Europeans and Biotechnology in 2002

Eurobarometer 58.0

(2nd Edition: March 21st 2003)

A report to the EC Directorate General for Research from the project 'Life Sciences in European Society' QLG7-CT-1999-00286

by

George Gaskell*, Nick Allum and Sally Stares
(Methodology Institute, London School of Economics, London WC2A 2AE, UK)

with

Martin W. Bauer, Nicola Lindsay and Morag Brocklehurst (UK)
Wolfgang Wagner, Helge Torgersen, Nicole Kronberger and Petra Grabner (Austria)
Erling Jelsøe, Arne Mortensen, Jesper Lassen and Mercy Wambui Kamara (Denmark)
Timo Rusanen and Maria Rusanen (Finland)
Daniel Boy, Suzanne de Cheveigne, Julie Bardes and Jacqueline Chervin (France)
Jürgen Hampel, Matthias Kohring and Joerg Matthes (Germany)
Giorgos Sakellaris and Aglaia Chatjouli (Greece)
Agnes Allansdottir and Francesca Matteuci (Italy)
Cees Midden, Anneleos Meijnders and Jan Gutteling (Netherlands)
Torben Hviid Nielsen and Siv Froydis Berg (Norway)
Tomasz Twardowski and Andrzej Przestalski (Poland)
Correia Jesuino, Carmen Diego (Portugal)
Björn Fjæstad, Susanna Ohman and Anna Olofsson (Sweden)
Heinz Bonfadelli and Urs Dahinden and Martina Leonarz (Switzerland)

and North American associates
Edna Einsiedel and Robin Downey (Canada)
Toby Ten Eyck and Susanna Priest (USA)

The Eurobarometer survey was managed and organised by Directorate General Press and Communication, Public Opinion Analysis Unit.

* Coordinator of *Life Sciences in European Society*, G.Gaskell@lse.ac.uk

Contents

List of figures

List of tables

1 Summary of key findings

This is the fifth in a series of Eurobarometer surveys on biotechnology and the life sciences. The surveys have been conducted in 1991, 1993, 1996, 1999 and in 2002. The survey is based on a representative sample of 16,500 respondents, approximately 1000 in each EU member state (see report for exceptions). Survey design and analysis was conducted by a research group 'Life Sciences in European Society' supported by DG Research. In a year when many European countries are involved in public discussions on aspects of biotechnology, this survey stands as a contribution to the informed debate.

1.1 General attitudes to technologies and biotechnology

Europeans are not technophobic. The greater majority think that telecommunications, computers and IT, the internet, solar energy and mobile phones will improve our way of life over the next 20 years. Trend data since 1991 shows little change in optimism for telecoms, computers and information technology.

Two interpretations of the 2002 survey are possible. For some Europeans, the jury is still out on biotechnology - 25% said "Don't know" when asked whether it would improve our way of life or not, about the same percentage as in 1999. By contrast amongst those who expressed an opinion, 44% of Europeans were optimistic and 17% pessimistic about biotechnology.

In the period 1999-2002, optimism has increased to the level seen in the early 1990s after a decade of continuously declining optimism in biotechnology. An index of optimism shows an appreciable change from the declining trend of the years 1991-1999. This rise in optimism holds for the all the EU Member States with the exception of Germany and the Netherlands, where such a rise was observed between 1996 and 1999.

1.2 Attitudes to medical, industrial and agri-food applications of biotechnology

Judgments about six applications of biotechnology – genetic testing of inherited diseases, cloning human cells and tissues, GM enzymes for soaps, transgenic animals for xenotransplantation, GM crops and GM foods show that Europeans continue to distinguish between different types of applications, particularly medical in contrast to agri-food applications.

Genetic testing for inherited diseases is seen as useful, morally acceptable and to be encouraged (supported) and the same holds for cloning human cells and tissues, even though this application is also seen as a risk. These two applications are supported in all the 15 EU member states.

A majority of Europeans do not support GM foods. These are judged not to be useful and to be risky for society. For GM crops, support is lukewarm, while they are judged to be moderately useful they are seen as almost as risky as GM foods. While GM crops are supported in Spain, Portugal, Ireland, Belgium, UK, Finland, Germany and the Netherlands, with the exception of Belgium, all the countries that called for the extension of the de facto moratorium on the commercial exploitation of GM crops (France, Italy, Greece, Denmark, Austria and Luxembourg) have publics that are, on average, opposed to

GM crops. Overall support for GM foods is seen in only four countries - Spain, Portugal, Ireland and Finland.

GM enzymes for the production of environmentally friendly soaps is seen as useful and is supported by a majority of Europeans. Only in France is the balance of opinion opposed.

Xenotransplantation is perceived to be both moderately useful and moderately risky and is only weakly supported. It gains overall support in all EU countries with the exception of Finland, Greece and Austria.

1.3 Movements in European attitudes 1996-2002

Amongst a sub-group of 'decided' Europeans, support for genetic testing has been both high and stable over the period 1996 to 1999. For GM crops and GM foods support declined and opposition increased over the period 1996-1999. Between 1999-2002 there is almost no change in levels of support or opposition in Europe considered as a whole. However, within individual countries there are varying degrees of change.

1.4 Changes in attitudes in the 15 EU countries: a turning point in 1999?

All the EU countries, with the exception of Spain and Austria, showed moderate to large declines in support for GM crops over the period 1996-1999. Thereafter support more or less stabilises in France and Germany and increases in all the other countries with the exception of Italy, which sees a 10% decline in support.

For GM food there is a rather similar pattern to GM crops. With the exception of Sweden and Austria all the European countries showed moderate to large declines in support over the years 1996-1999. Post 1999, the majority of countries show an increase in support for GM foods with the exceptions of Germany and Finland, which are stable, and Italy, France and the Netherlands which show further declines.

In summary, support for GM food and crops has stabilised across Europe as a whole between 1999 and 2002. Within this general picture, most countries show small to moderate increases in support, while Italy shows a marked decline. (These findings are not inconsistent with 1.3 above. The relative stability of France and Germany, with large populations, attenuates the impact of increased support in other countries when looking at Europe as a whole).

1.5 The engaged public of biotechnology

The engaged public of biotechnology are, on average, more supportive than the less engaged. The 'engaged' are people who are more aware, knowledgeable and behaviourally involved in the subject. They are more likely to be male, better educated, white collar workers, urban dwellers and younger than 55. Countries with higher percentages of the engaged public include Denmark, Luxembourg and Finland and with lower percentages Spain, Portugal and Belgium.

Compared to the least engaged respondents, those with higher engagement are more likely to judge the six applications to be useful, morally acceptable and to agree that they should be encouraged. However, the judgment on risk is only marginally influenced by

the level of engagement with biotechnology. This suggests that for the engaged public, the risks are apparent, but in the context of perceptions of greater usefulness and moral acceptability, such risks are tolerated.

Biotechnology does not attract the interest of a narrow group of Europeans who are particularly exercised by this issue alone. Rather, those who are most engaged with biotechnology are 'generalists' - with interests in a wider range of public affairs. In this way public opinion on biotechnology is likely to derive in part from views about the credibility of wider political and scientific institutions, as well as those solely related to biotechnology.

1.6 Confidence in actors involved in biotechnology

Around 70% of Europeans have confidence in doctors, university scientists, consumer organisations and patients' organisations. Around 55% have confidence in scientists working in industry, newspapers and magazines, environmental groups, shops, farmers and the European Commission. However, less than 50% have confidence in their own government and in industry. For all the actors mentioned more Europeans think they are doing a good job than a bad job. Yet, across Europe as a whole about 25% lack confidence in farmers, shops, government and industry.

In 2002, all of the actors have a confidence surplus (the difference between the percentages seen as doing a good and a bad job). Those actors with a higher confidence surplus include doctors, patients' organisations, university scientists and consumers' organisations. At the lower end, but still with a confidence surplus are industry, government, farmers and shops. There is more confidence in the European Commission, than in national governments in relation to regulation – surpluses of 52% and 43% respectively. Confidence in university scientists is higher than for scientists working in industry – surpluses of 76% and 56% respectively. And, for the media, confidence about reporting on biotechnology is almost 60%.

While the confidence index shows few changes from 1999 to 2002, a sizeable change is seen for industry. In 1999 industry had a confidence deficit of minus 10%, but by 2002 this has shifted into a surplus of 23%. A possible explanation of this change is that the public's association with the term industry has changed from agri-foods to medical biotechnologies.

1.7 The acceptability of uses of genetic information

The results on the acceptability of various uses of genetic data suggest that this is a potentially controversial issue; public concerns need to be taken into account.
Respondents were asked whether they would or would not support six uses of genetic information. Three in the medical domain -genetic tests results being available to doctors, the testing of unborn babies for inherited diseases and having a test oneself for serious diseases; and three in the public domain – genetic testing for forensic purposes, by government agencies and for commercial insurance.

While the three disease related medical applications attract majority support, it is also apparent that a significant minority is concerned about these medical uses of genetic

information. In the context of crime detection, the European public is split - 43% in favour and 44% against. Access to genetic information by government agencies and by commercial insurance is widely seen as unacceptable.
Across the 15 EU states there is a North/South divide in the willingness to allow access to genetic information. Greece, Spain and Portugal are more relaxed than Austria, Sweden, Finland, Germany and Denmark. Is genetic testing likely to emerge as a civil liberties issue in Northern Europe?

The engaged public more supportive than the unengaged public on the medical uses of genetic information. But in the case of the public uses, access to genetic information by the police, government agencies and insurance companies, there is a consensus amongst the engaged and unengaged publics that this is unacceptable.

1.8 Arguments in favour of buying GM foods

There are mixed opinions on the acceptability of buying and consuming GM foods. Respondents were asked if they would buy or consume GM foods if they contained less pesticide residues, were more environmentally friendly, tasted better, contained less fat, were cheaper, or were offered in a restaurant. For all 'reasons' offered there are more Europeans saying they would not buy or eat GM foods than those saying they would. The most persuasive reason for buying GM foods is the health benefit of lower pesticide residues, closely followed by an environmental benefit. Somewhat surprisingly, of the range of benefits included in this question set, price is apparently the least incentive for buying GM foods. However, what people say and what they do are sometimes rather different, and here it is likely that people are thinking as a citizen rather than as a consumer.

In the different EU countries between 30% and 65% percent reject all the reasons for buying GM foods. Countries with the highest percentage of rejecters are Greece, Ireland and France and with the lowest percentage are the UK, Austria and Finland.

Amongst the remaining non-rejecters it is notable that the mean number of acceptable reasons is relatively high. Once a threshold of minimal acceptability is reached, then people are inclined to find a number of the reasons acceptable for buying GM foods. These results could be taken as indicating a more or less total rejection of GM foods and discussed in terms of the impossibility of introducing such new products. On the other hand, it could be argued that if GM foods actually offered some of these benefits, and if they were labelled appropriately to give the rejecters the opportunity to express their preference, then the products might capture a sizable market share.

1.9 Social and cultural values and biotechnology

Europeans are concerned about the fragility of nature and about the impact of human actions and technology upon nature. While materialist values are evidenced in support for the economic growth, there is little perceived 'harmony of interests' between citizens and the either the private sector or powerful multinationals. On social and political values Europeans are somewhat left of centre, supporting trade unions and income redistribution. The values related to nature and to materialism are related to beliefs about

biotechnology. Those more optimistic about biotechnology tend to be more materialistic and less concerned about nature.

1.10 Factors underlying support and opposition to biotechnology

Four factors are consistently associated with support for the six applications of biotechnology when a total of fourteen factors are considered simultaneously in a model. These are materialist values, optimism about technology, confidence in actors involved in biotechnology and engagement with the issue of biotechnology. Men tend to be more supportive than women but there is no significant difference between their attitudes to genetic testing and GM enzymes. Controlling for all the other factors, people aged between 15 and 39 are more supportive of industrial and agri-food biotechnologies than people over 55, but there are no age differences in support for medical biotechnologies. Contrary to expectation, in catholic countries, people have higher odds of support for cloning human cells and tissues than in the non-catholic countries.

1.11 Conclusions

The final section illustrates the dynamics of public perceptions and the need for continuing vigilance, drawing on the findings on GM foods and crops, medical biotechnologies and genetic information. Future scenarios point to the possibility of more sober discussions of risks related to GM foods and crops, and the growth of risk tolerant support in Europe. But, unless new crops and products are seen to have consumer benefits the controversies of the 1990s may be reactivated. Bio-medical applications underline the importance of benefits in the public's response to biotechnologies and suggests that the public adopts a more utilitarian approach than many official bodies. It is suggested that genetic information in forensic, social security and insurance contexts may become a new focus of controversy and conflict, particularly if this issue becomes linked to wider concerns such as civil liberties.

The Eurobarometer survey shows that what people think about biotechnology is also related to their wider interests and social values. For this reason future research shold continue to explore how particular perceptions of biotechnology are situated in the more general context of European social and political attitudes.

2 Introduction

This report presents an analysis of Europeans' perceptions of biotechnology in 2002, based on a Eurobarometer survey (Eurobarometer 58.0) carried out in the fifteen member states of the European Union, during September and October 2002. Recent reports from the European Commission and Parliament have emphasised the need for "societal scrutiny and dialogue"[1] and "public consultation as part of the process of a comprehensive and transparent legislative framework".[2] Many European countries are initiating public consultations as part of this new directive on deliberate releases of GMOs. Survey research, such as the Eurobarometer, may be considered as one of a number of instruments through which the public voice may be heard. Such research provides a systematic and dispassionate picture of the broader contours of public perceptions. But a survey should not be viewed as a referendum, it is not a vote for or against particular issues and it is not, in itself, a form of participation or dialogue with the public. Yet it can become a form of interaction with the public, if the views expressed by the public in their responses to the survey questions are noted and inform discussions and decisions on the future of the science and technology.

Two features of survey research deserve comment. First a survey inevitably frames issues in a particular way and respondents are restricted to answering the questions within the response alternatives presented. From prior qualitative research and the existing literature, the European team that devised the questionnaire have made every attempt to capture the significant currents of opinion about biotechnology and to set these questions in the context of relevant social scientific concepts. Secondly, survey data does not speak for itself, providing self evident truths. The selection and interpretation of data such as percentages involve prior assumptions and value judgments about what is relatively important and relatively less important. This report is our interpretation of the data, but there are other equally legitimate interpretations.

The survey is the fifth in the series of Eurobarometer studies of public perceptions of biotechnology.[3, 4, 5, 6] The series started in 1991 (Eurobarometer 35.1) and the second in 1993 (Eurobarometer 39.1), both conducted in the twelve member states of the European Community. In 1996 the third in the series, (Eurobarometer 46.1), covered the fifteen member states of the European Union. The fourth in the series (Eurobarometer 52.1) was conducted in 1999 and was also fielded in Norway, Switzerland, Canada and the United States. The new survey in 2002 included some key trend questions designed to assess the stability or change in particular aspects of public perceptions, together with some new questions devised to capture more recent issues and developments in the field of biotechnology.

2.1 The structure of the report

The report is divided into two parts. Part 1 provides an analytic description of Europeans' perceptions of biotechnology in 2002, with, where possible, time series comparative data. Part 2 is a technical annex and includes the English language survey questionnaire, details of the survey sampling, weighting and other relevant information.

2.2 Brief technical details

2.2.1 Sampling

In each of the 15 European countries, questions about topics related to biotechnology were put to a representative sample of the national populations over 15 years of age. There are 17 sample areas: one for each country of the European Union, in addition Germany is divided into East and West, and United Kingdom into Great Britain and Northern Ireland. Each sample area contains a number of interviews, although this number may be somewhat above or below that aimed at. The target is 1,000 per sample area, except for Northern Ireland, 300, and Luxembourg, 600. More details of the sampling procedure can be found in the Technical Annexe.

2.2.2 Weighting

For each EU member state, a national weighting procedure, using marginal (RIM) and intercellular weighting (Iterative Proportional Fitting - IPF), is carried out, based on this universe description. As such, in all countries at a minimum, gender, age and region are introduced in the iteration procedure. An additional factor is added to bring East and West Germany together in one entity. East Germany counts for 20.8% and West Germany counts for 79.2%. The same principle is used to bring Northern Ireland together with Great Britain, to form the United Kingdom. Here Northern Ireland counts for 2.5% and Great Britain, for 97.5%.

In order to make a European weight, the data is extrapolated using population figures for each sample area (15 members = 17 sample areas). This weight is used for all of the analyses presented in this report. Each country's influence on the Europe-wide figures presented is therefore proportional to its population relative to the combined population of the 15 member states. More details of the weighting procedure can be found in the Technical Annexe.

2.2.3 Split ballot design

The survey employed a split-ballot design. Fifty percent of the sample in each country received one of two versions of the questionnaire. Alternative questions were asked in each of the two versions in order to cover a wider range of topics than would have been possible using a single-ballot design. The question sets that utilise this feature are described in the main body of the report as they arise.

2.2.4 Abbreviations

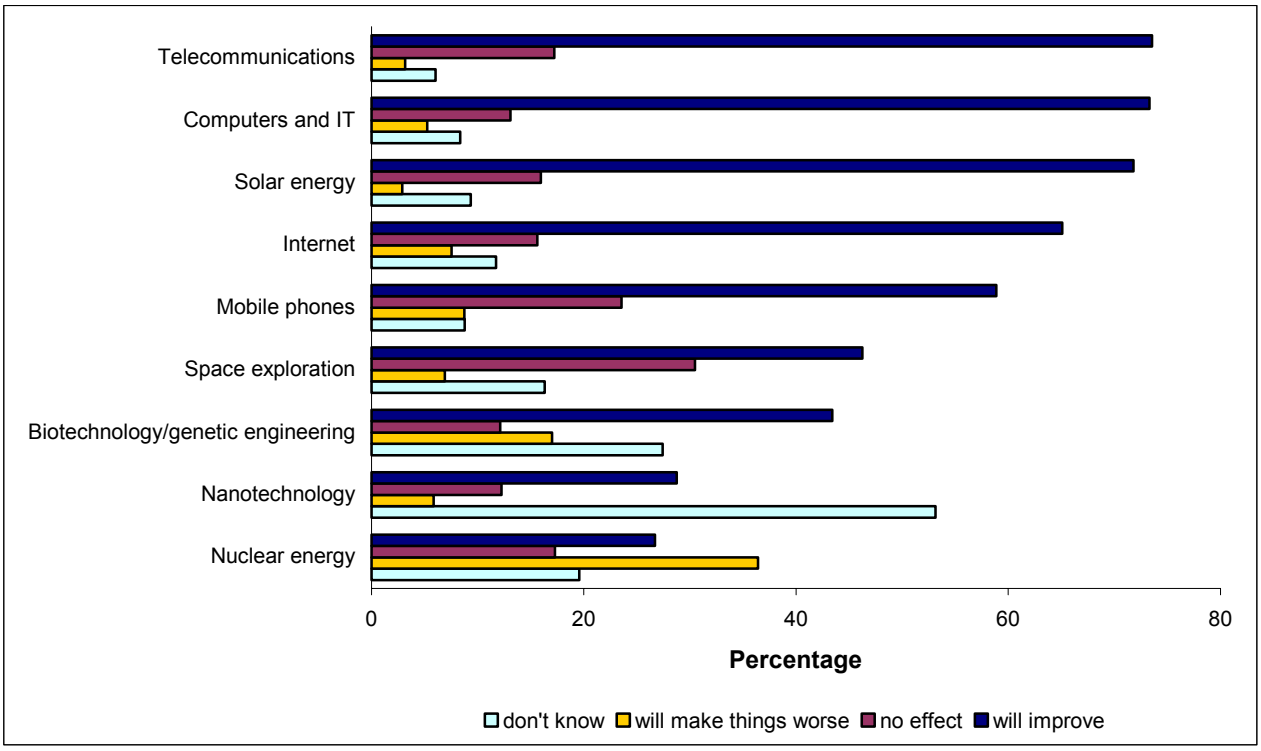
The abbreviations used for the member states are as follows:

B	Belgium	**I**	Italy	**LU**	Luxemburg	**FIN**	Finland
DK	Denmark	**E**	Spain	**NL**	Netherlands	**S**	Sweden
D	Germany	**FR**	France	**P**	Portugal	**A**	Austria
GR	Greece	**IRL**	Ireland	**UK**	United Kingdom		

3 Expectations about the impact of new technologies

In this section we look at Europeans' beliefs about some current and future technologies, including biotechnology and genetic engineering. Whether Europeans are optimistic or pessimistic about different technologies, and how such beliefs may have changed over time, provides a picture of the climate for technology in general - a context in which public views about biotechnology are formed. Since 1991 the Eurobarometer surveys have charted the public's general attitudes to science and technology. For each of six technologies (solar energy, computers and information technology, telecommunications, space exploration, the internet and biotechnology) respondents were asked, "*do you think it will improve our way of life in the next 20 years, it will have no effect, or it will make things worse?*" In the 1999 Eurobarometer nuclear energy was added to the list and in 2002, for the first time, mobile phones and nanotechnology were also included. The latter is a prospective technology with the potential for considerable impacts on European society over the coming decades. While in 2002 it is unlikely that many people will have had a clear representation of nanotechnology, it was included in the survey with a view to establishing a base line for studies in the future.

Figure 1 Impact of technologies on way of life

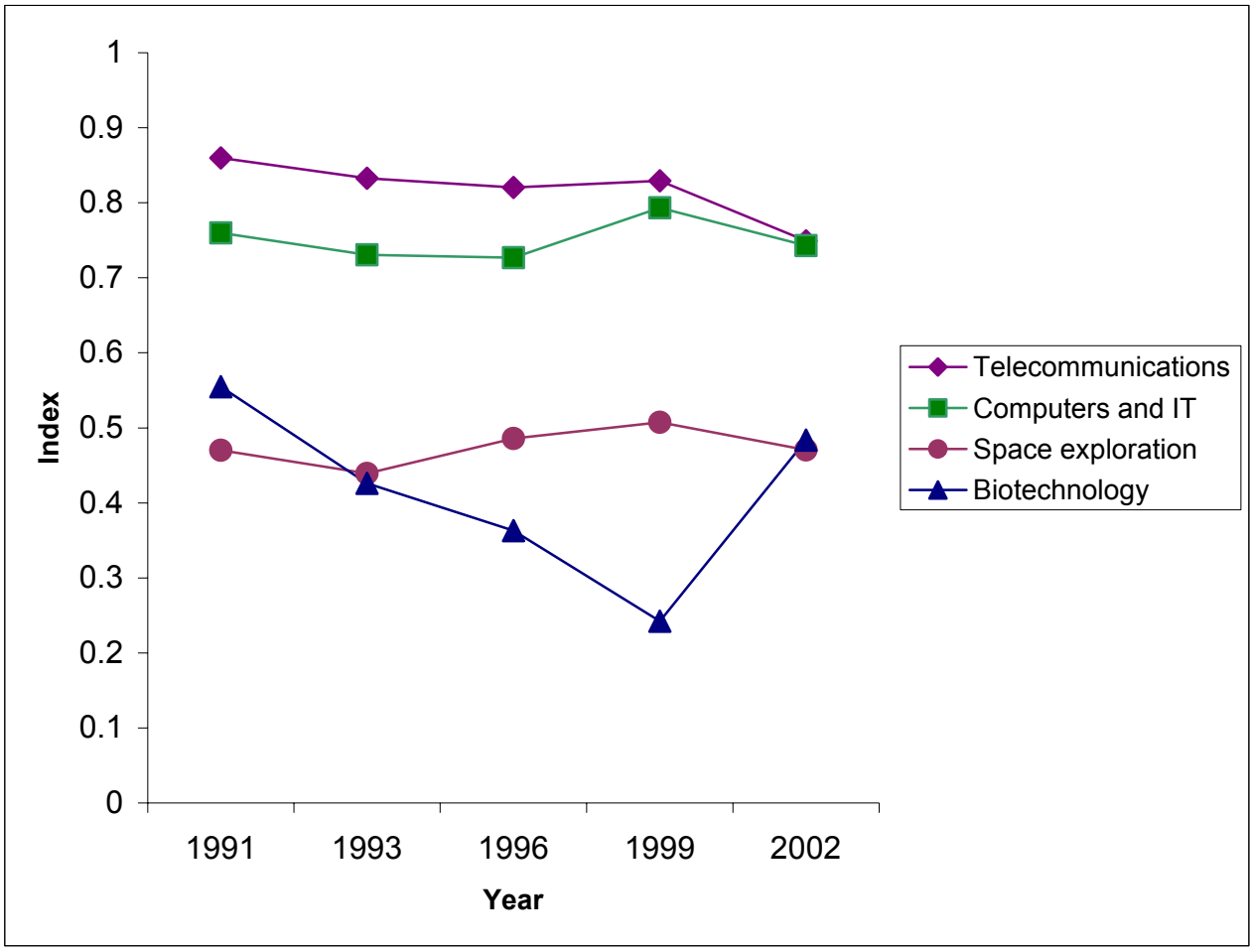


For biotechnology a split ballot was used with half the sample asked about "biotechnology" and the other half asked about "genetic engineering". For this analysis the combined results are used. Figure 1 shows that across the selected technologies Europeans are less optimistic about biotechnology and genetic engineering than the other technologies, with the exception of nanotechnology and nuclear power. That some 53% said "Don't know" about nanotechnology is hardly surprising. Yet of those who expressed a view, it is notable that five times as many thought it would improve our way of life, rather than make it worse. The contrast between the three so-called base technologies of the post World War Two years is striking. For modern biotechnology 43% are optimistic

and 17% are pessimistic. The comparable figures for nuclear power are 27% optimistic and 36% pessimistic; and for computers 73% optimistic and 5% pessimistic. It is notable that, notwithstanding the continuing controversies over GM foods and the high level of media exposure across many applications of biotechnology over the last three years, as many as 27% of Europeans said "Don't Know" to this question. By contrast "Don't Know " responses for computers were 8% and for nuclear power 20%. That the percentage of "Don't know" responses regarding biotechnology is about the same as in 1999, suggests either that the subject is still relatively marginal to people's everyday life or that weighing up the advantages and disadvantages of biotechnology remains now, as then, no easy matter.

The terms 'biotechnology' and 'genetic engineering', as in 1999, appear to have different connotations, although the gap is closing. 5% more Europeans see "biotechnology" as likely to improve their way of life in the future, than those asked the same question about "genetic engineering"; in 1999 the gap was 8%. The more positive connotation of biotechnology, perhaps a result of the association of "bio" with healthy and natural foods, holds across much of Europe with the exception of Italy, Spain and Portugal.

Figure 2 European optimism about technologies, 1991-2002



To assess the changes in technological optimism and pessimism over time (1991 through 2002) a summary index has been constructed. For this, the percentage of pessimists is subtracted from the percentage of optimists and the result divided by the combined

percentage of optimists, pessimists and those who say the technology will have no effect. In excluding the "Don't know" responses, this index is based on only those respondents who expressed an opinion. A positive score reflects a majority of optimists over pessimists, a negative score a majority of pessimists over optimists and a score around zero more or less equal percentages of the two. As the percentage of 'no effect' respondents increases so the index shrinks towards zero. This index has the following merits. Firstly it is an economical way of presenting the time series and country comparative data; secondly with substantial differences in the "Don't know" responses across countries the raw scores can be misleading, and thirdly it weights the balance of optimism and pessimism in relation to all the respondents who expressed an opinion on the question.

Looking at figure 2, the index of technological optimism shows a notable difference between the trajectories of biotechnology and the other technologies. Levels of optimism about telecommunications, computers and information technology and solar energy have been relatively stable over the decade. By contrast, optimism in biotechnology, which declined steadily over the period 1991-1999, rises appreciably between 1999-2002, back to the level of ten years ago. As seen in the survey responses, optimism in biotechnology fell from 50% in 1991 to 41% in 1999 and pessimism rose over the same period from 11% to 23%. From this nadir in 1999, by 2002 there are 43% optimists and 17% pessimists. But how is this change towards greater optimism across Europe as whole reflected at the country level?

Table 1 Index of biotechnology optimism 1991-2002

	1991	1993	1996	1999	2002	Mean 'don't know'
Spain	0.82	0.78	0.67	0.61	0.71	31
Sweden	-	-	0.42	-	0.61	18
Portugal	0.50	0.77	0.67	0.50	0.57	41
Italy	0.65	0.65	0.54	0.21	0.43	25
Belgium	0.53	0.42	0.44	0.29	0.40	24
France	0.56	0.45	0.46	0.25	0.39	22
Netherlands	0.38	0.20	0.29	0.39	0.39	21
Finland	-	-	0.24	0.13	0.31	20
Luxembourg	0.47	0.37	0.30	0.25	0.29	21
Ireland	0.68	0.54	0.40	0.16	0.26	36
Austria	-	-	-0.11	0.02	0.25	23
Germany	0.42	0.17	0.17	0.23	0.24	25
Denmark	0.26	0.28	0.17	-0.01	0.23	19
UK	0.53	0.47	0.26	0.05	0.17	29
Greece	0.70	0.47	0.22	-0.33	0.12	44
Mean (%) 'don't know'	32	28	25	27	26	27

Turning to the European country level, table 1 shows the index of optimism for biotechnology over the period 1991 to 2002. The countries are ordered from the most to

the least optimistic in 2002. It is informative to divide the time period into two phases – pre and post-1999. In the pre-1999 phase the majority of countries follow the wider European trend of declining scores on the index of optimism, despite the balance still favouring the optimists. The exceptions are Denmark and Greece where the outcome of this decline results in a majority of pessimists, as shown by a negative score on the index. The other exceptions are the Netherlands and Germany, where following a decline in the early nineties, the index of optimism shows an upward movement by the end of the decade.

By 2002 all the European countries have a majority of optimists and in all but two countries there is an increase in the index of optimism post-1999. Interestingly, the countries in question are the Netherlands and Germany, where the trend of increasing optimism at the end of the 1990s comes to an end; in both countries there is no change in the index of optimism in the post-1999 phase.

The consistency in the direction of change in the public optimism about biotechnology pre and post-1999 is quite remarkable. Albeit countries start from different levels of optimism about biotechnology. But that they almost all move in a similar direction in the period 1991-1999 and then move in the opposite direction post-1999 invites further consideration. Whatever the explanation (or explanations) for this change, it is unlikely to be located at a uniquely national level. It seems more likely that it is a consequence of events, or changes of some other type that may have occurred across Europe as a whole.

3.1 Technological optimism: implications

What conclusions can be drawn from the data on optimism and pessimism about technologies in general and biotechnology in particular? First, it is clear that Europeans cannot be characterised as technological luddites or suffering from a symptom of generalised technophobia. There is overwhelming optimism about the contribution to society of telecommunications, computers and information technology, solar energy and the internet. Second, Europeans assessments of technology cannot be described as driven by a generalised risk aversion. The possible health and environmental risks of mobile phones have been widely discussed, yet for every pessimist about mobile phones there are about seven optimists. Third, and perhaps contrary to expectation given the results for 1991-1999, there has been a shift towards greater optimism about biotechnology. With the exception of the Netherlands and Germany, where such a shift occurred in the years 96-99, all the European countries are now more optimistic about biotechnology and all now have a majority of optimists over pessimists.

There are a plethora of possible explanations for this movement towards greater optimism. Could it be that the de facto moratorium on the commercial exploitation of GM crops has taken the heat out of this particular controversy? Or could it be due to the promise of new medical interventions following the completion of the sequencing of the human genome? One of the agendas of this report is to see whether the analyses of other questions in the Eurobarometer survey show complementary changes in perceptions and provide some insights into the rising levels of optimism.

4 Evaluating applications of biotechnology

We now turn to public perceptions of six applications of biotechnology. The six include medical, industrial and agri-food applications. How, if at all, has the post-1999 increase in optimism about biotechnology affected public perceptions of particular applications of biotechnology? Respondents were asked whether they thought the applications of biotechnology were *useful for society, risky for society, morally acceptable* and whether they should be *encouraged*. The response alternatives for these questions were 4-point Likert type scales (definitely agree, tend to agree, tend to disagree and definitely disagree). For each country, the split ballots, A and B were used. Each respondent received one of the two versions of the survey in each of which three applications were presented.

Split ballot A

- Genetic testing: using genetic tests to detect inheritable diseases such as cystic fibrosis mucoviscidosis, thalassaemia.
- Xenotransplantation: introducing human genes into animals to produce organs for human transplants, such as into pigs for human heart transplants
- GM Food: using modern biotechnology in the production of foods, for example to make them higher in protein, keep longer or change the taste.

Split ballot B

- GM Crops: taking genes from plant species and transferring them into crop plants to increase resistance to insect pests.
- GM Enzymes: using genetically modified organisms to produce enzymes as additives to soaps and detergents that are less damaging to the environment
- Cloning human cells: cloning human cells or tissues to replace a patient's diseased cells that are not functioning properly, for example, in Parkinson's disease or forms of diabetes or heart disease. (Note that in the 1999 survey this question did not include the three examples of the uses of cloning human cells.)

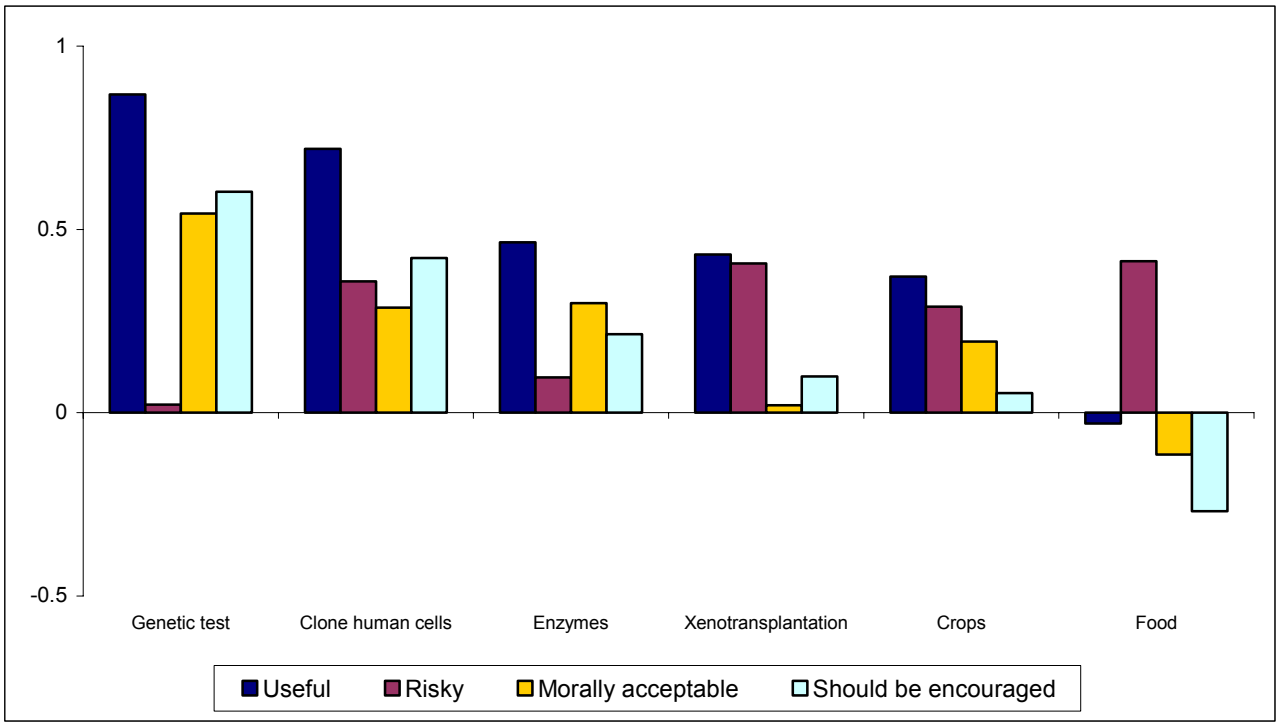
Figure 3 shows the mean scores on a scale ranging from +1.5 to –1.5 for the assessments of use, risk, moral acceptability and should be encouraged for each application. (The raw data have been recoded from 1 to 4 into -1.5 to +1.5 in order to show the midpoint of zero on the figure). Note that all "Don't know" responses are excluded and that the six applications are ordered from right to left by the level of encouragement.

The figure shows, as indeed was the case in 1999, that it makes little sense to talk of European public perceptions of biotechnology as if people were evaluating a single entity.[7] The European public continue to distinguish rather sharply between different applications. Looking at the left hand side of figure 3, genetic testing is perceived to be useful, only slightly risky (just above the zero midpoint), morally acceptable and to be encouraged. In comparison to the other applications, genetic testing is seen as more useful, less risky, more morally acceptable and supported. (For the remainder of this report we use the terms encourage and support interchangeably). On the far right of the figure, it can be seen that a majority of people disagree that genetically modified foods are useful, agree that they are risky, find them morally unacceptable and are not prepared to support them. The distinction between medical – the so-called "red" biotechnologies and

agri-food – so-called "green" biotechnologies is apparent. Of the "red" biotechnologies, genetic testing for inherited diseases, and the cloning of human cells and tissue to combat conditions like Parkinson's disease and diabetes are widely supported.

Contrary to what might be expected the term 'cloning' does not lead to automatic rejection. When cloning is employed in an application that is seen to be useful, people are prepared to discount the risks and affirm support. The 'green' biotechnologies attract much less support. A majority would not encourage GM foods, while GM crops gain very modest support.

Figure 3 European attitudes to six applications of biotechnology in 2002



The greater opposition to GM foods over GM crops, reflected in perceptions of lower usefulness, higher risk and lower moral acceptability, suggests that Europeans may be more concerned about food safety than the environmental impacts of agri-food biotechnologies. This is not to say that Europeans lack environmental concerns. The industrial application of biotechnology - the production of GM enzymes for environmentally friendly soaps - is judged to be useful and is supported by a majority of the public. Finally, in the case of xenotransplantation, people perceive both moderate risks and benefits while being ambivalent about its moral acceptability. These considerations lead to only weak support.

4.1 Support for biotechnology across Europe

Turning from Europe as a whole to the individual countries, table 2 maps the relative levels of support for the six applications and ranks the countries from the most supportive (Spain) to the most opposed (Austria). In the table, a single '+' or '-' represents a mean score in the range of 0 to plus or minus 0.49, while '++' and '--' represent mean score of plus or minus 0.5 and greater.

In all countries, public attitudes towards genetic testing are supportive and the same holds for cloning of human cells and tissues. That this application of cloning gains such support may be surprising, given the controversy it has raised in some countries. GM enzymes are supported in all countries with the exception of France. Xenotransplantation attracts moderate support in all countries except Finland, Greece and Austria. National attitudes to GM crops and GM foods are mixed. In four countries, Spain, Portugal, Ireland and Finland, there is support for both GM crops and food. Of the countries where a majority of people are negative about GM crops, a majority are also negative about GM foods. Countries supporting GM crops but not GM foods are Belgium, UK, Germany and the Netherlands.

Table 2 Level of support and opposition for six applications in 2002

	Genetic tests	Clone human cells	Enzymes	Xeno	Crops	Food
Spain	++	++	++	+	++	+
Portugal	++	++	+	+	+	+
Ireland	++	+	+	+	+	+
Belgium	++	+	+	+	+	-
Sweden	++	++	+	+	-	-
Denmark	++	+	+	+	-	-
UK	++	+	+	+	+	-
Finland	++	+	+	-	+	+
Luxembourg	++	++	+	+	-	--
Germany	+	+	+	+	+	-
Italy	++	++	+	+	-	-
Netherlands	+	+	+	+	+	-
France	++	+	-	+	-	--
Greece	++	+	+	-	-	--
Austria	+	+	+	-	-	-

++	Strong support	(0.5 and above)
+	Weak support	(0.0 to 0.49)
-	Weak opposition	(0.0 to -0.49)
--	Strong opposition	(-0.5 and below)

Interestingly, with the exception of Belgium, all the countries that called for the extension of the de facto moratorium on the commercial exploitation of GM crops (France, Italy, Greece, Denmark, Austria and Luxembourg) have publics that are, on average, opposed to GM crops.

4.2 Have attitudes changed since 1999?

For all but one of the applications (GM enzymes) time series data is available from previous Eurobarometer surveys. Genetic testing, GM crops and GM foods were included in the 1996 and 1999 surveys. Cloning human cells and tissues was included in 1999, (but without the three examples), and xenotransplantation in 1996. The data from the past surveys provides a basis for mapping changes in attitudes.

However, making simple comparisons between the mean scores is not appropriate as the format of the questionnaire changed from 1996 to 1999. In 1999 and 2002, survey respondents were asked whether or not they had heard about each application before giving their judgments of usefulness, risk, moral acceptability and encouragement. This prior question provided a basis for distinguishing between those respondents who were more likely to have an attitude formed before the survey, or at least some prior knowledge of the topic, and those who, it may be assumed, formed a judgment on the spot, probably without much relevant information. As a consequence of this prior question concerning awareness of the particular applications, there was a significant increase in the percentage of "Don't Know" responses in 1999 as compared to 1996.

4.2.1 Logics underlying support and opposition

In the light of this a way of comparing patterns of judgments over time was developed. The judgments of use, risk, moral acceptability and encouragement were each collapsed into a dichotomy (useful/not useful, risky/not risky etc.). This produces 16 possible combinatorial "logics", of which in practice only three were each used by more than 10% across the six applications. (see table 3). The following analysis of change over time uses only those respondents who gave a full set of responses consistent with one of the three common logics. These people, whom we call the 'decided public', constitute comparable sub-samples for 1996, 1999 and 2002.

Table 3 Three Common Logics

Logic	Useful	Risky	Morally Acceptable	Encouraged
1. Supporters	yes	no	yes	yes
2. Risk Tolerant Supporters	yes	yes	yes	yes
3. Opponents	no	yes	no	no

Logics 1 & 2 are similar in being supportive, but they display different perceptions of risk. For the "supporter", risk is not an issue. The "risk tolerant supporter" perceives risk but then discounts it. Opponents take a position exactly opposite to that of supporters. Table 4 shows the logics of support for each of the 6 applications used in 2002, and time series comparisons with the 1996 and/or 1999 Eurobarometers where there is available data.

It is important to bear in mind that the figures in the three columns are based on only those respondents who held one of the three common logics. As such column 1, 1996, is based on 58%of the sample. Column 2, for 1999 is based on 49% and column 3, for 2002 reflects 45% of the sample. The decline in the percentage from 1996 to 1999 is likely to be the result of the added new filter question. Thus it would not be appropriate to say, for example, that in 2002 some 48% of Europeans are outright supporters of genetic testing. Rather it can be concluded that 48% of the 'decided' Europeans (those with one of the three common logics) are outright supporters of genetic testing. On this basis we can be reasonably confident about observed changes in support and opposition from 1996 to 2002.

Over the past six years, support and risk-tolerant support for genetic testing has held roughly constant. The 7% decrease in outright supporters is partially compensated by a 4% increase in risk tolerant supporters, and opposition increases by 3%.

Table 4 The logic of judgments for six applications of biotechnology

		1996 (Base ≅ 58%)	**1999** (Base ≅ 49%)	**2002** (Base ≅ 45%)
Genetic Testing	Supporters	55	52	48
	Risk tolerant supporters	39	41	43
	Opponents	6	7	9
Crops	Supporters	45	36	36
	Risk tolerant supporters	35	33	34
	Opponents	20	32	30
Food	Supporters	30	23	22
	Risk tolerant supporters	31	26	28
	Opponents	39	52	50
Cloning human cells	Supporters	-	32	32
	Risk tolerant supporters	-	49	50
	Opponents	-	19	17
Xenotransplants	Supporters	23	-	29
	Risk tolerant supporters	33	-	44
	Opponents	45	-	27
Enzymes	Supporters	-	-	45
	Risk tolerant supporters	-	-	33
	Opponents	-	-	22

These changes however are on the margins of sampling error. Amongst the 'decided' Europeans, this medical application retains the support of over 90% of Europeans when the two supporting logics are combined. For GM crops, both categories of support declined and opposition increased between 1996 and 1999. Post 1999 there is virtually no change. Overall support in 2002 is 70% and opposition 30%. GM food has a similar trajectory to GM crops. Between 1996 and 1999 both categories of support declined and opposition increased. Post 1999 there is again virtually no change. Amongst the decided public in 2002, overall support and opposition for GM foods is equally divided. The time

series data for cloning human cells and tissues covers 1999 and 2002. Support for this application is unchanged, with an aggregate level of 82%. For xenotransplantation, the two available time points are 1996 and 2002. Over the six year period, the two categories of support increase from 56% to 73%, while opposition declines by 18% to 27%. Finally, in the case of industrial GM enzymes, there are 78% supporters and 22% opponents within the decided public.

What general implications can be drawn from these shifts in the two types of support and opposition? To what extent do the observed changes in judgments of the specific applications match the trend for biotechnological optimism? For genetic testing the trend, if any, is small. There is a hint of a movement from outright support to risk tolerant support and equally a hint of rising opposition. The most notable observation, however, is the continued high level of support for this medical application. This, as will be seen in section 6, should not be interpreted as general support for genetic testing for other purposes, but limited, as suggested by the question wording, to testing for inherited diseases.

For GM crops and GM foods pattern of change corresponds in part to the trend previously described for biotechnological optimism. Here there was a consistent downward trend from 1991 to 1999 and then an appreciable increase between 1999 and 2002. GM crops and GM foods match the first part of this trend. Both categories of support declined between 1996 and 1999, and opposition increased. Thereafter, but unlike biotechnological optimism, which took an upward turn in the years 1999-2002, both GM crops and GM foods stabilised. A similarly stable position over the period 1999-2002 is observed for the cloning of human cells and tissues.

4.3 How support, risk tolerant support and opposition has changed in the European countries

Further insights into changes in public perceptions can be seen by comparing shifts in attitudes on the six applications across European countries. Table 5 follows the logics analysis described above. For each application the columns are based on the combination of the two types of support (supporters and risk tolerant supporters). Once again, this analysis is based only on the 'decided public' as previously defined and in this sense the percentages should not be read as population estimates.

Table 5, based on the 'decided public' shows the percentage of supporters and risk tolerant supporters for the three applications included in 1996, 1999 and 2002 for each European country. For genetic testing, with a few exceptions, there is relatively little change over time. Between 1996 and 1999, support declined in Belgium, Greece and Luxembourg. From 1999 to 2002, Luxembourg returns to the level of support seen in 1996 and Germany shows a decline in support of 5%. In all the other countries support for genetic testing is high and stable.

Turning to GM crops, again there is considerable consistency across the European countries paralleling the trajectory of biotechnological optimism. From 1996 to 1999 all countries with the exception of Spain and Austria show moderate to large declines in support. Thereafter support more or less stabilises in France and Germany and increases

in all the other countries with the exception of Italy, which sees a 10% decline in support. A rather similar and consistent pattern with a turning point in 1999 is observed for GM foods.

Table 5 National changes in support for applications of biotechnology 1996-2002

	Genetic Testing			GM Crops			GM Food		
	1996	**1999**	**2002**	**1996**	**1999**	**2002**	**1996**	**1999**	**2002**
Belgium	95	90	92	89	74	80	72	47	56
Denmark	91	91	93	68	58	73	43	35	45
Germany	87	90	85	73	69	67	56	49	48
Greece	97	91	92	77	45	54	49	19	24
Italy	97	95	95	86	78	68	61	49	40
Spain	96	94	94	86	87	91	80	70	74
France	96	94	92	79	54	55	54	35	30
Ireland	96	94	94	84	67	77	73	56	70
Luxembourg	91	85	91	70	42	54	56	30	35
Netherlands	93	96	96	87	82	85	78	75	65
Portugal	97	96	93	90	81	84	72	55	68
UK	97	96	95	85	63	75	67	47	63
Finland	95	91	94	88	81	84	77	69	70
Sweden	92	92	93	73	61	73	42	41	58
Austria	74	78	78	39	41	57	31	30	47

With the exception of Sweden and Austria all the European countries show moderate to large declines in support over the years 1996-1999. Post 1999, the majority of countries show an increase in support for GM foods, as much as 16-17% in the UK, Sweden and Austria. The exceptions are Germany and Finland, which remain stable, and Italy, France and the Netherlands, which show further declines.

In the broader context of agri-food biotechnologies, Italy is an exceptional case in showing consistent and large declines in support for both GM crops and GM foods from 1996 to 2002. It is tempting to attribute this to the food culture as seen in the 'Slow Food' movement.

A further issue concerns those countries in which increases in support are observed in the post 1999 period. Clearly this amounts to a decline in opposition, but what is the balance between increases in outright and risk tolerant support? Excluding France, Italy and the Netherlands the average change in levels of support from 1999 to 2002 in the other twelve countries is 7%. Of these 6% are 'risk tolerant supporters' and 1% 'outright supporters'. A similar, but smaller trend is also observed for GM crops. The relatively greater increase in risk tolerant support is suggestive of a decline in risk aversion.

5 The 'engaged' public of biotechnology

In this section, we develop a model of an 'engaged' public of biotechnology. This draws on two strands of research. The first links people's attitudes to science with their scientific knowledge. The second linking participation in politics with political knowledge and

interest. The relations between attitudes to biotechnology and levels of engagement with biotechnology are then explored.

There has been a long standing interest in 'scientific literacy' and the public understanding of science.[8, 9, 10] A scientifically literate public, it is argued, is a prerequisite for effective democratic participation on issues of science and technology; all the more relevant as governments are increasingly taking up the idea of public participation and consultation about the direction of new technological developments. Scientific literacy appeals to a widely held belief among scientists and regulators that an informed public will also tend to be more supportive of science and technology. This view, supported by findings of moderate correlations between scientific knowledge, and interest in and support for science has been called the 'deficit model' of the public.[11, 12, 13, 14, 15, 16] For instance, Allum, Boy and Bauer found that within most European countries, the correlation between scientific knowledge and a composite measure of attitudes to biotechnology ranged between 0.15 and 0.20.[11] Evans and Durant found that scientific knowledge and general attitudes to science in the UK were correlated at 0.30.[15] Two implications follow from this model. Firstly, that opposition to new technologies is grounded in ignorance or mis-information, sometimes presumed to be the result of biased media reporting. And secondly, that information campaigns to inform the public about the 'facts' and methods of science will be effective in cultivating greater public confidence in science and technology.

However, the finding that those who have greater scientific knowledge tend to be more supportive of science and technology does not mean that scientific knowledge itself is the key determinant of attitudes to science and technology. It might be just the reverse. Supporting science, for example in the belief that it will bring progress, may make people more interested in matters of science, prompt them to be attentive to media coverage of science and encourage them to find out more about it. And the same could be true for the active opponents of science and technology. Their critical position may well motivate them to take a considerable interest in new scientific developments, which they see as a threat to society. Hence, the deficit model of the public as an explanation of public attitudes to science and technology is open to question and the role of the central construct, 'scientific knowledge' problematic. Perhaps the most that can be claimed, and it is not an unimportant claim, is that scientific knowledge, like knowledge of the political system for example, is a resource with which citizens may understand scientific developments and contribute to public debates on such issues.

Our approach builds on the concept of the 'issue public', taken from political science.[17] Members of the 'issue public' are more likely to be better informed and to seek out new information on political issues, to have a coherent belief system, more resistant attitudes and to be more likely to participate in political processes such as elections. We showed that this concept could be usefully applied to public perceptions of biotechnology using data from the 1999 Eurobarometer survey.[7]

In light of these considerations, we identify the 'engaged' public of biotechnology using not only knowledge of biology and genetics, but also other relevant indicators. These concern past and intended behaviours and awareness of biotechnological applications.

5.1 Reported and intended behaviours

Respondents were asked three questions relevant to their engagement with biotechnology:

- '*Before today had you ever talked about modern biotechnology with anyone?* (response categories: frequently, occasionally, once or twice, or never)

- '*I would take the time to read articles or watch TV programmes on the advantages and disadvantages of developments in biotechnology*' (response categories: tend to agree, tend to disagree and don't know)

- '*I would be prepared to take part in public discussions or hearings about biotechnology'* (response categories: tend to agree, tend to disagree and don't know)

Those responding either 'frequently' or 'occasionally' to the first question were given a score of one, as were those responding 'tend to agree' to the second and third questions. We would expect that these three behavioural indicators would be inter-correlated. For example, those who had talked about biotechnology before would be more likely to be interested in a television programme on the topic. And this is confirmed by a test that shows that the items form a cumulative scale with adequate statistical properties (Cronbach's alpha = 0.50). Hence we can create a summary score of behavioural involvement for each respondent.

5.2 Awareness of biotechnologies

Following the concept of the issue public in political science, we expect, in accordance with our results from the 1999 Eurobarometer that those who are behaviourally involved with biotechnology are likely to have heard more about the subject and, as such, be aware of a greater number of applications of biotechnology. Before respondents gave their views on each of the three applications of biotechnology (as described in section 3) they were asked the question

- "*have you heard of this application of biotechnology before, or not?*"

The three items form a reliable scale (Cronbach's alpha = 0.67) and provide an index of awareness of biotechnologies for each respondent, with a range from 0 to 3.

5.3 Knowledge of biology and genetics

The 1999 Eurobarometer survey included a set of questions about basic biology and genetics, many of which were also asked in the 1996 survey. Respondents were asked to say "true" or "false" in answer to each (a "Don't Know"' option was also available). The questions were of two types. First, there was textbook knowledge - the kind of facts that a person might learn at school or from a popular science magazine or television programme. Seven such items were included in the survey.

The second type of knowledge question, while factual in nature, was also designed to assess what can be best described as menacing images of food biotechnology. For these image items, which were developed from qualitative research prior to the 1996 Eurobarometer survey, an incorrect answer reflects a lack of scientific knowledge, but also

an inclination to assent to the idea that food biotechnology is associated with adulteration (q3), infection (q4) and monstrosities (q8). Table 6 shows the knowledge questions and the percentages of correct answers for Europe as a whole for 1996, 1999 and 2002.

A first point to note is that correct answers to question 5 have increased from 44% to 53% from 1999 to 2002. For methodological reasons the focus of the question was changed from the "father's " genes in 1999 to the " mother's " genes in 2002. Given that no other question shows such a sizeable change, we are inclined to assume that the result reflects more on the question wording than on real changes in knowledge. As such we will not consider this question further, particularly in time series comparisons.

For the other questions, those dealing with biology (q1 & q6) and pre-natal screening (q7) are answered correctly by the majority of Europeans. By contrast, with the exception of q3 on cloning, the smaller percent correct for the questions about genetics (q9 & q10) indicates that this area is not very familiar. This is not surprising, as many Europeans will have left formal education before genetics entered the school curriculum. That 66% gave the right answer to q3 on cloning probably reflects the extensive media coverage of cloning from the birth of "Dolly the sheep" in 1997 to the present day.

On the three questions tapping menacing images (q2, q4 & q8) between 35%and 50% of Europeans correctly reject each of the statements. At the same time, 35% of Europeans agreed that ordinary tomatoes do not have genes, 20% that eating genetically modified fruit could modify a person's genes and 27% that genetically modified animals are always bigger than ordinary ones.

Table 6 Correct answers for the knowledge quiz 1996-2002

	% Correct		
	1996	**1999**	**2002**
1. There are bacteria which live from waste water	83	83	84
2. Ordinary tomatoes do not contain genes, while genetically modified tomatoes do	35	35	36
3. The cloning of living things produces genetically identical offspring	46	64	66
4. By eating a genetically modified fruit, a person's genes could also become modified	48	42	49
5. It is the father's [1999] / mother's [2002] genes that determine whether a child is a girl	N/A	44	53
6. Yeast for brewing beer consists of living organisms	68	66	63
7. It is possible to find out in the first few months of pregnancy whether a child will have Down's Syndrome	81	79	79
8. Genetically modified animals are always bigger than ordinary ones	36	34	38
9. More than half of human genes are identical to those of chimpanzees	51	48	52
10. It is impossible to transfer animal genes into plants	27	26	26

That about 20 and 35% of Europeans assent to these menacing image propositions does not necessarily mean that they actively held such views before being asked the question in the survey interview. It is likely that many would not have thought about the issue before. Hence, a more realistic interpretation is that when asked these questions about the unfamiliar area of genetics, their general unease and possible anxieties about the technology leads them to assume the worst when asked about specific issues. This is much the same process as stereotyping. If a stereotype as a general evaluation is negative, then the holder is likely to impute negativity to all specific aspects of the object in question, including those of which they were previously unaware.

5.4 Country differences and changes over time

The number of correct responses to the nine knowledge items (excluding q5) was computed and table 7 shows the mean scores for each country and year. While, for Europe as a whole, there was no change in knowledge from 1996 to 1999, between 1999 and 2002 a non-significant increase of 0.15 is observed. To put this change into context, if the 9 items were converted into a 100 point scale, the increase from 1999 to 2002 amounts to 1.6 points

Returning to knowledge as a possible attribute of the engaged public of biotechnology we find that taken together the nine knowledge items form a reliable scale (Cronbach's alpha = 0.74). Hence the total number of correct answers is used as an index of knowledge of biology and genetics for each respondent.

Table 7 National trends in biology knowledge 1996-2002

	Mean scores (0-9)		
	1996	**1999**	**2002**
Sweden	5.53	6.23	6.35
Denmark	5.78	5.87	5.98
Netherlands	5.87	5.99	5.58
Finland	5.52	5.31	5.52
UK	5.36	4.87	5.33
Luxembourg	4.70	4.81	5.21
France	4.89	5.09	5.16
Germany	4.62	4.66	4.79
Austria	3.88	4.44	4.78
Belgium	4.51	5.02	4.71
Italy	4.84	4.48	4.68
Spain	4.04	4.40	4.54
Ireland	4.10	4.21	4.35
Greece	3.77	4.33	4.06
Portugal	3.74	3.50	3.93
Europe	4.77	4.78	4.93

5.5 The engaged public of Europe

An index of engagement with biotechnology was constructed as follows. Each of the three indicators, awareness of applications of biotechnology, reported and intended behaviours and biology knowledge, were entered into a principal components analysis. A single

component accounted for 56% of the variance in the three indicators. All three of these variables had component loadings of around 0.75, which means they all contribute approximately equally to the 'engagement' component. This means that engagement in biotechnology is a general characteristic composed, in equal measure, of the three indicators. A single component score of engagement was produced for each respondent.

Next, we categorised respondents into four equal quartiles according to their engagement score relative to the distribution of all European respondents. Given that the index of engagement is a derived score, which in absolute terms has no 'real world' referent, the following procedure was adopted to compare levels of engagement across the fifteen European countries. We define the engaged public of biotechnology as those people falling in the top quartile (25%) of the distribution of engagement scores for all the countries. This threshold is arbitrary and is not meant to convey the idea that only the top 25% are engaged in biotechnology and the remaining 75% of the European public are unengaged. But with this arbitrary criterion we can make comparisons between the countries based on the percentage representation of the engaged in each country. All things being equal we would expect to find 25% in each country, but clearly all is not equal as shown in the final column of table 8. This table also shows the percentages and mean scores for each country on the measures that make up the index of engagement.

Table 8 Europeans' engagement with biotechnology

	% Have talked about frequently or occasionally	% Would take part in public discussions or hearings	% Would watch a TV programme or read an article	Number of applications heard about (mean, 0-3)	Number of correct answers to knowledge quiz (mean, 0-10)	Number of correct answers to knowledge quiz (mean, 0-9)	% Engaged
Denmark	50	44	77	2.23	6.60	5.98	47
Luxembourg	37	45	81	1.95	5.82	5.21	33
Finland	43	40	68	1.71	6.21	5.52	31
France	37	44	80	1.76	5.70	5.16	29
Netherlands	35	26	67	1.82	6.25	5.58	29
Sweden	30	27	83	1.56	7.04	6.35	27
UK	23	28	67	2.00	5.90	5.33	26
Germany	40	43	72	1.78	5.30	4.79	25
Italy	36	24	68	1.84	5.20	4.68	23
Austria	34	41	61	1.78	5.26	4.78	22
Greece	20	43	73	1.66	4.53	4.06	18
Ireland	18	29	64	1.50	4.86	4.35	18
Belgium	24	24	59	1.52	5.22	4.71	17
Spain	24	15	41	1.70	5.02	4.54	15
Portugal	22	33	56	1.34	4.33	3.93	12
Europe	32	33	68	1.79	5.46	4.93	25

Looking at table 8, it is clear that, in most cases, a country's ranking on any one variable is close to its overall ranking on the engagement index. The majority of Europeans have not talked much about biotechnology and say they are unlikely to attend a public meeting on the issue. However, most Europeans would take the time to watch a TV programme

about biotechnology and will previously have heard about two of the three applications of biotechnology that they were asked about in the survey.

The countries with the highest percentages of engaged public are Denmark, France, Luxembourg, Sweden, Finland and the Netherlands. With lower percentages are Portugal, Spain, Belgium, Greece, Austria and Ireland. The overall European pattern reflects a 'north-south' divide, a pattern that would appear to correspond broadly both to the onset of media coverage and of regulatory activities on biotechnology.[18] But there are exceptions; Germany and the UK have a long history of regulation and of media reporting on biotechnology, yet they are close to the European mean.

One explanation for this is that the measure of engagement is a snapshot at a point in time – 2002, and it would be inappropriate to assume that levels of engagement are constant over time. While levels of engagement may reflect a longer term underlying interest in biotechnology it might also reflect the extent to which biotechnology is a controversial issue within different countries at particular times.

5.6 The profile of the engaged public

Who are the engaged public of biotechnology? To explore this question we are interested in the individual characteristics of the engaged public. We therefore recalculated our indicator of engagement in a way that takes account of, or controls for, national differences. To do this we took our engagement component score and divided respondents into four quartiles from the distribution of scores within each country separately. We again considered membership of the top quartile as indication of engagement with biotechnology, but in this formulation it is, by definition, 25% of each country's respondents that are thus classified. In this way we can examine the predictors of a person being one of the engaged public of biotechnology in his or her own country, irrespective of differences in the mean level of engagement between European countries. For the purposes of this analysis, we made the simplifying assumption that the predictors of engagement have the same effects across the whole of Europe.

A logistic regression was carried out with engagement as the dependent variable (engaged/not engaged). Independent variables included a range of socio-demographic variables as follows: age (in four bands), gender, type of area of residence (rural/urban), type of occupation (white collar/other, manual/other) and the age of completion of full-time education. The results indicate that the most typical European citizen engaged with biotechnology is male, a white collar worker, educated at university, younger than 55 and living in an urban area. The finding that women and less well educated people are less likely to report interest in biotechnology than men accords with previous empirical research.[7]

5.7 How engagement with biotechnology relates to attitudes

To investigate the relations between engagement with and attitudes towards biotechnology, table 9 shows the contrast between the attitudes of respondents in the lowest (within-country) quartile of engagement with those in the highest quartile. Since it can be assumed that in different countries the opportunities for, and forms of engagement may differ, the selection is based on the aggregation of the upper and lower quartiles for

each country separately. The table shows the judgments of usefulness, riskiness, moral acceptability and overall encouragement of the six applications. The percentages represent respondents who either 'agree strongly' or 'agree' with each of the statements (see previous section for question wording). Those who did not express an opinion, by answering 'don't know' are excluded from the analysis.

The overall pattern is remarkably consistent across the six applications. Compared to the least engaged respondents, those with higher engagement are more likely to judge applications to be useful, morally acceptable and to agree that they should be encouraged. But the pattern for judgments of 'riskiness' is intriguingly different. Here, the level of engagement with biotechnology only marginally influences the judgment on risk.

Thus, while greater engagement with biotechnology is associated with higher levels of encouragement, the engaged public is no more likely to perceive these applications as having lower risks to society. This suggests that for the engaged public, the risks are apparent, but in the context of perceptions of greater usefulness and moral acceptability, such risks are less influential in the overall judgment of encouragement. This interpretation complements the previous findings on the growth of risk tolerant support accounting for the overall increases in encouragement for the applications of biotechnology under consideration (see section 3).

An obvious possibility, in light of these results, is that the difference in attitudes between the most and least engaged respondents is due to the different educational backgrounds of the two groups.

Table 9 European judgments about six applications of biotechnology by engagement

	Percentage in agreement							
	Useful		**Risky**		**Morally acceptable**		**Encouraged**	
	Least engaged	**Most engaged**	**Least engaged**	**Most engaged**	**Least engaged**	**Most engaged**	**Least engaged**	**Most engaged**
Genetic tests	81	91	59	51	66	81	71	82
Xeno	60	78	72	67	43	62	47	64
Food	50	54	70	68	43	53	39	46
Crops	63	74	64	64	57	68	53	61
Enzymes	66	78	59	55	61	74	58	69
Clone human cells	76	87	69	66	61	72	66	76

To test this possibility, we again carried out the analysis shown in table 9, but this time comparing the attitudes of the most and least engaged within three levels of education, defined by the age at which respondents completed their continuous full time education. The entire cross tabulation would be unwieldy to present here so results from just one application, genetic testing, are shown in table 10 (each of the six applications of biotechnology show much the same pattern).

It is apparent from the table that controlling for education makes little or no difference to the difference in attitudes between the most engaged and least engaged. For judgments of

usefulness, moral acceptability and encouragement, there is around ten percentage points between the most and least engaged for people of all educational backgrounds.

Table 10 The effect of engagement on attitudes to genetic testing, controlling for education

	Percentage in agreement (Genetic testing)							
	Useful		Risky		Morally acceptable		Encouraged	
Age completed full time education	Least engaged	Most engaged	Least engaged	Most engaged	Least engaged	Most engaged	Least engaged	Most engaged
Up to 15 years	79	94	63	46	62	80	69	85
16-19 years	81	90	58	58	71	82	71	80
20+ years	77	91	60	53	61	83	72	83

This is much the same result as the overall figures given in table 9. An exception to this pattern is apparent for those who completed their full time education between the ages of 16 and 19. For this group, the extent to which respondents are engaged with biotechnology has no effect on their judgments of risk from genetic testing.

Given these results, it seems likely that whatever it is about being engaged with biotechnology that leads people to judge it more or less favourable is not simply a matter of general educational background.

Further light is shed on the relative importance of usefulness, riskiness, and moral acceptability in the decision to support an application or not by considering the next question asked in the survey. After people had been asked to make their judgments about use, risk, moral acceptability and support for GM food in ballot A and cloning human cells and tissues in ballot B, they were asked two further questions as follows:

- *Using modern biotechnology in the production of food is called GM foods/Cloning human cells or tissues to replace a patient's diseased cells that are not functioning properly is called therapeutic cloning. In deciding whether GM foods/therapeutic cloning should be encouraged or not, which was the most important issue for you - the issue of usefulness or the issue of risk or the issue of moral acceptability?*
- *And which was the second most important issue for you? The issue of usefulness or the issue of risk or the issue of moral acceptability?*

Table 11 presents a cross-tabulation of responses to these questions for the most and least engaged groups. Of respondents least engaged with biotechnology, 45% stated that risk was the most important issue for them in coming to a judgment about GM food and 32% mentioned risk as the most important factor in their judgments about therapeutic cloning. The comparable percentages for the most engaged respondents are 42% and 26%. These differences are small but statistically significant. Larger differences between the most and least engaged are seen in the importance attached to the issue of usefulness. The most

engaged respondents are more likely to cite usefulness as their most important criterion for judging both GM food and therapeutic cloning.

Table 11 The relative importance of usefulness, risk and moral acceptability

	Percentage who agree most important attribute is…			
	GM food		Therapeutic cloning	
	Least engaged	Most engaged	Least engaged	Most engaged
Usefulness	41	47	50	59
Risk	45	42	32	26
Moral acceptability	15	12	18	15

Moral acceptability is clearly a less important consideration for both the most and least engaged, but even here we see the least engaged giving it relatively more weight. The least engaged are more likely to exercise the 'moral veto'.[19]

These findings on the engaged and unengaged publics underline the importance of going beyond the assessment of knowledge when trying to understand public attitudes towards biotechnology. The 'knowledge deficit model ' of the public in relation to science and technology gives some indication of the bases of positive and negative attitudes, but certainly does not tell the whole story. It is too simplistic to attribute opposition to science merely to a lack of knowledge and to suggest that a dose of scientific information will cure people's scepticism. Engagement with biotechnology is a combination of a number of personal and contextual characteristics. To be knowledgeable about science is partly the outcome of an education and culture that is interested in science. As such people have more confident opinions and more resources upon which to arrive at a view. These resources may lead to both supportive views, for example on the 'red biotechnologies' and to opposition, for example for the 'green biotechnologies'. Nevertheless, it is also clearly the case that the engaged public is, on average, always more supportive than the less engaged across all applications of biotechnology investigated in the survey. And this is true even after taking into account a person's formal level of education.

5.8 Engagement, science, technology and politics

In the previous section, an engaged public of biotechnology was identified. The attitudes of this engaged public are somewhat different from those people who are less interested and involved with biotechnology. In the survey, some further questions were asked that were designed to tap the extent to which respondents feel interested and informed about other more general issues – science and technology; politics; food and nutrition. People were asked the extent of their agreement with ten statements on a three-point scale - with the labels "hardly any of the time", "some of the time" and "most of the time". All ten items and the percentage distribution of responses for the whole of Europe are shown in table 12.

Combining the percentages for 'some' and 'most' of the time, a majority of Europeans express interest in both science and politics, although roughly one third report hardly ever being interested in either topic. People feel slightly less informed than they are interested

in politics: 26% feel well informed most of the time while 33% report being interested in politics most of the time.

Table 12 European interest in science, politics and food issues

	Hardly any of the time	Some of the time	Most of the time
I am interested in what is going on in politics	28	39	33
I feel well informed about what is going on in politics	32	43	25
I find it difficult to follow political arguments and debates	31	41	28
I am interested in science and technology	28	41	31
I feel well informed about science and technology	38	44	18
I understand science stories in the news	25	45	30
I become confused when I hear conflicting views on science and technology	28	46	26
I am concerned about the quality and nutritional value of foods	15	36	49
I know how to choose good quality foods	10	37	53
I don't know what to think when I hear new stories about what we should and should not eat	22	48	31

The gap between interest and information is, in common with findings from past research, greater still for science and technology. Only 18% feel well informed most of the time while 40% feel informed about science and technology hardly any of the time. The great majority of Europeans are concerned about food quality and consider themselves more than capable of making the right choices about what they choose to eat. Nevertheless, nearly 80% feel uncertain some of the time or most of the time about stories they hear in the news about what they should or should not eat.

Returning to the engaged public of biotechnology, an interesting question concerns the relationship between interest in biotechnology and in the other areas considered here. The expectation is that people who are interested and informed about biotechnology are probably interested in other kinds of science and technology as well. But biotechnology in Europe has a political dimension too. Hence we might also expect that people who are more informed about and interested in politics might be more likely to be part of the engaged public of biotechnology. To test these propositions, items 1,2, 3 (about politics) and, separately, items 4,5 and 6 (about science and technology) were subjected to principal components analysis. For both politics and science items, a single factor emerged, which was used to compute scores for attentiveness to politics and to science and technology, for each respondent.

To investigate the association between engagement in biotechnology and attentiveness to science and politics, the same logistic regression analysis as described in section 4.6 was run, only this time adding the two new measures as predictors alongside the sociodemographic variables. Both attentiveness to science and technology and to politics were significant predictors of engagement with biotechnology even after accounting for

age, education and social class. Interestingly, with the two new predictors included in the analysis, the effects of gender and of living in a rural area, on engagement become non-significant. The implication is that women and rural dwellers are less interested in biotechnology than men and urban residents because they tend to be less attentive to science, technology and politics in general.

The evidence from these analyses is that biotechnology does not attract the interest of a narrow group of Europeans who are particularly exercised by this issue alone. Rather it seems that those who are most engaged with biotechnology are 'generalists' - people that have interests in a wider range of public affairs.[20] Hence, interest in politics, science and technology and biotechnology is akin to a way of life, an attitude of mind and a set of information seeking habits and behaviours. To the extent that the more engaged public tends to express more positive opinions about biotechnology than sections of the European public that are less engaged, it seems that public opinion on this issue will be linked to the credibility of political and scientific institutions more widely than those solely concerned with biotechnology.

6 Confidence in key actors and trust in sources of information

This section explores the prevalence of confidence in actors involved in biotechnology and trust in sources of information. For the greater majority of Europeans, biotechnology is not a part of everyday personal experience. People come to know about new scientific discoveries and technological developments from television, radio, newspapers and magazines. In this way an understanding of biotechnology draws on 'second hand', or mediated, information rather than personal experience. Exposed to mediated information, questions may arise: are the sources credible? Are these actors competent to pronounce of such matters? Are they motivated by sectional interests or have they the public interest in mind?[21]

Such questions raise the issues of trust and confidence[22], which have been researched in relation to science and technology since the emergence of nuclear power.[23] It has been argued that without confidence in key actors - scientists, regulators etc, people are likely to have exaggerated perceptions of risks, as the assurances provided by the experts that the risks are low or manageable are treated with scepticism. In the Eurobarometer survey two forms of questioning on the issue of confidence and trust were used. Respondents were asked "*Now I'm going to ask you about some people and groups involved in the various applications of modern biotechnology and genetic engineering. Do you suppose they are doing a good job for society or not doing a good job for society?"*

The judgment of an actor group as 'doing a good job for society', is likely to be based on a view that the actor is both competent and behaves in a socially responsible way. Thus, 'doing a good job' constitutes a proxy measure of confidence. For those respondents who express a view, that is excluding the "don't know" responses, subtracting the percentage of respondents who say 'doing a good job' for those saying 'doing a bad job' provides an estimate of the relative levels of confidence in different actors.

Table 13 is in two parts. In the first four columns are the percentages of all Europeans saying 'good job' and 'not a good job' across the fourteen actors are shown. "Don't know" responses are not presented in the table.

Table 13 European confidence in biotechnology actors in 1999 and 2002

	% in 1999		% in 2002		Confidence surplus or deficit (excluding DKs)	
	Doing a good job	Not doing a good job	Doing a good job	Not doing a good job	1999	2002
Medical doctors keeping an eye on the health implications of biotechnology	69	11	76	8	72	80
Consumer organisations checking products of biotechnology	70	12	70	11	72	73
Newspapers and magazines reporting on biotechnology	59	18	59	16	53	57
Ethics committees advising on the moral aspects of biotechnology	53	18	-	-	50	-
Environmental groups campaigning against biotechnology	58	18	59	17	54	56
Shops making sure our food is safe	59	21	56	24	46	39
Farmers deciding which crops to grow	55	20	55	21	46	44
Our government in making regulations on biotechnology	45	29	46	26	22	27
The churches offering viewpoints on biotechnology	33	31	-	-	3	-
Industry developing new products with biotechnology	30	38	41	27	-12	20
University scientists doing research in biotechnology	-	-	70	11	-	73
Scientists in industry doing research in biotechnology	-	-	59	17	-	55
Organisations of patients or their relatives looking after patients' interests	-	-	72	8	-	79
The European Commission making laws on biotechnology for all European Union countries	-	-	51	18	-	48

In the final two columns the confidence surplus or deficit is shown for 1999 and 2002. For this calculation the "Don't know" responses are excluded, hence this provides a relative ranking of levels of confidence for those Europeans who expressed an opinion.

Looking at the actual percentages for 2002 (data columns 3 and 4) around 70% of Europeans have confidence in doctors, university scientists, consumer organisations and patients' organisations. Between 50% and 59% have confidence in scientists working in industry, newspapers and magazines, environmental groups, shops, farmers and the European Commission. However, less than 50% have confidence in their own government and in industry. For all the actors mentioned more European think they are each doing a good job than a bad job. Yet, across Europe as a whole between 20% and 27% lack confidence in farmers, shops, government and industry.

Comparing 2002 to 1999 the responses are rather consistent. The exceptions, are industry and to a much lesser extent shops. Industry gains the confidence of 11% more people and confidence in shops declines by 3%.

A second way of looking at the data is to consider only those respondents who expressed an opinion either way. Because the level of "Don't know" responses varies considerably across the actors, the differences between the percentage saying 'doing an good job' and 'doing a bad job' provides a confidence surplus/deficit index for comparisons across actors and across time.

For 2002, all of the actors have a confidence surplus. Those actors with a higher confidence surplus include doctors, patients' organisations, university scientists and consumers' organisations. At the lower end, but still with a confidence surplus are industry, government, farmers and shops. Two contrasts are of note. There is more confidence in the European Commission, than in national governments in relation to regulation – the confidence surpluses are 52% and 43% respectively. And there is more confidence in university scientists than for scientists working in industry – confidence surpluses of 76% and 56% respectively.

Turning to the changes from 1999 to 2002, the most dramatic is seen in the perception of industry. In 1999 there was a confidence deficit for industry of minus 10%, but by 2002 this has shifted into a surplus of 23%. Table 14 shows how the confidence surplus/deficit has changed across the European countries.

With the exception of the Netherlands and Portugal, which show small increases in confidence surplus, in all other countries substantial shifts towards greater confidence are observed. Of note is the change from a confidence deficit to a confidence surplus in Denmark (35), Greece (61), France (50), UK (45) and Austria (56).

What could account for such a shift in the confidence in industry across Europe? Could it be related to greater confidence in national regulation and relatively high confidence in the European Commission? Another plausible explanation is that the connotations of the term "industry" have changed over the three years. In 1999 the term "industry" may have been associated with the controversial agri-food technologies. By 2002 agri-food biotechnologies have increasingly become a regulatory issue, biomedical discoveries have been prominent and as such the immediate associations linked to "industry" have shifted towards bio-medical technologies.

In contrast to the widespread belief about a 'crisis of confidence' in scientific and technological institutions in European society, these results can hardly be construed as a cause for concern.

Table 14 Change in biotechnology industry's confidence/surplus deficit 1999-2002

%	1999	2002	Change
Greece	-38	23	61
Austria	-9	47	56
France	-35	15	50
Ireland	-30	17	47
United Kingdom	-16	29	45
Sweden	-46	-10	36
Denmark	-20	15	35
Spain	2	32	30
Italy	-32	-3	29
Luxemburg	-10	18	28
Finland	24	47	23
Germany	3	20	17
Belgium	9	22	13
Netherlands	31	35	4
Portugal	31	33	2
Europe	-12	20	32

Yet, the second question provides, at first sight, a rather different picture. Asked, " *which of the following sources, if any, you would trust to tell the truth about modern biotechnology",* the respondents show that trust is a scare resource, see table 14. While the medical doctors were seen by 76% to be "doing a good job" the medical profession is selected by only 54% to be trusted to tell the truth.

Table 15 Which organisations Europeans select as trusting to tell the truth about biotechnology

	% Trust
The medical profession	54
Consumer organisations	49
Environmental organisations	46
Universities	33
Animal welfare organisations	26
Television and newspapers	23
International institutions (not companies)	17
National government bodies	14
Farmer organisations	13
Religious organisations	8
None of these (SPONTANEOUS)	6
A particular industry	5
Political parties	3
'Don't Know'	6

In order of trustworthiness, the medical profession is followed by consumers' organisations, environmental organisations, universities, and television and the media. National government bodies achieve only 14% and industry 5%.

The time series data (table 16) show that across the years 1991 to 2002 the ranking of the organisations in terms of trustworthiness is very consistent. Only in the case of environmental and consumer organisations is there a change. Equally, for each organisation, the percentage of Europeans selecting them as trustworthy is fairly stable. It is of note that in the period 1996 to 1999, which elsewhere we termed the 'watershed years',[24] trust in all the organisations declines.

Table 16 Trust in organisations 1991-2002

	1991	1993	1996	1999	2002
Consumer organisations	52	55	58	55	49
Environmental organisations	53	61	56	45	46
Universities	37	39	35	25	33
Animal welfare organisations	29	32	31	25	26
National government bodies	20	17	17	15	14
Religious organisations	10	8	12	8	8
A particular industry	6	6	7	4	5
Political parties	5	4	7	3	3

This parallels a steep decline in optimism about biotechnology (section 3) and in support for GM crops and GM foods (section 4). Post 1999 trust stabilises with the exception of consumer organisation, which see a further decline and universities which recover from the low figure of 1999.

While the rank ordering of actors "doing a good job" and organisations "trusted to tell the truth" is broadly comparable, the discrepancy between the two indicators invites some discussion. There are two issues here, the first concerns the form of the question, the second about the concept of trust, more generally. To ask which of a list of twelve organisations one "trusts to tell the truth about biotechnology" may be interpreted by respondents as inviting them to select those they would trust the most. This is supported by the finding that in 2002, on average, respondents selected about three of the twelve organisations. Since respondents were not asked who they would not trust, all we can conclude is that some are trusted more than others, but not that those organisations selected only infrequently are distrusted.

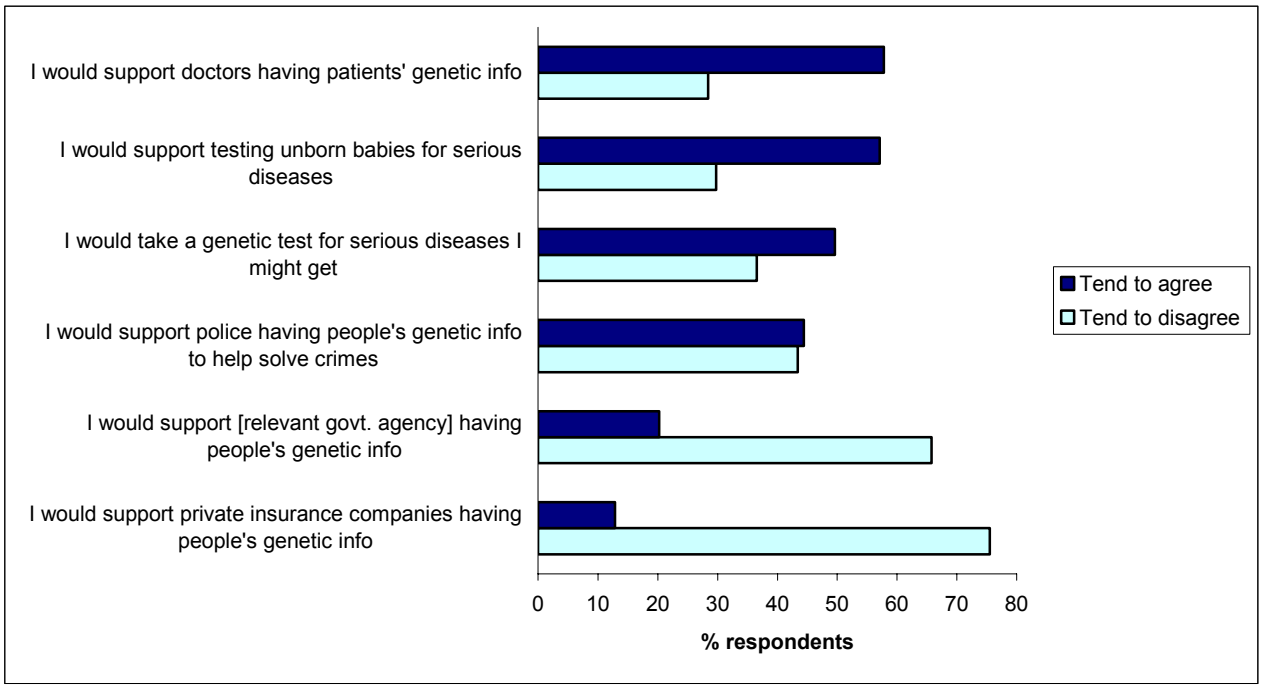
The second consideration concerns the nature of trust itself. Trust is often part of the taken for granted and is not the focus of deliberation.[25] To ask about trust directly is to question its very basis, to sow the seeds of doubt. A question such as 'do you trust' invites the perception that something could be wrong and forces the respondent to think about the reasons for trust. In this sense a direct question may measure a general image of an organisation, an image more to do with risk perception itself, than with trust which is (as is mistrust) a reaction following the risk perception. Equally, for some respondents the

direct question may lead to socially desirable answers, popular clichés. For example: people will often say they do not trust the media when, in terms of actions the media is a major source of information.

7 Opinions about the uses of genetic information

Although many of the proposed outcomes of the human genome project, for example in the areas of gene therapy and pharmacogenetics, are still to be realised, the prospect of the using individuals' genetic information for various purposes and the establishment of genetic data bases has entered media debates.

Figure 4 Europeans' opinions about access to genetic information



Genetic information is not merely of medical import, but of personal and societal interest. As genetic testing technologies are applied in such contexts as crime detection, paternity testing and genetic testing for disease, the boundaries between the clinic and society and between the patient and the citizen are blurred. In recognition of these issues, genetic information has emerged as important field for investigation from social, legal and ethical perspectives.[26]

For the first time the Eurobarometer asked respondents a set of questions related to the acceptability of different uses of genetic information. Respondents were asked whether they "tended to agree" or "tended to disagree" to the release of genetic information for use in medical, forensic, social security and commercial insurance contexts. Figure 4 presents the finding for Europe as a whole.

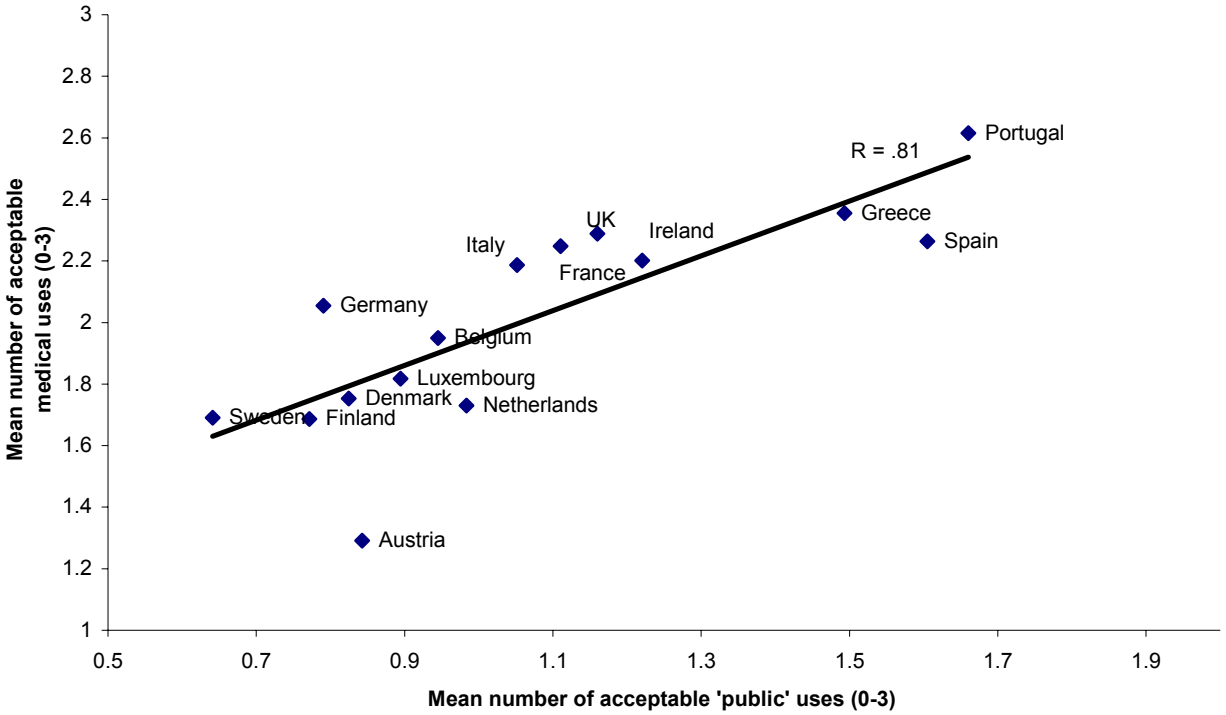
While the three disease related medical applications attract majority support, it is also apparent that a significant minority is concerned about even medical uses of genetic information. In the context of crime detection, the European public is split - 43% in favour and 44% against. For social security and commercial insurance, the use of genetic

information is widely seen as unacceptable. Before commenting on these results, we look at the results the European countries separately.

7.1 Country comparisons

A multivariate analysis of the responses to the different uses of genetic information shows that the six uses fall into two distinct clusters. The first cluster comprises the three applications of genetic testing for health purposes: test results available to doctors, testing unborn babies for inherited diseases and having a test oneself for serious diseases.

Figure 5 Acceptable medical and public uses of genetic information



Such medical testing is probably considered to be in the private domain with a presumption of confidentiality, similar to personal health records. In the second cluster are uses that fall within what we call the 'public' domain: testing for forensic purposes, social security and insurance. Figure 5 shows the relative levels of acceptability of the two clusters – private and public – for the European countries.

Note that the scales for both medical and public uses run from 0-3. In figure 5, both the axes are truncated to the actual range of observed values in order to most clearly show the position of each country on each measure. As can be seen from the positive slope, there is a strong correlation, of 0.81, between the two types of uses. In other words, countries where more people consider medical uses of genetic information to be acceptable, are very likely to be countries where more people also consider public uses to be acceptable. In all countries there is more support for testing for the medical uses described (mean number of acceptable uses = 2.01) than the public uses (mean number of acceptable uses = 1.06). Countries giving more support to uses of genetic testing in general – the top left hand side of the figure - include Portugal, Greece and Spain. In all three countries there is support for uses in both the private and public domains. In the bottom right quadrant are seven countries, Sweden, Finland, Denmark, Luxembourg, the Netherlands, Belgium and

Germany. In these countries there is less support for both the private and the public uses of genetic information. What is interesting here is the north/south divide. Do the differing social and cultural contexts provide possible explanations? The northern countries have a longer history of state organised health and social security systems, but equally some of these countries have collective memories of episodes of state sponsored eugenics. Perhaps the greater resistance in the Northern countries relates to the emergence of emancipative values[27] and concerns about civil liberties. While survey data raises such questions, the answers are beyond the scope of the data available. Yet, our research on media coverage and policy making points to another line of enquiry.

The less supportive Northern countries are those with a much longer history of the biotechnology industry, media coverage, debates and regulatory activity, and as seen in section 4 a greater percentage of the public who are "engaged" in biotechnology. Having found that the "engaged" public are generally more prepared to support other applications of biotechnology than the less engaged, are these findings on the uses of genetic information a counter example? For this we need to look at associations at the individual level (to avoid the ecological fallacy of assuming that findings at the aggregate level apply to individual respondents). Comparing the top quartile of the engaged public with the bottom quartile, we find no significant difference on public uses of genetic information, but a significant difference on medical uses. The engaged public are more likely to be in favour of genetic information being used by doctors for therapeutic and diagnostic purposes. This finding is in line with results reported earlier where engagement with biotechnology was shown to be associated with more encouraging attitudes towards genetic testing for heritable diseases. But in the case of genetic information being used by the police, government agencies and insurance companies, there seems to be a consensus amongst the engaged and unengaged publics that there are limits to the type of access that should be given to people's genetic information.

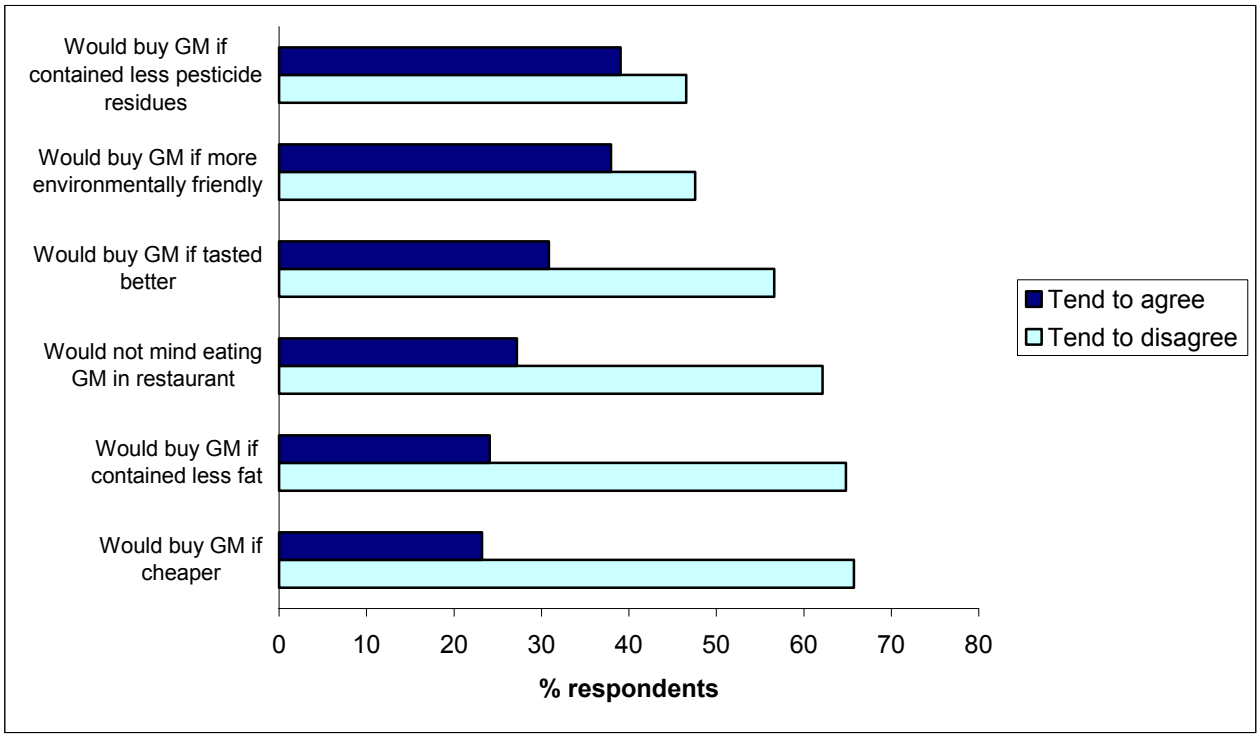
Taken as a whole these results on the acceptability of various uses of genetic data suggest that this is a potentially controversial issue. The findings suggest that there is public anxiety about the use of genetic data and it seems likely that these anxieties will be accentuated with increasing awareness of the development of genetic data banks. Will the expansion of genetic data banks even for medical uses meet with some public resistance? A number of European countries have introduced new regulations for the uses of genetic testing. The Eurobarometer results suggest that without appropriate steps to ensure that the use and storage of genetic information is introduced within the context of socially sustainable legislation, genetic testing may face generate similar controversies to those that have surrounded GM foods.

8 GM foods: hypothetical purchasing intentions

Respondents were asked whether they thought they would buy GM foods described as offering one of a number of particular benefits, for example lower prices or less pesticide residues. Also included was a question as to whether they would mind eating foods with GM ingredients in a restaurant. It is important to bear in mind that these questions are hypothetical in the strong sense of the word. Since there are no GM foods currently in the shops, the respondents are not able to reflect on actual or related experiences. If, for example, shoppers were asked whether they would buy a pink apple, they would be able to base a judgment on some familiarity with apples of other colours. But, with questions

about GM foods the issue is genuinely novel. In such circumstances it has been found that respondents are more likely to express 'citizen' rather than 'consumer' preferences.[28] With this caveat in mind the findings are presented in figure 6

Figure 6 European attitudes to purchasing and eating GM food



For all of the hypothetical situations there are more Europeans saying they would not buy or eat GM foods than those saying they would. The most persuasive reason for buying GM foods is the health benefit of lower pesticide residues, closely followed by an environmental benefit. Somewhat incredibly, of the range of benefits included in this question set, a lower price is apparently the least incentive for buying GM foods. However, what people say and what they do are sometimes rather different - is this an example of people responding as 'citizens' rather than as 'consumers'? For example, when a canned tomato purée, explicitly labelled "made with genetically modified tomatoes", it sold well in the UK.

When considering the data for the fifteen European countries we find that the distribution of responses is such that a mean score reflecting the number of acceptable reasons for buying GM foods is meaningless. In some countries more than 50% of respondents rejected all of the six reasons offered. To depict the data in an economical and informative manner, Figure 7 plots the position of each country on two dimensions. The Y axis shows the percentage of those in a country who reject all the reasons (rejecters); the X axis is the mean number of acceptable reasons for buying GM foods amongst those remaining respondents who did not reject all the reasons (non-rejecters), in other words the mean number of 'tend to agree' responses for these people).

The first point to note is that there is no association, at the country level, between the percentage of 'rejecters' and the mean number of acceptable reasons for the 'non-rejecters'.

Scanning from the bottom of the figure to the top, it can be seen that the UK, Austria and Finland have the lowest percentage of 'rejecters' while Greece and Ireland have the most, more than 50%. Scanning from the right hand side to the left hand side, it can be seen that the non-rejecters in Luxembourg, Austria, Greece, Italy and France have the lowest mean number of acceptable reasons (in a range of 2.5 to 2.8), while Portugal, Ireland and the UK have the higher means (range 3.4 to 3.6).

Figure 7 Acceptable reasons for buying GM food

Across all the countries it is notable that the mean number of acceptable reasons amongst the non-rejecters, is relatively high, indicating that the public is split on this issue. The rejecters operate a total veto, but once a threshold of minimal acceptability is reached, then people are inclined to find a number of the reasons acceptable for buying GM foods.

Two interpretations of these results come to mind. On the one hand, they could be taken as indicating a more or less total rejection of GM foods and discussed in terms of the impossibility of introducing such new products. On the other hand, it could be argued that if GM foods actually offered some of these benefits, and if they were labelled appropriately to give the rejecters the opportunity to express their preference, then the products might capture a sizable market share.

9 Value-orientations and attitudes to science and technology

In addition to asking questions about biotechnology, respondents were also asked about their general 'value-orientations'. Fifteen statements were presented, to which respondents could 'tend to agree' or 'tend to disagree'. The full wording for all of these statements can be found in the Technical Annexe to this report. We were interested in several clusters of values that might underlie differing attitudes to biotechnology. The percentage of people agreeing and disagreeing with each of these statements is presented in table 17.

Three statements refer to people's view of nature and its fragility or robustness in respect of human interventions: *'Nature can withstand human actions'*, *'Nature is fragile and easily damaged by human actions'*, *'Modern technology has upset the balance of nature'*. Two items tap 'materialist'[29] values: *'Economic growth brings better quality of life'* and *'Exploiting nature is unavoidable if humankind is to progress'*. Another two items were designed to measure attitudes towards globalisation: *'Globalisation is a real threat nowadays'* and *'Multinational companies are too powerful nowadays'*. Emancipative or socially liberal values are tapped by two statements: *'In general, people should be given more say in what the government decides'* and *It is a good thing that people can organise public meetings to protest against the government'*. Finally, items tapping political values on a continuum from right-wing to left-wing are as follows: *'The government should redistribute income from the better-off to the less well off'*, *'There is no need for strong trade unions to protect working conditions and wages'*, *' What is good for business is good for the citizens'* and *' Private enterprise is the best way to solve [OUR COUNTRY]'s problems'*.[30]

Table 17 Value-orientations in Europe

	Tend to agree	Tend to disagree	Don't know
Modern technology has upset the balance of nature	73 (58)*	17 (69)*	10
Economic growth brings better quality of life	60 (64)	28 (51)	12
Globalisation is a real threat nowadays	53 (58)	24 (63)	23
Exploiting nature is unavoidable if humankind is to progress	39 (65)	49 (56)	12
Nature is fragile and easily damaged by human actions	88 (59)	7 (64)	5
Social order and stability are essential for society	85 (61)	6 (50)	9
Nature can withstand human actions	25 (63)	62 (59)	13
What is good for business is good for the citizens	16 (65)	71 (58)	13
Traditional values should not guide us in this new century	24 (63)	60 (60)	16
Multinational companies are too powerful nowadays	80 (60)	9 (60)	11
In general, people should be given more say in what the government decides	84 (60)	8 (60)	8
Private enterprise is the best way to solve (our country)'s problems	35 (63)	40 (60)	25
There is no need for strong trade unions to protect working conditions and wages	25 (61)	60 (59)	14
The government should redistribute income from the better-off to the less well off	59 (60)	27 (61)	14
It is a good thing that people can organise public meetings to protest against the government	83 (60)	7 (61)	10

* Bracketed figures are percentages of respondents who agree that biotechnology will improve our way of life over the next twenty years

The first two columns in Table 17 show the percentage of respondents who agree and disagree with each of the fifteen statements. The number of people saying 'don't know' is indicated in the third column. In brackets are the percentages of respondents who agree that biotechnology will improve our way of life over the next twenty years according to

agreement or disagreement with each of the values statements. Responses to the values statements show that Europeans are conscious of the impact of human actions and technology on nature. Yet there is ambivalence about exploiting nature in the interests of progress. A majority believe economic growth brings better quality of life and in this regard there is also ambivalence. Europeans are split on whether private enterprise is the best way to solve a country's problems, with one quarter saying they don't know. Most think multinational companies are too powerful and only a small percentage think that what is good for business is good for citizens. On other political issues, Europeans, on average, are left of centre. There is support for strong trade unions and for income redistribution. Emancipative values are seen in the overwhelming support for people having more say in government and in the right to organise public protest. The association between value orientations and beliefs about biotechnology is illustrated by the percentages shown in brackets in table 17. The values most strongly associated with optimism about the contribution of biotechnology to society are related to views about nature and to materialism.

Those who are more concerned about nature are less optimistic about biotechnology, while those who espouse materialist values are more optimistic. Political orientation and emancipative values, by contrast, have little or no link with beliefs about biotechnology.

10 The factors underlying support and opposition to biotechnology

We conclude our exploration of European attitudes towards biotechnology by examining the simultaneous effect of the variables we have found that may underlie people's attitudes. Since some of these predictors are likely to be intercorrelated, it is only by looking at the effects of each one while controlling (holding constant) the others that we can identify the key causal predictors.

Table 18 shows the results of the six binary logistic regression analyses. In these we assess the relative impact of different factors on the odds of agreeing that each of the six applications should be encouraged. Fourteen such factors are considered here.

The first block concerns background characteristics: gender, education and age. We also compare respondents in catholic countries compared to non-catholic countries because of possible differences in sensitivities to human cloning and xenotransplantation. Following Giorgi and Marsh,[31] we use the dominant religion of the country, which they found to be more closely related to social values than the religious denomination of individual respondents. The second block includes general interests and values elicited with questions that do not mention biotechnology. Political and scientific interest are each based on summed responses to three questions asking respondents to what extent they are interested, well-informed, and understand political and scientific news stories respectively. A high score indicates high interest. Materialist values and views about nature are measured with three items described in section 9 above. Optimism in technology is the sum of the eight areas of technology which 'will improve our way of life'; this excludes biotechnology. The final block concerns indicators of engagement with biotechnology and confidence in relevant actors involved in biotechnology. Engagement with biotechnology is a composite score based on a principal components analysis of elements of engagement (having heard of, discussed, seen or read about biotechnology, along with knowledge about biotechnology) where a high score indicates greater

engagement. Confidence in relevant actors is an index based on the sum of 'doing a good job' scores in three types of actor relevant to agri-foods and medical applications respectively.

Table 18 Logistic regressions predicting encouragement of GM foods and cloning human cells and tissues

	Percentage change in relative odds of support					
	Genetic testing	Cloning human cells	Xeno-trans-plants	Enzymes	GM Crops	GM Food
Background characteristics						
Age (15-24 vs 55+)	ns	ns	ns	+43	+25	+25
Age (25-39 vs 55+)	ns	ns	ns	+27	+22	ns
Age (40-54 vs 55+)	ns	ns	ns	+31	ns	ns
Gender (male vs female)	ns	+14	+19	ns	+18	+29
Education (20+ years of education, vs any less education)	ns	ns	+16	ns	ns	ns
Catholic countries (A, B, E, FR, IRL, I, LU, P vs all others)	ns	+30	ns	ns	ns	ns
General interests and values						
Political interest (0-6 scale)	ns	ns	ns	ns	ns	ns
Scientific interest (0-6 scale)	+6	+5	+5	ns	ns	ns
Economic growth brings better quality of life (agree vs disagree)	+39	+30	+32	+42	+33	+42
What's good for business is good for the citizens (agree vs disagree)	ns	ns	+30	ns	ns	+63
Exploiting nature is unavoidable if humankind is to progress (agree vs disagree)	ns	+30	ns	ns	+38	+27
Technology optimism (0-8 scale)	+10	+15	+10	+9	+12	+13
Confidence and engagement with biotechnology						
Confidence in industry, government, shops (0-3 scale)	-	-	-	+23	+29	+38
Confidence in government, university scientists, scientists in industry (0-3 scale)	+34	+53	+18	-	-	-
Engagement (Most engaged vs all others)	+36	+21	+36	+44	+32	+17

ns = not significant at α=.05

For each application in table 18, the percentage change in the relative odds of support is presented. Thus we see that, for example, if we control for all of the other factors in the model, people aged between 15 and 24 are 43% more likely to support GM enzymes than are those over the age of 55. Similarly, they are 25% more likely to support both GM crops and GM food. However, there is no difference between those aged 15 to 24 and those aged 55+ in the likelihood of support for genetic testing, cloning human cells and tissues and for xenotransplantation. Looking at the table as a whole, we find four variables that are consistently associated with higher support for the six applications. These are materialist values, the link between economic growth and quality of life, optimism about technology,

confidence in actors involved in biotechnology and engagement with the issue of biotechnology.

A number of the other factors from the first and second blocks are related to greater levels of encouragement for some, but not all, applications. In terms of background characteristics, when we hold all other variables in the model constant, men are generally more supportive than women, but there is no significant difference in the odds of support for genetic testing and GM enzymes. Again, holding everything else constant, age is not related to the odds of encouraging any of the three medical applications. Yet for GM enzymes, crops and foods, younger people are more supportive than older people. Turning to general interests and values, those who agree that exploiting nature is unavoidable are more likely to be supportive of cloning human cells and tissues, GM crops and GM foods. Finally, and counter to our initial expectations, in catholic countries, people have higher odds of support for cloning human cells and tissues than in the non-catholic countries. This is consistent with findings from the survey showing greater support in the southern countries than in the north. Yet for the other five applications, an interpretation of the north/south divide might point to differences between northern and southern countries in some of the variables in our model. However, what is interesting in the case of cloning is that these variables cannot account for the greater support in the catholic countries. Whilst it should be borne in mind that this could be a chance finding, it certainly merits further research.

11 Conclusions

While the main findings of this Eurobarometer survey are set out in the summary, some concluding comments are in order. The survey underlines the value of time-series quantitative research on public perceptions of science and technology. The series of Eurobarometer surveys on biotechnology from 1991 to 2002 have allowed us to identify relatively enduring beliefs, longer term shifts in opinions and shorter term fluctuations. While perceptions of agri-food or 'green' biotechnologies have been much influenced by events and controversies over time, perceptions of medical or 'red' biotechnologies have remained relatively stable.

What are the general implications of this assessment of public perceptions of biotechnology in 2002? The picture is interestingly different from 1999 and, from the viewpoint of those involved in the regulation and implementation of the technology, there are mixed messages. Three issues illustrate the dynamics of public perceptions and the need for continuing vigilance.

In the survey we find that support for GM crops and foods has increased in some countries and where it has increased we see more risk tolerant support. This may imply that the debates about risk have lost their ferocity and that the risk issue is now discussed more soberly. Yet at the same time a majority of Europeans do not support agri-food biotechnologies. Perhaps the risk issue has been temporarily handled by the moratorium - a strategy that has bought time and has been moderately successful. But what will happen when new crops and products arrive? While industry will describe them as bringing a range of benefits, what will the public think? Will they too see benefits? This will be crucial, as it is the perception of benefits that seems to be the driving force behind the emergence of risk tolerant support. However, if these new crops and products do not

meet the public's criterion of usefulness, then the controversies of the 1990s could well be reactivated.

The importance of tangible benefits is illustrated by the findings for medical applications. The widely recognised contribution of bio-medical technologies to health generally outweighs perceived risks and moral concerns. This is particularly evident in the levels of support observed for the cloning human cells and tissues and to a lesser extent in the case of xenotransplantation, despite the emphasis on ethical dilemmas accompanying both applications as evidenced in official documents and some scientific research. Is this an indication that relying solely on "ethical" deliberations, such as those considered by ethics committees, fails to capture the public mood? Perhaps the public is more utilitarian than political bodies and ethical committees.

Finally, could genetic information become the next focus of controversy? Throughout the 1990s support for genetic testing for inherited diseases was both high and stable. In 2002 we took a closer look at a number of other uses for genetic information in the medical and public domains. The results show that the exploitation of genetic information in forensic, social security and insurance contexts raises anxieties across all European countries, particularly in the North. Is this a warning signal of impending controversy and conflict? The degree of conflict may depend as much on timely regulation as on the extent to which genetic information becomes associated with other issues. Just as GM foods and crops became a platform for a number of other debates - food safety after the BSE and dioxin scares, the role of agriculture, the integration of the food chain and food as a cultural item, genetic information may reactivate fears of eugenics and become associated with civil liberties, social equality and justice.

More generally, the findings on Europeans and biotechnology illustrate the complexity of the relations between science and society. There are no simple or single explanations for the dynamics of public perceptions, or of the representations that underlie people's views. What we find is that a 'matrix' of variables including interest in aspects of the public domain such as science and politics, optimism about technologies, social and cultural values, engagement with the issue of biotechnology and confidence in industry, regulation and other civil society groups, all contribute to the public's representation of and opinions about biotechnologies. Yet, it must also be recognised that socio-cultural and technological systems interact in complex ways. Understanding these interactions requires attending to factors visible on the institutional or societal level, as well as the individual level; the regulatory climate, not just specific regulations; media systems, not just specific messages; and social values, not just individual opinions. All these contribute to the trajectory of a new technology. As such, a survey provides a particular perspective, a mapping of the contours of public perceptions. It is a perspective that invites complementary research foci in order to interpret the results in the broader social and cultural context. This has been one of the key objectives of the research group 'Life Sciences in European Society' that produced this report.

12 References

1. Commission of the European Communities, 'Life sciences and biotechnology - a strategy for Europe' *COM 27* (2002).

2. European Parliament and Council of the European Union, 'Directive 2001/18/EC of the European Parliament and of Council', *Official Journal of the European Communities* **L 106**, 1-38 (2001).

3. INRA, 'Eurobarometer 35.1' (1991).

4. INRA, 'Biotechnology and genetic engineering. What Europeans think about in 1993' (Survey conducted in the context of Eurobarometer 39.1, 1993).

5. INRA, 'Eurobarometer 46.1, Les Europeens et la Biotechnologie Moderne' (1997).

6. INRA, 'Europeans and biotechnology' (2000).

7. Gaskell, G., N. C. Allum, W. Wagner, T. Hviid Nielsen, E. Jelsoe, M. Kohring, M. W. Bauer, 'In the public eye: representations of biotechnology in Europe' in *Biotechnology 1996-2000: the years of controversy* G. Gaskell, M. Bauer, Eds. (Science Museum Publications, London, 2001).

8. Miller, J. D., 'The measurement of scientific literacy', *Public Understanding of Science* **7**, 203-223 (1998).

9. Miller, J. D., 'Scientific literacy: a conceptual and empirical review', *Daedalus* **11**, 29-48 (1983).

10. Durant, J., G. Evans, P. Thomas, 'The public understanding of science', *Nature* **340**, 11-14 (1989).

11. Allum, N. C., D. Boy, M. W. Bauer, 'European regions and the knowledge deficit model' in *Biotechnology: the making of a global controversy* M. Bauer, G. Gaskell, Eds. (Cambridge University Press, Cambridge, 2002).

12. Sturgis, P. J., N. C. Allum, 'Gender differences in scientific knowledge and attitudes toward science: reply to Hayes and Tariq', *Public Understanding of Science* **10**, 427-430 (2001).

13. Ziman, J., 'Public understanding of science', *Science, Technology and Human Values* **16**, 99-105 (1991).

14. Wynne, B., 'Public understanding of science'. (1995).

15. Evans, G., J. Durant, 'The relationship between knowledge and attitudes in the public understanding of science in Britain', *Public Understanding of Science* **4**, 57-74 (1995).

16. Bauer, M. W., J. Durant, G. Evans, 'European public perceptions of science', *International Journal of Public Opinion Research* **6**, 163-186 (1994).

17. Almond, G., S. Verba, *The civic culture* (Little,Brown, Boston, 1963).

18. Bauer, M. W., G. Gaskell, Eds., *Biotechnology - the making of a global controversy* (Cambridge University Press, Cambridge, 2002).

19. Gaskell, G., N. C. Allum, M. W. Bauer, J. Durant, 'Worlds apart? the reception of genetically modified foods in Europe and the US', *Science* **July 16 1999**, 384-387 (1999).

20. Delli Carpini, M. X., S. Keeter, *What Americans know about politics and why it matters* (Yale University Press, New Haven [Conn.], 1996).

21. Barber, B., *The logic and limits of trust* (Rutgers University Press, New Brunswick, N.J., 1983).

22. Luhmann, N., *Trust and power* (Wiley, Chichester, 1979).

23. Slovic, P., J. H. Flynn, M. Layman, 'Perceived Risk, Trust, and the Politics of Nuclear Waste', *Science* **254**, 1603-1607 (1991).

24. Gaskell, G., M. W. Bauer, 'Biotechnology in the years of controversy: a social scientific perspective' in *Biotechnology 1996-2000: the years of controversy* G. Gaskell, M. Bauer, Eds. (Science Museum Publications, London, 2001) pp. 3-11.

25. Luhmann, N., 'Familiarity, Confidence, Trust: Problems and Alternatives' in *Trust: Making and Breaking Cooperative Relations* D. Gambetta, Ed. (Department of Sociology, University of Oxford (Electronic edition: available at http://www.sociology.ox.ac.uk/papers/luhmann94-107.doc, 2000).

26. Richards, M., 'How distinctive is genetic information?' *Studies in History and Philosophy of Biological and Biomedical Sciences* **32**, 663-687 (2001).

27. Welzel, C., R. Inglehart, H. Klingemann, 'The theory of human development: a cross-cultural analysis', *European Journal of Political Research* **42**, 311-380 (2003).

28. Noussair, C., S. Robin, B. Ruffieux, 'Do consumers not care about biotech foods or do they just not read the labels?' *Economics Letters* **75**, 47-53 (2002).

29. Inglehart, R., *Culture shift in advanced societies* (Princetown University Press, Princetown, 1990).

30. Heath, A., G. Evans, J. Martin, 'The Measurement of Core Beliefs and Values: The Development of Balanced Socialist/Laissez Faire and Libertarian/Authoritarian Scales', *British Journal of Political Science* **24**, 115-133 (1993).

31. Giorgi, L., C. Marsh, 'The protestant work ethic as a cultural phenomenon', *European Journal of Social Psychology* **20**, 499-517 (1990).