities would be required to do the same for gas. In fact the UK is *already* short of gas storage – current UK storage is 4 per cent of annual gas usage, compared with other major gas users such as Germany, France and Italy, all of whom have storage for over 20 per cent of their annual usage.

In addition, the cost of uranium for nuclear fuel is only a small proportion of overall generating costs (less than 10 per cent, compared to the cost of gas, which accounts for around 60 per cent of the cost of gas-fired generation), so prices of nuclear electricity are stable.

Nuclear power worldwide has an excellent safety record when compared objectively to alternative sources of energy. We are already safely and securely managing and storing nuclear wastes and the issues relating to a longer-term solution are not technical, but relate to policy.

## What we want from the White Paper

At the moment the nuclear option is effectively closed in the UK, and urgent action by Government is needed in order to render it open. BNFL – along with the rest of the UK's nuclear industry - hopes that the forthcoming Energy White Paper will introduce measures which will let nuclear compete on an equal footing with other generation sources in attracting investment. Specifically we would like to see:

- **A framework to enable long term electricity contracts – at prices which will encourage new baseload capacity –** in order to provide enduring stability to the market and provide investors contemplating new nuclear plant with improved confidence of an adequate financial return. Current market conditions serve to make only the shortest-term investments attractive, whereas a nuclear plant must be viewed as an investment over a period of at least 20 years or so. The design lifetime of a new reactor would be 40 years or more
- **A mechanism to level the playing field for low carbon generation, by incentivising all low carbon sources objectively.** The cost of all 'externalities' (such as all forms of environmental impact) should be included within the costs of electricity generation, to allow different options to compete fairly. Currently the UK's Climate Change Levy penalises carbon-free nuclear electricity (and large hydroelectric plants) in the same way that it does $CO_2$ – generating coal and gas plants. Despite its name, it only offers incentives to builders of new renewable generating capacity, not to other carbon-free forms
- **Implementation of improved planning processes for all major UK infrastructure projects, which give certainty on inquiry timescales.** Planning is an obstacle for all power plants – nuclear, renewable and fossil-fired – as well as many other major building projects. The UK's planning processes urgently need to be improved to operate more effectively, whilst retaining the legitimate role of the regulator to scrutinise and challenge the full range of safety and environmental issues, as well as the democratic rights of local communities to participate in decision-making which affects their lives. Without such improvement, the UK's ability to renew and improve its infrastructure will be severely limited
- **Commitment to Government/Industry joint funding for early regulatory approvals of new designs** for use in the UK. Such an approach would take up to five years off the lead time for reactor delivery, and is already helping to re-establish the nuclear option in the US, as part of their 'Nuclear Power 2010' initiative, which aims to get a new reactor operating by that date. In the UK regulatory resources and skills in the areas relevant to new reactors will need substantial enhancement if this is to be achieved
- **Certainty on used fuel and waste costs for potential investors** through 'pay as you go' funding for long term waste management. A clear policy is needed, so that potential investors can be sure of their future financial obligations related to used fuel and waste management
- **Progress in ensuring that legacy waste issues do not cloud decision making in respect of new nuclear build,** thus helping to remove the misperception which frequently links and confuses these two aspects of the industry. Used fuel and wastes from future nuclear stations are well understood and are already being handled safely and effectively. Furthermore, a 40-year programme of nuclear generation to replace the existing UK capacity with BNFL's AP1000 reactor design would add only 10 per cent to the volumes of wastes already being safely managed in the UK
- **Government funding to support both underpinning nuclear research (in reactor technology and waste management), and UK participation in international nuclear fission R&D projects,** which will contribute to the transfer of valuable expertise and know-how from one generation of nuclear industry employees to the next. As we look to a future programme of nuclear reactor construction and operation in the UK, it is vital to retain and build on the skills and expertise which we already have.

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### *@ a glance...*

BNFL hopes that the Government will support nuclear power in the 2003 Energy White Paper and remove the obstacles to its implementation

Nuclear energy offers a clean, reliable and efficient way of generating electricity with almost no greenhouse gas emissions

Unless urgent action is taken, its contribution to the UK's power generation will disappear over the next 20 years

Current market conditions are biased against investment in new nuclear capacity in the UK

Renewables are part of the UK's energy future but they cannot always be relied on to produce power when it is needed

# Sorting out renewable energy

Bernard Bulkin makes some science-based predictions

**The UK has set a target of generating 10 per cent of its electricity from renewable sources by 2010, if this can be accomplished at reasonable cost to the consumer, and is considering increasing this to 20 per cent by 2020. These are nice round numbers that fit together well. But do they have any basis in the science and technology of renewable energy sources?**

**The new solar roof on the National Indoor Athletics Training Centre at the Alexander Stadium, Birmingham. This is currently the largest solar roof in Britain. It is expected to generate 80,000 units of electricity per year; more than the building's expected electrical requirements. Surplus clean power is automatically exported to the grid for use elsewhere. Annual carbon dioxide savings are estimated at 35 tonnes.**
***Solarcentury www.solarcentury.co.uk***

Science gives us guidance about renewables, and allows us to sort them according to propensity for change. Policy should take note of this guidance.

A recent report for the DTI suggested that the 20 per cent target would have significant cost for the grid, in the range of £150 million to £400 million a year. But the grid is only one aspect of the technology. Behind it are the costs and technologies of the various generation modes that come under the heading of 'renewable'.

**Different renewables**

Viewed from a scientific perspective, I think it is unfortunate that renewables are considered as a group. Within this group we have great diversity, including, at least,

- Photovoltaics (PV) and solar thermal, covering a number of different designs and materials, and ultimately also covering PV-derived hydrogen for fuel cells
- Wind
- Hydroelectricity – often divided into small and large hydro, but from a technical point of view these are not differentiated
- Tidal and wave – by contrast, often lumped together though the technologies may be quite different
- Geothermal
- Biomass – both intentionally grown for energy, and waste products of food production. While biomass burning in many parts of the world is classified under 'renewable energy', it is no such thing, as it often involves extensive deforestation and changes in land use
- Landfill gas, sewage, waste – from a technology point of view this can also be considered as biomass.

Each of these involves several different technologies and realisations. What they do have in common, however, is that in the UK all are more expensive than the power derived from the newest gas fired power plants, which are the low cost mainstream option today. Indeed, the economic challenge will not go away, because if we look ahead to 2010 or 2020 we can expect further (moderate) reductions in the cost of gas combined cycle plants.

This then poses challenges to policy makers as well as policy implementers: How do we make decisions in the short and long term about which of these technologies are likely to decline in cost most dramatically so as to take their place in the primary energy mix of the country, ultimately without subsidies? And what is the real cost of the external impacts of the new and current technologies? What policies level the playing field and which slant it too far?

**Deciding between the options**

A first approach to this, and perhaps the one most commonly offered, is 'We don't know, let the market sort this out'. This gives very little interesting information. A second and more dangerous approach, from a policy point of view, is that legislators become attached to a particular one of these technologies, and back it with policy instruments that distort the market.

Is there anything better than these two alternatives for answering the question? I think there is. It involves looking at what is going on in the world of science today that could impact the different areas of renewable energy.

Science covers a lot of ground, and each person believes that his or her own work is the 'hot' topic. But there is a broad consensus today that the action is in three main areas: biotechnology, information technology, and materials science (including nanotechnology). I would suggest that if we want to sort out renewables according to their prospects for dramatic cost reduction, we need to look at which ones will be impacted by developments in these three scientific fields.

**Impacts of new technologies**

The first thing to say is that, for the most part, information technology plays only a small role here. It plays a role in improving all aspects of manufacture, in control of the technologies once they are installed, in interfaces with the grid. But most of this applies to primary energy sources now in use as well, so there will be little relative improvement.

Turning to specific technologies, hydroelectricity is easiest to categorise, as it is technologically mature and has little to gain from any of the three scientific fields. I put tidal and wave in the same category. These are essentially low-tech renewables, involving large quantities of cement and turbines that are turned by the water power. They will show only the slow incremental improvement associated with lowering of manufacturing costs through volume production, and since they do not lend themselves to high volume production, probably very little of that.

At the other extreme are biomass (broadly defined to include waste) and photovoltaics.

**The line-up**

Energy derived from biomass is right at the heart of areas that can benefit from developments in biotechnology. It is not surprising to see that Craig Venter, one of the great entrepreneurs and thinkers of biotechnology, has turned his attention to this area, with the formation of his Institute for Biological Energy Alternatives. Whether it is for power generation, domestic/industrial/agricultural energy, or for transport, we can expect biotechnology to lead to improvements of several orders of magnitude in the organisms that are used (e.g. alga Chlamydomonas reinhardtii for hydrogen production, methanotrophs for methanol synthesis), and these will translate into big reductions in cost, coupled with the ability to produce energy at scale.

Photovoltaics are the other big winner. They benefit from developments in materials science. The state of photovoltaics today is indicative of this, with a number of different silicon and non-silicon technologies competing for commercialisation. Many more are on the horizon, including those just emerging from the laboratories of nanotechnology, and organic photovoltaics – still in the laboratory. It will take some time, but photovoltaics have the potential to be transformed by these developments.

Moreover, the small size of individual modules also could lead to a long-term cost advantage, as the benefits of mass manufacturing can be brought to bear. In this regard PV is unique among the renewables, unless wind projects become much more prevalent. Note that a degree of caution is required when comparing costs/kWhr for PV *vs.* other renewable sources, or non-renewable ones. PV is generally a technology that has to compete locally for electricity generation at the retail level, while wind feeds the grid and competes at the wholesale price.

Fuel cells, and hydrogen, are not inherently a renewable technology, and it is a frequent mistake of the popular press to characterise them that way. Of course, if hydrogen were produced from water via some form of solar power, this would be a renewable energy cycle, as the fuel cell then converts the hydrogen back to water. Fuel cells will also benefit from advances in materials science and even from biotechnology, given that certain enzymes are effective proton pumps.

Geothermal and wind are, I believe, somewhere intermediate. There are new ideas in geothermal power, some of them involving advanced materials and electronic devices. Unfortunately the application, rather than being general, is likely to be for specific niches. Wind may still derive some benefits from new materials of higher strength combined with easier manufacture, to facilitate operation in strong wind (although some believe most of this has already been achieved) and perhaps from information technology, in allowing optimisation for both wind strength and direction. These improvements may allow wind to earn and maintain a place in power generation.

## @ a glance...

The UK has set a target of generating 10 per cent of its electricity from renewable sources by 2010

There is great diversity amongst renewables, but all are more expensive than the power derived from the newest gas fired power plants

We need to decide which renewables technologies are likely to decline in cost most dramatically

To do this, we need to look at which ones will be impacted by developments in the three scientific fields where the action is: biotechnology, information technology, and materials science (including nanotechnology)

On this basis, biomass and photovoltaics are the most likely contenders, followed by geothermal and wind, with fuel cells and hydrogen least favoured

**How do we make decisions in the short and long term about which of these technologies are likely to decline in cost most dramatically so as to take their place in the primary energy mix of the country, ultimately without subsidies?**

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# Controlling chemical and biological weapons

Graham Pearson detects mixed messages

**The last couple of years have seen greater world-wide attention to weapons of mass destruction, whether possessed by 'rogue' states or by terrorist groups. The international community must do all it can to make their use unlikely. Its current efforts are sending somewhat mixed messages.**

Chemical and biological weapons are totally banned by separate international Conventions, and the states parties – those countries which have signed and ratified them – review the operation of each Convention every five years. The first review of the Chemical Weapons Convention is about to begin, and its prospects are encouraging with promises of steady consolidation of an effective regime. In contrast, the recent review of the Biological Weapons Convention was disappointing and was just rescued by agreement of a modest way forward.

**The Chemical Weapons Convention**

The use of chemicals as a weapon is totally prohibited under any circumstances by the Chemical Weapons Convention, which came into force in 1997. Its 148 states parties are meeting in The Hague on 28 April 2003 for two weeks, to carry out the first review. They will be required to take into account any relevant scientific and technological developments.

**The First Five Years**

The Chemical Weapons Convention obliges each state party never under any circumstances to develop, produce, otherwise acquire, stockpile or retain chemical weapons or to use chemical weapons. In addition, each state party is obliged to destroy any chemical weapons it possesses within 10 years from the entry into force of the Convention (i.e. by 2007), and to destroy or convert any chemical weapons production facilities. Four states parties – Russia, the United States, India and South Korea – have declared the possession of chemical weapons and, by the end of 2001, over 6,500 metric tonnes of agent had been destroyed in over 2 million munitions.

The prohibition of chemical weapons is all-embracing. The Convention[1] defines chemical weapons as 'Toxic chemicals and their precursors, ***except where intended for purposes not prohibited under this Convention, as long as the types and quantities are consistent with such purposes.***' The text in bold, known as the general purpose criterion, ensures that *all* chemical weapons, past, present and future, are entirely prohibited.

The Convention includes a verification regime under which states parties are required to make annual declarations relating to specific chemicals, known as the scheduled chemicals, which have been used as chemical weapons or as precursors, and relating to other chemical production facilities. Routine inspections to verify these declarations are carried out by the Organisation for the Prohibition of Chemical Weapons (OPCW), located in The Hague.

**Preparing for the Review Conference**

The International Union of Pure and Applied Chemistry (IUPAC) held a workshop in Bergen, Norway in July 2003 attended by 79 participants from 34 countries around the world. The report[2] of this workshop identifies the key scientific and technological issues to be taken into account at the First Review Conference. It highlights the global developments in chemistry and industrial facilities, particularly advances in synthetic methods and in chemical processing technology, which will pose new challenges to the Convention. It also outlines recent and probable future developments in analytical chemistry that might help the inspectors.

**Prospects for the First Review Conference**

Prospects for the conference are encouraging, with promises of steady consolidation of an effective regime. States parties need to seize the opportunity of the Review Conference to reaffirm the complete prohibition of chemical weapons, the importance of the general purpose criterion, and the enactment by all states parties of the necessary national penal legislation to implement the Convention nationally. The verification regime needs to be steered to ensure that the new challenges posed by developments in chemistry and in industrial facilities are effectively addressed. The states parties need to focus on what the Convention can do for them in creating a safer, more secure world.

**Checking for contamination after alleged use of chemical weapons**
***Organisation for the Prohibition of Chemical Weapons***





**Biological weapons: deliberate disease**

The deliberate use of disease as a weapon is totally prohibited by the Biological and Toxin Weapons Convention, which came into force in 1975. Its 146 states parties also review the operation of the Convention at conferences held at five-year intervals, at which they normally agree on a final declaration. This has the effect of strengthening both the norm that biological and toxin weapons are totally prohibited, and the prohibition regime, which – although less detailed than that for chemical weapons – provides a framework under which states parties can gain confidence that others are carrying out their obligations under the Convention.

**The Fifth Review Conference**

The Fifth Review Conference opened on 22 November 2001 and was scheduled to be completed by 7 December 2001. Given the anthrax attacks in the USA in September/October 2001, and international concern about biological weapons – as well as worries about the increasing pace of developments in biotechnology – expectations were high for a successful conference. However, just under two hours before the end of the conference, when the parties were very close to agreeing a final declaration, the US declared that the draft of a legally-binding compliance protocol (similar to the verification provisions in the Chemical Weapons Convention) would not enhance security from biological weapons, and tabled a proposal calling for the termination of the states parties' seven years of effort to negotiate it. This led to the conference being adjourned for a year.

The Review Conference resumed on 11 November 2002 with high expectations. After all, the words 'biological weapons' had been used in the last year more than ever before by President Bush and Prime Minister Blair, and global concern about and attention to bioterrorism had increased steadily. Although the US had appeared to be opposed to any form of further work, in the event the resumed conference, although regrettably finding a final declaration too difficult, agreed a modest step forward.

**Outcome of the conference**

Each year prior to the Sixth Review Conference in 2006, the parties will meet annually for one week, preceded by two-week expert meetings, to discuss and promote common understanding and effective action on:

i. The adoption of necessary, national measures to implement the prohibitions set forth in the Convention, including the enactment of penal legislation
ii. National mechanisms to establish and maintain the security and oversight of pathogenic microorganisms and toxins
iii. Enhancing international capabilities for responding to, investigating and mitigating the effects of cases of alleged use of biological or toxin weapons or suspicious outbreaks of disease
iv. Strengthening and broadening national and international institutional efforts and existing mechanisms for the surveillance, detection, diagnosis and combating of infectious diseases affecting humans, animal, and plants
v. The content, promulgation, and adoption of codes of conduct for scientists[3]

Topics i and ii will be considered in 2003, iii and iv in 2004 and v in 2005.

This outcome at least ensures that a continued dialogue takes place among the states parties, even though it seems unlikely that any follow-on action will be addressed until 2006.

**Empty shell or worthwhile progress?**

Many states parties particularly regretted the lack of a final declaration. Following the anthrax attacks of September/October 2001, they would have expected a declaration to underline states parties' obligations under the Convention.

The success of the new approach will depend entirely on the extent to which the states parties prepare for and engage in the annual meetings. As Ambassador Tibor Tóth, President of the Review Conference, has warned, without effective preparation and engagement, the new approach could just be an empty shell. Yet, there is undoubtedly an opportunity to make worthwhile progress at least nationally, and through the sharing of best practice, to make initial steps to improved measures internationally to implement the Convention.

## *@ a glance...*

The international community is sending mixed messages about strengthening the ban on chemical and biological weapons

The ban on chemical weapons looks as though it will be consolidated at the imminent review conference of the Chemical Weapons Convention

However, the recent review of the Biological and Toxin Weapons Convention (BTWC) was disappointing

Given the opposition of the United States to a legally-binding compliance protocol, all it could do was to agree a modest step forward

States which have ratified the BTWC must engage effectively in this step, otherwise it may prove to be an empty shell

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# Not a good ID

## Following the Government's consultation on entitlement cards, Simon Davies sounds a warning

**The Government's proposal for a national Entitlement Card has generated controversy over the potential impact on privacy and civil rights. While these are crucial issues, the consequences of the proposal are far more wide-ranging and significant. At its heart, the proposal creates the capacity for government surveillance on a scale rarely seen in the developed world.**


Mexican consulate issues ID cards in December 2001

The civil liberties argument against ID cards has been debated for more than two decades. Rights advocates have consistently argued that not only will such an initiative turn Britain into a more authoritarian society, but it will fundamentally change for all time the relationship between citizen and state, the nature of government, and the character of the nation.

## Modern ID cards

This profound impact is inevitable because the modern ID card of the last couple of decades is not merely a simple piece of plastic. It is the visible component of a highly complex web of interactive technology that fuses the most intimate characteristics of the individual, with the machinery of state. It is also the means by which legal and administrative powers of government can – in theory – be both streamlined and amplified.

Almost every national ID card system introduced in the last fifteen years has contained three components that have the potential to devastate personal freedom and privacy.

To begin with, each citizen may be obliged to surrender his finger print or retina print to a national database. This information is combined with other personal data such as race, age and residential status. A photograph completes the dossier. Then, in order to give the card the necessary legal gravity, its introduction must be accompanied by a substantial increase in police power. Authorities will, after all, want to demand the card in a wide range of circumstances, and people must be compelled to comply. The most significant, yet most subtle, element is that the card and its numbering system then form the administrative basis for a linkage of information between all government departments. The number is ultimately the most powerful element of the system.





## Technology and validation

Such a system, linked through tens of thousands of card readers to a central database, is the conventional means of dealing with the problem of counterfeit cards. The technology gap between governments and organised crime has now narrowed to such an extent that even the most highly secure cards are available as blanks weeks after their official introduction. Criminals and terrorists can in reality move more freely and more safely with several fake identities than they ever could in a country with multiple forms of ID.

To make sure people are who they claim to be, the new generation of cards – such as those introduced this year in Malaysia – incorporate a chip containing the 'biometric': a fingerprint, retina or hand scan of the holder. The card and the finger are placed into a reader, and the person is 'validated'. Authorities can access further personal information stored on the chip to confirm the holder's identity. This validation process can be undertaken on the street, in airports, schools, banks, swimming pools or office buildings.

These weighty outcomes are rarely promoted by government. Instead, such initiatives are benignly dressed up as 'citizen cards' that guarantee entitlement to benefits and services and which streamlines a person's dealings with government.

## Not then, not now

Five years ago, after the last debate over ID cards, the government quietly buried such proposals when it discovered that a card would cost billions of pounds more than expected, would do little to prevent crime, and may end up becoming a momentously unpopular initiative. How much more unpopular will the measure be when people learn that the system will demand a scan of their body parts?

The government seems to have forgotten this recent history. On the last two occasions that this proposal was seriously floated, it became clear that support for ID cards was patchy at best. The last time around (crime was the issue of the moment), even the Association of Chief Police Officers (ACPO) argued that a card would have little impact on crime and could damage the relations between police and the public.

Times and circumstances change, it is true, but if an ID card was unworkable five years ago, why would it work now? The short answer is that it would not work these days, unless the biometric was added and the whole system was verified through a national database. That is not a card: it is a national surveillance infrastructure.

### *@ a glance...*

The current generation of identity cards uses biometric data – fingerprint, retina print or hand scan – of the individual

The card is numbered and forms the administrative basis for a linkage of information between all government departments

Such cards will become internal passports, abused by officials who will use them as a mechanism for prejudice, discrimination or harassment

Australians, New Zealanders and Canadians have rejected such cards

The government should scrap the whole idea of an ID card and concentrate on more proven measures to deal with the problem of terrorism

## What will cards mean?

If such a scheme is introduced in the current climate, three outcomes are inevitable.

First, a high security ID card will become an internal passport, demanded in limitless situations. Don't leave home without it. Second, millions of people will be severely inconvenienced each year through lost, stolen or damaged cards or – more potentially devastating – through failure of the card's computer systems or the biometric reading machinery. Finally, as research by the human rights group Privacy International has shown, the cards will inevitably be abused by officials who will use them as a mechanism for prejudice, discrimination or harassment. This latter point was addressed by the High Court in 1954 when it outlawed the wartime ID card.

Other countries have also reached this conclusion. No common law country has ever adopted an ID card. When a national card was proposed in Australia in 1986, the idea was hastily scrapped after the biggest public campaign in recent history. The New Zealand and Canadian public have responded with similar vigour, while the United States has traditionally opposed national cards.

Cost is yet another consideration. Five years ago the government estimated that the overall cost of manufacturing and managing a card would be around £15 per head. The cost of a biometric card these days will run to at least £35. This adds up to an expenditure in excess of £2 billion. This figure may double when the cost of computer system modification is added.

So why is David Blunkett so keen on ID cards? No-one really knows, possibly least of all David Blunkett. The idea is superficially attractive, but other countries have discovered that the technology creates more problems than it solves. ID cards have always served as a sexy political response to a crisis, but a quick scan of countries with ID cards shows that their introduction in recent times usually turns into an administrative and social nightmare.

## Fighting terrorism?

No government has yet been able to identify any country where the presence of a card has deterred terrorists. To achieve such an outcome, a government would require measures unthinkable in a free society.

The government thus faces a grave choice. Either it introduces a high security biometric card that will surely challenge every tenet of freedom, or it introduces a low or medium security card that will soon be available to criminals and terrorists on the black market.

Or, of course, it can scrap the whole idea of an ID card and concentrate on more proven measures to deal with the problem of terrorism.

**The idea is superficially attractive, but other countries have discovered that the technology creates more problems than it solves**

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# Fat kittens

## John Postgate deplores the BBSRC's market ethos

**I read Julia Goodfellow's reflections on this topic (SPA, 12/2002) with growing dismay.**

Research: tragic market ethos

I welcomed her opening sentence, asserting that the public does not like industry's relationship with publicly-funded science. As a research scientist who spent his working life in publicly-funded research, my immediate response was: 'Nor do I, for God's sake! The public is absolutely right – what's her remedy?' But from then on it was downhill all the way. I finally learned that the BBSRC finds that everything is lovely, that entanglement with industry is jolly good for research, that we should applaud scientists who commercialise themselves – and that the public should learn to trust them!

Have we learned nothing from Britain's fiascos in transport, power, water, health, education?

No matter how Treasuries, Chancellors and politicians may wriggle, there are large areas of civilised society which simply have to be supported out of public funds; where the 'trickle-down' model of unconstrained capitalism simply does not work. Among such areas is basic scientific research.

Today, few major industries can get along without doing, or sponsoring, scientific research, but their research, quite reasonably, needs to bear upon the marketing interests of that industry and its shareholders' profits. In times of affluence, companies looking to exploit the latest scientific advances may embark upon relatively basic research projects, but come a recession or severe competition, then costs have to be cut – and basic research is the first to go.

Market-directed constraints not only limit the choice of research topics, they also entrain commercial secrecy. A company's researchers may not discuss their progress with scientific colleagues from outside, and often even within, the company lest they say something which might benefit a competitor, influence the company's stock market quotation or foul up a patent application. Any research findings which might have broad scientific value are slow to reach the scientific community because their publication is delayed, sometimes indefinitely, because industries wish to protect their investment.

This secrecy invades publicly-funded research institutions as well. A lamentable development of the past quarter century has been pressure by Government, through the Research Councils, to urge research scientists to form themselves into businesses, or into what are laughably called partnerships with industry. The intention has been to promote rapid practical application of fundamental discoveries, and indeed it has done this. But the longer-term effect has been to impede basic research by promoting secrecy and inhibiting communication between scientists. I have known laboratories funded by the taxpayer in which graduate students were forbidden to talk about their research to other students in the same room, let alone co-operate or help each other, because their respective research programmes were sponsored by different industrial concerns. What a dreadful way to train young scientists, let alone to advance knowledge!

The great majority of important, radical and useful scientific advances have originated from unconstrained, curiosity-driven research, a truism confirmed yet again when a huge 1998 survey by the USA's National Science Foundation revealed that 75 per cent of recent patent applications cited basic, publicly-funded research as the basis for their innovations.

Research today has an unwholesome atmosphere in which its objective is seen to be moneymaking rather than either the public good or the advancement of knowledge. We have even generated our Fat Kittens in science, analogous to the Fat Cats of our privatised utilities! Is it any wonder that the public mistrusts the whole set-up?

There has always been need for accountability, and for keeping an eye on the practical fallout of research, even during science's golden years of the 1950s and 1960s. And of course scientists can be starry-eyed about publishing for the benefit of mankind as a whole, and so lose patenting rights to quick-witted and grasping industries. But the pendulum has now swung to the opposite extreme. I find it tragic that the market ethos now dominates one of Britain's once universally-admired Research Councils.

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# Discrimination at the Royal Society?

**Dear Editor,**

In the October 2002 issue of S&PA, Dr Harris replies to Dr Gibson's discussion of the Royal Society. He fulminates against the idea that the Royal Society should be organised along the lines of 'a political party or social club where political correctness is all'. If he had reflected on the well-documented history of the Royal Society's track record on the admission of women[1], he would have found little evidence to sustain his assertion that the Royal is 'blind to a candidate's sex...'.

From the Sex Discrimination (Removal) Act of 1919 onwards, women were eligible for election into the Royal Society. However, no woman was proposed until Kathleen Lonsdale in 1943, despite Gowland Hopkins and William Bragg – whose laboratories had included numbers of outstanding women scientists – having been presidents of the Royal.

When Lonsdale was proposed, the President, then Sir Henry Dale, actively set about recruiting a second nominee (despite the convention that the President is not involved in elections), steadily reiterating 'one won't do' as the self-evident rationale for his actions. The second nominee (may I suggest rather more politically acceptable than the pacifist Lonsdale, who had served a prison sentence for her beliefs) was Margery Stephenson. As Dorothy Hodgkin observed, 'by this time Stephenson was elderly, already very distinguished, and could have been elected twenty years before, if anyone had thought to propose her.'

This record suggests that Royal Society's vaunted 'blindness to sex' was rather blindness to the achievements of one sex to the conspicuous advantage of the other. Nor does its miserable subsequent performance (around 3-4 per cent) inspire confidence that it has learnt from its own history. Where is the President of the Royal who will be as active as Dale and insist that 'three per cent won't do'?

Lastly, Dr Harris seems slightly out of touch with the management of modern research. Since the Amsterdam Treaty (signed up to by Britain), which mainstreamed gender, the European research system has been grappling with the problems of getting competent and qualified women more appropriately represented at every level of the system. Europe has recognised that both justice, and the need to have the most competent researchers involved, entails such an approach. The Royal's self- reproduction of the scientific elite by predominantly one gender and one 'race' is neither helpful to society nor science. The European research system is changing. Time for the Royal and Dr Harris to catch up.

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**Dear Editor,**

Hilary Rose is a famous discoverer, and occasional inventor, of glass ceilings, so much so that it is rumoured that Norman Foster sought her advice before finalising his design for the Centre Court of the British Museum. She is of course quite right to chastise the Royal Society for its appalling attitude to women scientists during the first half of the twentieth century. But then is then and now is now. Speaking as someone who has recent experience of the RS selection and election procedures, I can assure her that to suggest that today, the Society is biased against women, is so far off the beam as to be simply absurd. No selection system is perfect, but Hilary should look to closer to home to find an example of a real injustice.

I have no quarrel with Hilary and her ilk; it is the politicians that get up my nose. Why did Ian Gibson and his committee pick on that most hard-working and virtuous organisation, the Royal Society, for especial attention? My reaction is rather like Evelyn Waugh's when he heard that a biopsy taken from his friend, Randolph Churchill, had been found to be benign: 'How like the doctors to find the only part of Randolph which was not malignant, and then to cut it out!'

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# Repatriation of remains

**Dear Editor,**
**I disagree with Dr Foley (S&PA, December 2002), who argues that the collection of Aboriginal human remains is kept as part of the global human heritage and not the preserve of any one cultural group.**

In 1999, I wrote to Dr Foley requesting access to archives relating to the Aboriginal human remains held as part of the Duckworth Osteological Collection at Cambridge University. At that time I was a research officer for an Aboriginal organisation working on an Australian government-funded project documenting European collections of Aboriginal human remains. Dr Foley refused my request to provide further information about the collection.

Although Foley published a listing of Aboriginal human remains in the Duckworth Collection in 1992, it provides minimal detail. The University of Cambridge has a policy of returning the remains of known individuals to 'close kin'. However, by refusing access to archives, it is impossible to determine whether there are individuals within the collection that fulfil the University's own criteria for repatriation. It appears, therefore, that this collection is the exclusive domain of scientists wishing to study the remains, and is certainly not part of a 'global human heritage'.

The lack of provision of information to requesting Indigenous communities was recently criticised by the Commons Cultural, Media and Sport Committee.

While the University's own policy distinguishes between named individuals who have died recently and those in the distant past, many Aboriginal communities make no distinction between named or unknown individuals.

Institutions with collections of human remains must now be prepared to engage with those who may have a more personal, religious or spiritual interest in the collections they curate.

I agree with Jane Morris when she suggests that the heart of the issue is consent. The institutions must be prepared to engage with relevant communities and obtain consent for research on such sensitive collections, as is the case currently in Australia.

Finally, the relationship between Aboriginal communities and science does not have to be adversarial. There are many examples where researchers and scientists have worked closely with Aboriginal people and communities on projects with the informed consent of communities. It is when information is withheld, and consent not sought, that problems will occur.

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# The Madness of George II?

## Jack Harris considers a current irony

**America has entered one of its periods of historical madness, but this is the worst I can remember: worse than McCarthyism, worse than the Bay of Pigs and in the long term potentially more disastrous than the Vietnam War.**
***– John le Carré, The Times, 15 January 2003***

How I agree with John le Carré. The title of his article was 'The United States of America has gone mad' and I wondered if this was indeed so. Could President George Bush have gathered around him such a team of right-wing ideologists that they generate a sort of groupy madness, which is now dominating US government policy?

If anyone doubts the extreme folly of Bush's administration, consider its following actions and omissions: refusal to take part in UN light arms negotiations or even to discuss measures to prevent militarisation of space, continued failure to ratify the Comprehensive Test Ban Treaty and allocation of $15m (£9m) to increase the readiness of the Nevada test site to resume nuclear testing, walking out of discussions on implementation of the Biological Weapons Convention for fear of damaging commercial prospects of US pharmaceutical companies, continuing rejection of the Land Mines Convention, unilateral withdrawal from the Anti-Ballistic Missile Treaty, redefinition of the nuclear weapon protocols to permit tactical battlefield usage, exemption of the US from the International Criminal Court, proposal for the selling of oil and gas tracts in the Alaska Wildlife Preserve, withdrawal from the Kyoto Protocol, assumption of the right to imprison US and foreign nationals without trial or even charges being brought. The list seems endless.

### Star Wars II

Being dragooned into a dangerous war with Iraq isn't our only worry. Britain is being asked to allow the US to upgrade the Fylingdales radar station so that it can play a part in America's Ballistic Missile Defence system, also known as Star Wars II. Our government (surprise, surprise) has indicated it is likely to accede to this request. This would of course imply that Britain supported Bush's Ballistic Missile Defence (BMD) programme.

For American Republicans, BMD is more of an act of faith than a rational choice. Bush plans to spend $6-7b/yr (£3,800m - £4,400m) on anti-ballistic weapons defence in spite of the fact that $60b (£38,000m) has already been squandered on such programmes without tangible benefit. A negative effect is that it will prompt the Russians and Chinese to upgrade or expand their missile arsenals, and has already led to America withdrawing from the long-standing US/Russian Anti-Ballistic Missile Treaty.

### North Korea

In order to help to justify their new ABM programme, Bush has exaggerated the threat to America posed by North Korea. It is true that this maverick country has a successful missile industry and probably enough fissile material for a nuclear weapon or two, but it could not possibly present a threat to the American mainland. It does though, with its million-strong army and multiplicity of conventional weapons, threaten South Korea. It is also, with its unpredictable leader Kim Jong Il, ruled by a truly mad administration, much more so than even the Bush government.

From the start of his presidency, Bush seemed to attack the relatively amicable status quo between the US and North Korea. In a now notorious speech, he described Iraq, Iran and North Korea as the 'axis of evil'. Having sown the wind, he is now reaping the whirlwind. When North Korea admitted to having started to manufacture highly enriched uranium, Bush, apparently forgetting that it was fears of shortage of oil which led to the Japanese attacking Pearl Harbour in 1942, stopped the US providing North Korea with oil according to the existing agreement. Retaliation was inevitable and North Korea dismissed their international inspectors, restarted their graphite reactor programme and withdrew from the Non Proliferation Treaty. Perhaps too late, Bush is now trying to be conciliatory.

Jack Harris

The situation is very grave. America came into being partly as a result of the madness of our George III. How ironic that its reputation is being so badly damaged by the possible madness of its very own George II.

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# Cradle to grave

## Women face lifelong obstacles in science, argues Ian Gibson

**Over the Christmas break, I read the report of Baroness Greenfield on Women in Science, Engineering and Technology, which is now nestling on the desk of the Secretary of State for Trade and Industry.[1]**

I also read Brenda Maddox's account of the life of Rosalind Franklin, who played a significant role in the unearthing of the DNA structure – 50 years ago this year.[2] In the political world at Westminster, with eyes on the next general election (2005), political parties are vying for policies on representation of women in Parliament. The talk is of all-women short lists, encouraging better selection procedures, informal networks, positive discrimination, gender rights male and female, as everyone anguishes over the problem of looking modern and recognising gender equality.

### From prejudice to economic problems

The problem women face in developing careers in science, engineering and technology, is identified by Greenfield and her collaborators as not purely one with a social and cultural dimension, but also with strong economic aspects. Barriers exist, intentional or not, all the way through the school system to academia and industry. One major recommendation is to provide funding for women who have a career break to return to study, part-time or full-time, to work on a project or on research in academia and industry. Formal flexible working is becoming the vogue.

In contrast, Rosalind Franklin found prejudice during her full-time scientific career, which focused on personal attacks and whispering campaigns. She has, however, belatedly been recognised for her work in nucleic acid structures, although I cannot remember much mention of her work during the 1950s, 60s and 70s.

No doubt, as Greenfield progresses, we will have a working science centre addressing problems for women in science, which will be a focus for the media, head-hunters, government, industry and the professional societies; a returns scheme and an appraisal of employers in recruiting women and developing flexible working patterns.

**What is required is a cradle to grave report, which gives confidence to young women who are enthused and want to study science, engineering or technology.**

### Address earlier issues

Whilst these are welcome initiatives, there is little appraisal of the role of school in the education of scientists and the stimulation, or lack of it, given to young women in developing their interests and the prospects of a career, which too often ends in short term contracts.

The Commons Select Committee, in recent reports, illustrated this with cases where women can be on short-term contracts (three months to one year) for *all* of their scientific careers, and where enthusiasm for science is neutered by poor facilities, the lack of women science teachers who could feature as role models and a curriculum which fails to recognise the scientific matters which engage our young people – triple jabs, GMOs and so on.

Without these issues being addressed, what is the future for women in science, or indeed young men? The report addresses the problems for women in science now, at certain key stages post school.

What is required is a cradle to grave report, which gives confidence to young women who are enthused and want to study science, engineering or technology.

### Seizing the initiative

The development and practice of scientific skills in the work place environment is a social process, whilst reproductive rearing of children

Ian Gibson

is a private process, taking place largely in the enclosed family. The scientific career, like other careers, does not allow for this and there is no logical reason why a woman scientist shouldn't take time off and return again to her career path. This should be encouraged.

If you wait for employers to move, you will wait for ever. The government must seize the initiative of the Greenfield report and ensure that the prejudices faced by Franklin and outlined by Greenfield are recognised, monitored and steps taken to prevent the loss of a large sector of creativity and talent. It cannot be tackled in a piecemeal fashion. It demands a 'cradle to grave' approach.

*REFERENCES*

1. *Baroness Susan Greenfield,* SET Fair. *November 2002 www.set4women.gov.uk*
2. *Brenda Maddox,* Rosalind Franklin, The Dark Lady of DNA. *Harper Collins, 2002*

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