

### **II.E.3. PUBLIC OPINION<sup>1</sup>**

This section reviews the results of surveys of public opinion concerning genetic engineering. We want to know which applications people support and which they oppose, and to what degrees, and why, in order to help us assess the feasibility of various policy initiatives. Our main interest concerns human genetic engineering. However, we begin in Section II.E.3.a by reviewing surveys concerning technology in general, and in Section II.E.3.b we review attitudes about the genetic engineering of micro-organisms, plants and animals. These results provide a useful context for assessing attitudes towards human genetic engineering in Section II.E.3.c.

#### ***II.E.3.a. Attitudes about Technology and Types of Technologies***

Table 1 in **II E-35** suggests that attitudes held by Americans about science and technology in general are largely positive, and have not varied greatly over the past 15 years. Tables 2 and 3 show that for many people this general endorsement of science and technology may be tempered by concerns over the pace of technological change, its impacts, and the suspicion that it is “out of control.” **II E-36** suggests that attitudes of people in industrialized countries such as Australia, Japan and the United Kingdom about science and technology in general may be roughly comparable to those held in the United States.

This largely positive attitude about science and technology in general does not hold for all technologies in particular. The tables in **II E-37** suggest that Americans regard nuclear power and genetic engineering more problematically than they do many other technologies or areas of scientific research. Skepticism about these two technologies appears to be even more pronounced in countries other than the United States. The tables in **II E-38** show that in Europe, Canada and Japan genetic engineering is looked upon less favorably than are any of six other

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major categories of technology, although majorities (in Europe, a strong plurality) still believe it will be, on balance,

**Box II-E-35. Attitudes towards science and technology (USA)**  
[percents]

Table 1

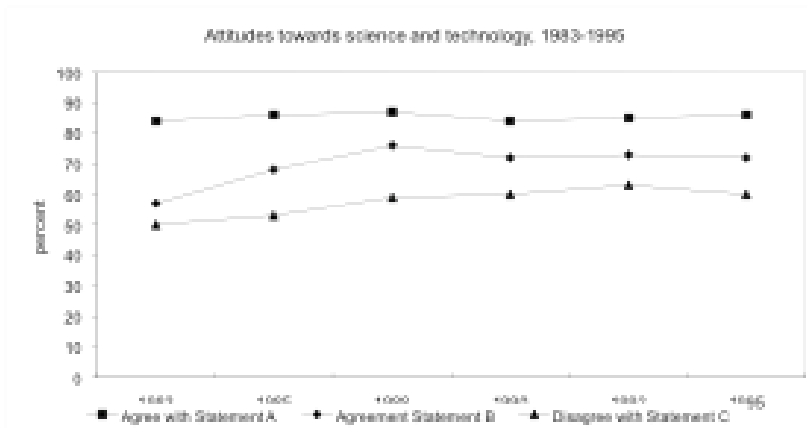
Now I would like to read you some statements like those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or disagree.

Statement A: "Science and technology are making our lives healthier, easier, and more comfortable."

Statement B: "The benefits of science are greater than any harmful effects."

Statement C: "Science makes our way of life change too fast."

	1983	1985	1988	1990	1992	1995
Agree with A:	84	86	87	84	85	86
Agree with B	57	68	76	72	73	72
Disagree with C	50	53	59	60	63	60



source: Science and Engineering Indicators 1996. National Academy of Sciences, Washington, DC. Appendix Table 7-20. N = 2004. [www.nsf.gov/sbe/srs/scind96](http://www.nsf.gov/sbe/srs/scind96)

Table 2

Which of the following statements do you agree with more strongly?

Rapid technological change is producing some pain and economic dislocation, but in the long run will be good for the United States.	54
Rapid technological change is causing severe job losses and is harmful for the United States.	42
Both/neither/not sure	4

source: Business Week/Harris Poll survey, Feb. 16, 1996; IPO 95-6:411. N = 1004.

Table 3

Please tell me whether you tend to agree or disagree: technology has almost gotten out of control.

	agree	disagree	not sure
1978	43	41	16
1990	45	53	2
1993	50	47	3
1994	53	46	1

source: Lou Harris & Associates, Equinox Survey, 1994; APO 1994:670. N (94) = 1250.

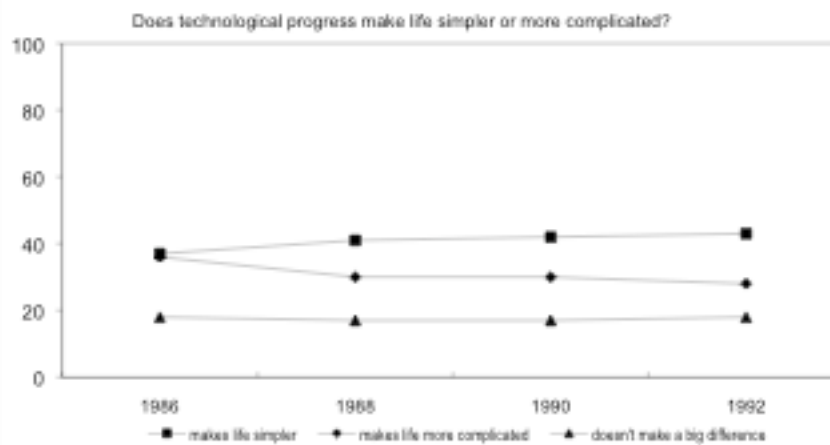
**BOX IIE-36. ATTITUDES TOWARDS SCIENCE AND TECHNOLOGY**  
(W. Germany, UK, Australia, Japan)

[percents]

Table 1.

Do you think that technical progress makes life simpler for people or does it make it progressively more complicated?" [West Germany]

	simpler	more complicated	about the same	don't know
1986	37	36	18	9
1988	41	30	17	12
1990	42	30	17	11
1992	43	28	18	11



source: Demoscopie Allensbach, July 1992; IIP0 92-3. N = 2100.

Table 2.

Most problems can be solved by application of more and better technology.

	Australia	Japan
agree	55	46
neither agree nor disagree	22	33
disagree	23	21

source: Macer, 1994, Int'l Bioethics Survey, Table 4b, p190. N (Aus) = 201, N (Jpn) = 352.

Table 3.

Overall, do you think that science and technology do more harm than good, more good than harm, or about the same of each?

	Australia	Japan	UK
more good	66	42	44
about same	27	45	37
more harm	4	5	9
don't know	3	8	10

source: Macer 1994, Int'l Bioethics Survey, Table 19, p 211.

**BOX IIE-37. COMPARISONS OF TECHNOLOGIES**  
[percents]

Table 1

Now, let me ask you about some specific developments. From what you know or have heard, do you think (READ ITEM) will make the quality of life a lot better for people such as yourself, somewhat better, somewhat worse, or much worse?

	solar energy	organ transplants	genetic engineering	robots & automation	nuclear power
better	92	87	66	60	51
worse	4	9	22	33	43
don't know	4	4	12	7	6

source: Office of Technology Assessment, *Public Perceptions of Biotechnology*, 1987. Table 33, p. 49. N = 1273.

Table 2

Would you say that, on balance, the benefits of [ITEM] have outweighed the harmful results, or have the harmful results of [ITEM] been greater than its benefits?

	scientific research	nuclear power	genetic engineering
Benefits exceed harmful results	72	43	43
Beneficial and harmful results equal	16	14	22
Harmful results greater than benefits	13	42	35

source: Science & Engineering Indicators, 1996, National Academy of Sciences. Appendix Tables 7-21, 22, 23. N = 2006.

**BOX IIE-38. COMPARISONS OF TECHNOLOGIES (EUROPE, CANADA, JAPAN)**  
[percents]

I am going to read out a list of areas in which new technologies are currently developing  
For each of these areas, 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?

Table 1

EUROPE	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	74	14	4	8	19
Telecommunications	81	9	7	6	12
New Materials or Substances	64	12	6	17	11
Computers & Info Technology	77	8	8	7	10
Space Exploration	49	28	8	15	6
Genetic Engineering	45	10	21	25	2

Table 2

CANADA	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	85	9	3	3	28
Telecommunications	88	5	5	2	18
New Materials or Substances	76	10	7	7	11
Computers & Info Technology	83	4	11	2	8
Biotechnology	72	6	9	13	8
Space Exploration	55	31	9	5	6
Genetic Engineering	54	9	26	11	2

Table 3

JAPAN	will improve	no effect	will make things worse	don't know	ratio, improve/ make worse
Solar Energy	92	5	1	3	92
New Materials or Substances	71	7	3	19	24
Telecommunications	76	13	5	6	15
Space Exploration	54	17	6	23	9
Computers & Info Technology	77	4	9	11	9
Biotechnology	62	4	12	22	5
Genetic Engineering	54	7	12	27	4

Sources:

Table 1: Eurobarometer 46.1, Fall 1996. INRA (European Commission). The Eurobarometer polls upwards of 17,000 persons in the EU countries: Belgium, Denmark, Germany, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and UK. Country results are weighted by population to give proportional aggregate results.

Web site: [www.za.uni-koeln.de/data/en/eurobarometer](http://www.za.uni-koeln.de/data/en/eurobarometer).

Table 2: Einsiedel (1997) as reported in Macer (1997).

Table 3: Macer (1997); *Eubios Journal of Asian and International Bioethics* 7 (137-151).

beneficial. Table 1 in **IIE-39** suggests that Germans believe genetic and nuclear technologies will have mostly negative impacts on “worldwide environment problems,” whereas six other categories of technology will have positive impacts. Table 2a in IIE-39 shows that Australians also rank genetic engineering and nuclear power unfavorably. The consistently low ranking of genetic engineering seen in the surveys just reviewed is less obvious in the results for Japan shown in Table 2b, although nuclear power once more comes in last.

Genetic engineering is one type of biotechnology, but it is central to the most consequential biotechnological processes. In many contexts the terms “genetic engineering” and “biotechnology” can legitimately be used interchangeably. Table 2 in IIE-39, as well as Table I and Table 2 in I IIE-38, suggest that people commonly evaluate “biotechnology” more favorably than “genetic engineering.”

The intent of the remainder of this section is to focus on attitudes about genetic engineering, but at points it is useful to consider attitudes about broader biotechnology topics.

### ***II.E.3.b. Attitudes about Genetic Engineering in General, and of Micro-Organisms, Plants and Animals***

Although Americans hold genetic engineering in lower regard than they do other technologies, they believe that it is, on balance, beneficial. Table 1 in **IIE-40** shows that by a strong margin (69 percent to 16 percent) New Jerseyans believe genetic engineering will improve the quality of their lives. Table 2 in IE-40 shows that by a thinner margin (43 to 35 percent) a national sample of Americans believes that the benefits of genetic engineering are greater than its risks. This evaluation has held roughly constant since at least the mid-1980’s. Support for genetic engineering rises steadily with education, as shown in Table 3.

**Box IIE-41** suggests that survey responses concerning genetic engineering may be strongly influenced by prefatory material provided for the question. In the example shown the

**BOX IIE-39. COMPARISONS OF TECHNOLOGIES (OTHER COUNTRIES)**  
[percents]

Table 1

Which technologies are seen as positive or negative with respect to the solution of worldwide environmental problems? [West Germany]

Responses on a scale from -5 (very negative) to +5 (very positive):

solar technology	+3.71
computer technology	+2.30
aerospace technology	+1.26
pharmaceutical industry	+1.14
communication technology	+0.89
chemical industry	+0.21
genetics	-1.06
nuclear technology	-1.18

source: Demoskopie Allensbach, 1993. IFO 1993-94:447. N = 1500.

Table 2

Do you have any worries about the impact of research or applications of....

2a. AUSTRALIA

	no worries	a few/ some	a lot	ratio of no/a lot
computers	51	37	12	4.25
biotechnology	33	50	17	1.94
in vitro fertilization	30	46	24	1.25
pesticides	19	48	33	0.58
genetic engineering	19	47	34	0.56
nuclear power	16	36	48	0.33

2b. JAPAN

	no worries	a few/ some	a lot	ratio of no/a lot
computers	57	41	2	28.50
biotechnology	37	58	5	7.40
genetic engineering	22	63	15	1.47
pesticides	21	62	17	1.24
in vitro fertilization	13	73	14	0.93
nuclear power	15	53	32	0.47

source: Macer 1994, Tables 6a-6f, pp 193-197. N (Aus) = 201, N (Jpn) = 352.

**BOX II-40, PUBLIC ASSESSMENTS OF GENETIC ENGINEERING**  
[percents]

Table 1

From what you know or have read, do you think genetic engineering will make the quality of life for people such as yourself better or worse? [New Jersey residents]

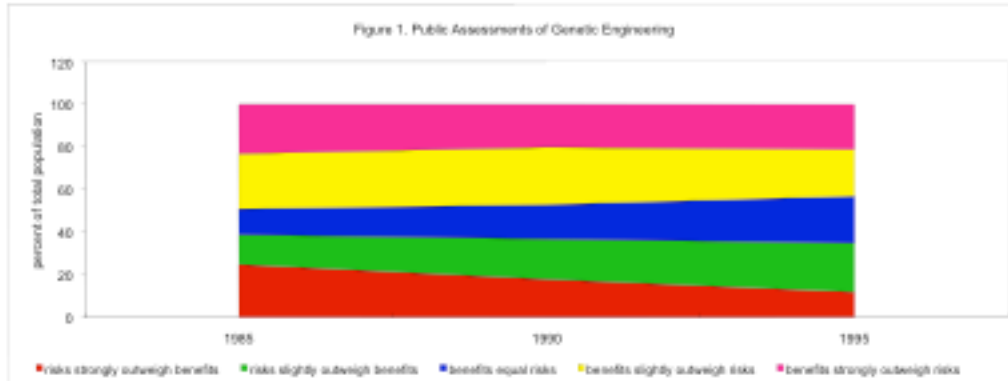
much better	20
somewhat better	49
somewhat worse	10
much worse	6
not sure	14

source: Hallinan, III, & J. Metcalfe, 1995. Public Perceptions of Agricultural Biotechnology: a survey of New Jersey residents. N = 604.

Table 2

Some people have argued that the creation of new life forms through genetic engineering research constitutes a serious risk, while other persons have argued that this research may yield major benefits for society. In your opinion, are the risks of genetic engineering research greater than its benefits, or are the benefits of genetic engineering research been greater than its risks?

	1985	1990	1995
benefits strongly outweigh risks	23	20	21
benefits slightly outweigh risks	26	27	22
benefits equal risks	12	16	22
risks slightly outweigh benefits	14	19	23
risks strongly outweigh benefits	25	18	12



Note: In 1995 the survey question was "In your opinion have the benefits of genetic engineering research outweighed the harmful results, or have the harmful results of genetic engineering research been greater than its benefits?"  
source: Science and Engineering Indicators 1996, Appendix Table 7-23.

Table 3

by educational level, 1995  
[percent]

	Benefits greater than risks	Benefits equal risks	Risks greater than Benefits
all adults	43	22	35
less than high school graduates	29	30	32
high school graduates	41	21	37
baccalaureates	65	16	20

source: Science and Engineering Indicators 1996, Appendix Table 7-23.

**BOX II-E-4.1. ANOTHER ASSESSMENT OF GENETIC ENGINEERING**  
[percents]

In 'Jurassic Park' the dinosaurs were supposedly produced by genetic engineering. Genetic engineering means the process of changing genes or DNA in a cell for medical, agricultural or other scientific research. On balance, do you believe that the potential benefits of genetic engineering outweigh the risks or that the risks outweigh the benefits?

	Benefits outweigh risks	Risks outweigh benefits	Not sure
national	34	57	9
some high school	22	62	16
high school graduate	26	64	10
some college	34	58	8
college graduate	52	44	4
post-graduate	69	28	3

source: Harris survey, June 1993, APOI 1993:872. N = 1253.

prefatory material associates genetic engineering with the dinosaurs of *Jurassic Park*. This is the single instance among all the surveys reviewed in this exercise in which a national sample judged the risks of genetic engineering in general to outweigh the benefits.

**Box IIE-42** suggests that European attitudes towards biotechnology and genetic engineering are roughly comparable to attitudes towards genetic engineering in the United States. However, the survey question shown combines the terms “biotechnology” and “genetic engineering” and thus obscures the distinction, noted above, that people draw between these.<sup>2</sup> (In fact, as we’ll see shortly, Europeans are less supportive of many forms of genetic engineering than are Americans.)

**Box IIE-43** shows results from the first major survey done in the United States on public attitudes towards biotechnology and genetic engineering, conducted in 1987 by the Office of Technology Assessment.

Table 1 and Table 2 in IIE-43 suggest that opinion has been roughly evenly divided between those who believe that genetic engineering is likely to pose serious dangers and those who believe this is unlikely, with those who believe this is likely having an edge.

Table 2 in IIE-43 suggests that a majority of Americans may be willing to tolerate risks at the level of perhaps 1 in 500 or so that a local species of plant or fish will go extinct as a result of the use of a genetically engineered organism.<sup>3</sup> But this judgment has no significance unless the meaning of the “use” of a genetically engineered organism has been specified.<sup>4</sup> In any

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<sup>2</sup> The countries shown in Box IIE-42 are ranked according to the final column, which shows the ratio of those respondents who believe biotechnology and genetic engineering will improve things over those who believe these technologies will make things worse. The rank order of the results suggests possible correlations with per capita income, level of education, geographic location, and religion.

<sup>3</sup> Linear extrapolation of the approval rates shown between the risk levels of 1 in 100 and 1 in 1,000 suggest that 51% approval would be achieved for a risk level of about 1 in 700. An exponential extrapolation suggests 51% approval at a risk level somewhere between 1 in 300 and 1 in 500.

<sup>4</sup> “Use” might be defined as the commercial adoption of a particular engineered organism (say, a transgenic pest-resistant form of wheat), once and for all. Alternatively, “use” might refer to every instance in which the transgenic wheat is commercially deployed, in every discrete locality, for any given year or other time period. If a single local species of plant or fish was lost every 100 or 1000 times the transgenic

**BOX IIE-42. ATTITUDES TOWARDS BIOTECHNOLOGY AND GENETIC ENGINEERING IN THE EUROPEAN UNION**

[percents]

Table 8.1

Science and technology change the way we live. Do you think that biotechnology and genetic engineering will improve our way of life in the next 20 years, will have no effect, or will make things worse?

	will improve	no effect	will make things worse	don't know	no answer	ratio of improve/ make worse
Portugal	46	2	2	49	0	23
Spain	58	3	4	34	0	14.5
Ireland	48	10	5	36	0	9.6
Greece	39	2	6	52	0	6.5
Italy	56	6	10	29	0	5.6
EU	51	9	11	28	0	4.6
France	54	10	13	23	0	4.2
Belgium	49	8	12	30	0	4.1
Germany	44	19	12	25	1	3.7
UK	51	7	14	28	1	3.6
Luxembourg	48	14	14	24	0	3.4
Netherlands	48	8	19	24	0	2.5
Denmark	44	9	24	24	0	1.8

source: Eurobarometer 1991. From data presented in Lemkow (1993), Public Attitudes Towards Genetic Engineering.

wheat was “used,” far more local species would be lost if under the second definition of “use” than under the first.

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**BOX IIE-43. ATTITUDES ABOUT THE RISKS AND MORALITY OF GENETIC ENGINEERING**

[percents]

All tables are from data presented in Office of Technology Assessment, 1987. N(9.1-4) = 1273; N(9.5) = 585.

Table 1

From what you have heard and read, how likely do you think it is that genetically engineered products will represent a serious danger to people or the environment--very likely, somewhat likely, somewhat unlikely, or very unlikely?

likely	52
unlikely	42
not sure	6

Table 2

From what you have heard or read, how likely do you think it is that the use of genetically engineered organisms in the environment will (READ ITEM) -- very likely, somewhat likely, somewhat unlikely, very likely...

	likely	unlikely	not sure
Create antibiotic-resistant diseases	61	28	11
Produce birth defects in humans	57	34	9
Create herbicide-resistant weeds	56	33	11
Endanger the food supply	52	42	7
Mutate into a deadly disease	46	44	10
Increase the rate of plant or animal extinction	45	46	9
Change rainfall patterns	42	46	12

Table 3

Suppose that a new genetically engineered organism had been developed which would significantly increase farm production with no direct risk to humans. Would you approve the environmental use of that organism if the risk of losing some local species of plants or fish was (READ ITEM)?

	Approve	Not approve	Not sure	No answer
Risk level unknown	31	65	3	1
1 in 100	40			0
1 in 1,000	55	37	9	0
1 in 10,000	65	27	3	5
1 in 100,000	71	21		
1 in 1,000,000	74	18	2	5
Unknown, but very remote	45	48	9	5

Table 4

If there was no direct risk to humans and only very remote risks to the environment, would you approve or disapprove the environmental use of genetically engineered organisms designed to produce...

	Approve	Disapprove	Not Sure
Disease-resistant crops	73	23	4
Bacteria to clean oilspills	73	23	4
Frost-resistant crops	70	27	3
More effective pesticides	56	40	4
Larger game fish	53	43	4

Table 5

Do you believe that creating hybrid plants and animals through direct genetic manipulation of DNA is morally wrong, or not?

morally wrong	24
not morally wrong	68
depends	4
not sure	4

event the precise calculation of risk levels is very difficult, and analysts typically conclude that risks are “unknown but very remote.” The survey results suggest that a plurality of Americans (48%) would consider this level of risk to be unacceptable.

The question that generated the results shown in Table 4 in IIE-43 was designed to assess the extent of support for genetically engineering various organisms if secondary “health and environmental” concerns had been resolved. We see that the use of genetic engineering to produce disease and frost-resistant crops, and to produce oil-eating bacteria, is strongly approved, but that its use to produce more effective pesticides and larger game fish is significantly less approved of, although majorities are still supportive.<sup>5</sup> Opinions concerning the related question of the morality of genetic manipulation are shown in Table 5 in IE-43. These results are consistent with those shown in Table 4, and suggest that moral concerns are particularly strong motivators of opposition to genetic engineering, as described in the question, for perhaps just under 25% of Americans.

**Box IIE-44** displays attitudes about genetic engineering held in 15 European countries and the United States. The pattern seen in Box IIE-42, where Germanic countries show higher concerns about genetic engineering than do Latin and Mediterranean countries, is evident in Table 1 in IIE-44, but not so strongly. Table 2 suggests that genetic engineering is perceived by Europeans as a greater food risk than artificial coloring, cholesterol, fat or sugar, but less of a risk than bacterial contamination, pesticide residues, mold and food irradiation.

Most of the surveys just reviewed evaluate genetic engineering in a general sense, but attitudes about genetic engineering can vary significantly depending on the type of organism

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<sup>5</sup> Note that the question above Table 4 in IIE-43 uses the phrase “only very remote risks”, rather than “unknown but very remote”, which was evaluated in Table 3 in IIE-43. The first phrase implies a higher degree of certainty than is typically the case in these matters. The second phrase acknowledges this uncertainty, which presumably accounts for the low level of approval shown in Table 3.

**BOX IE-44. EUROPEAN ATTITUDES ABOUT THE RISKS OF GENETIC ENGINEERING**  
[percents]

Table 1

Percent of respondents that perceive genetic engineering as a serious health hazard

> 50%	40%-50%	< 40%
Sweden 65	Spain 49	UK 39
Portugal 62	Ireland 48	France 38
Austria 60	Netherlands 48	Luxembourg 38
Germany 57	Belgium 44	Greece 33
	Denmark 44	Italy 30
	Finland 41	Norway 28
		USA 21

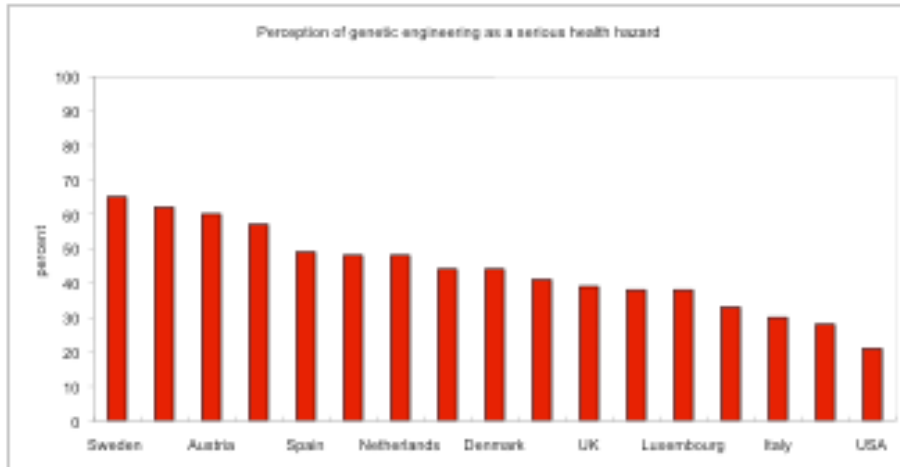
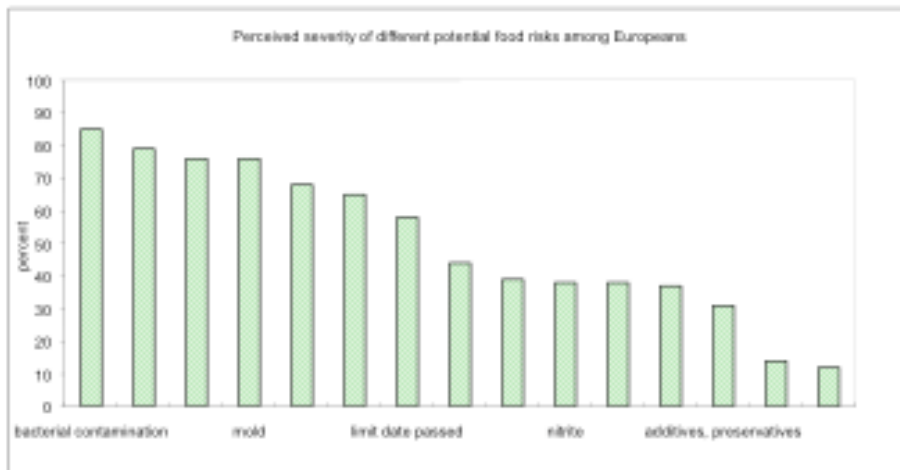


Table 2

Percent that perceive the items listed as potential food risks

bacterial contamination	85	artificial coloring	39
pesticide residues	79	nitrite	38
antibiotics, hormones	76	cholesterol	38
mold	76	fat	37
product alteration	68	additives, preservatives	31
food irradiation	65	salt	14
limit date passed	58	sugar	12
genetic engineering	44		



source: T.J. Hoban, Consumer acceptance of biotechnology: an international perspective. Nature Biotechnology 15 March 1997:232-234.

whose genes are being modified, the phylogenetic distance between the donor and recipient of a transgene, personal and social benefits and risks thought to be generated by the application, the likely extent of use, the possibility of irreversible impacts, ethical considerations, and other factors.

The tables shown in **IIE-45** demonstrate that people have significantly more reservations about genetic engineering involving animals than they do about genetic engineering involving plants, and that reservations are strongest about genetic engineering involving humans.<sup>6</sup> Table 4 in IIE-45 shows twelve applications of genetic engineering involving micro-organisms, plants and animals. Some applications are approved by upwards of 90% of people surveyed while others are approved by only 40% or less. Of the 12 applications listed, 10 meet with approval of a majority of respondents, with 5 of these receiving over 75% approval.

These results contrast somewhat with the generally high levels of skepticism about the safety of genetic engineering shown in Tables 1 and 2 of IIE-43. If we assume that the results shown accurately represent people's attitudes, a reasonable inference is that people judge the benefits of most of the products listed in Table 2, Table 3 and Table 4 in IIE-45, to outweigh the risks foreseen in Table 1 and Table 2 of IIE-43.

Opinion surveys commonly show that people who may express disapproval of genetic engineering in general will nonetheless approve of particular genetic engineering applications. An example can be seen by comparing Table 1 in IIE-45, in which 65% of respondents disapprove of using genetic engineering to create hybrid animals, with Table 3 in that box, in which 63% of respondents *favor* genetic engineering to make animals resistant to diseases.<sup>7</sup>

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<sup>6</sup> The results shown in Table 5 in IIE-45 suggest that "genetic manipulation of human *cells*" is regarded by people to be unacceptable, but only slightly so. It is possible that the responses would have shown greater unacceptability had the question asked about "genetic manipulation of human *beings*".

<sup>7</sup> Of course, differences in the wording or interpretation of the questions, and fact that the sample populations are different, might account for some of this seeming discrepancy. All transgenic animals, including those engineered to be disease resistant, are, by definition, hybrids.

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**BOX II-45. OPINIONS ABOUT DIFFERENT APPLICATIONS OF GENETIC ENGINEERING**  
[percents]

Table 1

In general, do you approve or disapprove of creating hybrid plants [animals] using genetic engineering?

	plants	animals
approve	61	28
disapprove	31	65
not sure	7	7
refused	1	1

source: Hallman & Metcalf, 1995. Survey of New Jersey residents. N = 604.

Table.2

It is now or will soon be possible to alter the genetic makeup of plants and animals used to produce food. Do you favor or oppose altering the genetic makeup of plants to:

	favor	oppose	not sure
make them resistant to plant diseases.	69	26	5
increase the yield or amount of food which can be grown.	77	19	4

Table 3

Thinking about animals we use as food, do you favor or oppose altering the genetic makeup of animals to...

	favor	oppose	not sure
make them resistant to animal diseases.	63	31	6
increase the amount of meat obtained from them.	51	44	5

source: Time/ONN Poll, Dec. 2 1993. AP01 1993:873.

Table 4

Based on what you know, do you approve or disapprove of scientists using genetic engineering to create...

	approve	disapprove	not sure
New drugs to cure human disease	93	5	2
Hormones like insulin to help people with diabetes	93	5	2
More nutritious grain to feed people in poor countries	86	13	1
Bacteria to clean up oil spills	83	12	5
New grass that doesn't need to be mown so often	78	19	3
Fruits and vegetables that are less expensive	73	24	3
Fruits and vegetables that have own chemical defenses against pests	65	31	4
Better tasting fruits and vegetables	67	32	1
Fruits and vegetables that last longer on supermarket shelf	57	41	2
Hormones that enable cows to produce beef with less cholesterol	57	40	3
Hormones that enable cows to give more milk	40	57	3
Hormones that enable cows to give more beef	39	59	2

source: Hallman, W. and Metcalfe, J., 1995. Survey of New Jersey residents. N = 604.

Table 5

On a scale of 1 to 10 where 1 is totally unacceptable and 10 is totally acceptable, where would you rank genetic manipulation of...

plant cells	6,6
bacteria	5,6
animal cells	5,3
human cells	4,5

source: Office of Technological Assessment, Public Perceptions of Biotechnology, 1987:51. N = 1273.

**BOX IIE-46. PUBLIC PERCEPTION OF VARIOUS APPLICATIONS OF BIOTECHNOLOGY**  
[percents]

People surveyed were asked if they agreed completely, agreed somewhat, disagreed somewhat, or disagreed completely, with each of the four statements A through D, as applied to each of the six applications 1 through 6, shown below.

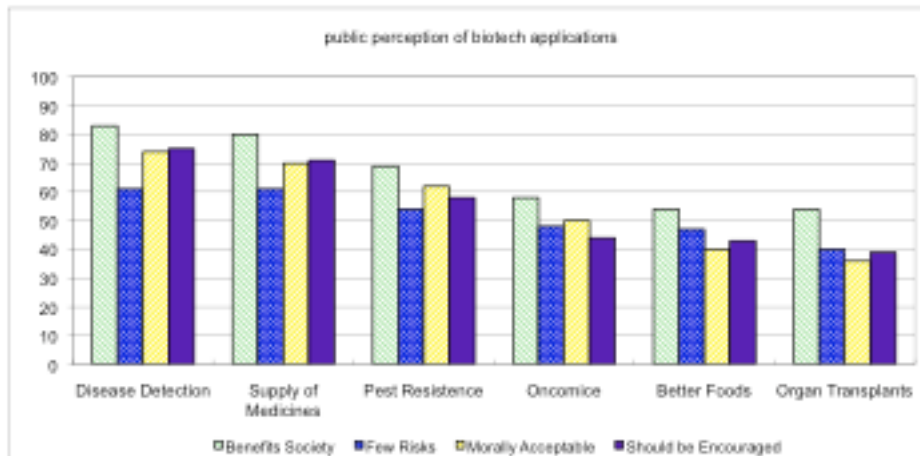
- A. This application benefits society
- B. This application involves risks for society
- C. This application is morally acceptable
- D. The application should be encouraged

**Applications:**

1. Using modern biotechnology in the production of foods, for example to make them higher in protein, keep longer, or change the taste (BETTER FOODS)
2. Taking genes from plant species and transferring them into crop plants to make them more resistant to insect pests (PEST RESISTANCE).
3. Introducing human genes into bacteria to produce medicines or vaccines, for example to produce insulin for diabetics (SUPPLY OF MEDICINES)
4. Developing genetically modified animals for laboratory research studies, such as a mouse that has cancer-causing genes (ONCOMICE)
5. Introducing human genes into animals to produce organs for human transplants, e.g. into pigs for human heart transplants (ORGAN TRANSPLANTS)
6. Using genetic testing to detect diseases we might have inherited from our parents, such as cystic fibrosis, mucoviscidosis, thalassaemia (DISEASE DETECTION)

Percents completely and somewhat in agreement with each statement

RESULTS	A. benefits society	B. little risk	C. morally acceptable	D. should be encouraged
Disease Detection	83	61	74	75
Supply of Medicines	80	61	70	71
Pest Resistance	69	54	62	58
Oncomice	58	48	50	44
Better Foods	54	47	40	43
Organ Transplants	54	40	36	39



sources: Eurobarometer 46.1, Fall 1996. N = 17198. Access via [europa.eu.int/comm/dg12/press/1997/pr180997.html#graph](http://europa.eu.int/comm/dg12/press/1997/pr180997.html#graph)

**Box IIE-46** shows the results of an extensive European survey in which persons were asked to evaluate six possible applications of biotechnology with respect to social benefit, social risk, and moral acceptability. The results regarding benefits and risks are ambiguous, as explained in the footnote, but the results concerning moral acceptability, and whether or not the application should be encouraged, are straightforward.<sup>8</sup> We see that the use of biotechnology to develop genetic tests for human diseases, to produce affordable medicines, and to develop pest-resistant plants are all judged to be moral activities, and to be worthy of encouragement. The development of laboratory animal “disease models,” genetically modified foods and animal-to-human organ transplants are not judged by a majority of persons to be morally acceptable, and they are not judged by a majority of Europeans to be worthy of encouragement.<sup>9</sup>

Table 1 in **IIE-47** suggests that the number of respondents who are willing to buy genetically engineered foods may be less than the number shown in Table 4 in IIE-45 who say they “approve of” genetically engineered fruits and vegetables.

Table 2 in IIE-47 suggests that the level of concern that New Zealanders and Japanese have about genetically engineered foods does not differ greatly among basic food categories. However, Table 3 shows that the acceptability of transgenic foods can vary greatly depending upon the source and object of the modification. In both Japan and Australia, vegetables modified with animal genes are less acceptable than vegetables modified with genes from other plants, and

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<sup>8</sup> The fact that more people believe that a particular application “benefits society” than do the number that say the application “involves risk” says nothing about the *magnitude* of the benefits or risks that an individual ascribes to that application. Thus it is impossible to infer from the responses given whether the sample population believed that the benefits were greater than the risks for any of the applications, other than by assuming that the fourth question, “should this application be encouraged?” in fact incorporates that judgment. But in that case the first two questions are unnecessary.

<sup>9</sup> Oncomice and transgenic foods are commercially available in Europe and are the focus of considerable protest by activists there who seek to have such items banned or otherwise discouraged. Animal-human organ transplants (xenotransplants) are not currently allowed in Europe. Proponents believe that genetic engineering can make xenotransplants safe and available for tens of thousands of critically ill people each year. Opponents fear the spread of animal diseases to humans.

**BOX IIE-47. PREFERENCES REGARDING GENETICALLY ENGINEERED FOOD**  
[percents]

Table 1

Would you be very willing, somewhat willing, not very willing, or not at all willing to buy genetically engineered (ITEM) if it were the same price as similar...

	willing	not willing	don't buy it anyway
corn	56	42	1
tomatoes	56	42	1
apples	55	42	1
milk	38	60	1
beef	37	60	1
baby food	27	64	5

source: W. Hallman and J. Metcalfe, 1995. Survey of New Jersey Residents, p 27. N = 604.

Table 2

If any of the following were to be produced from genetically modified organisms, would you have any concerns about using them?

**NEW ZEALAND**

	no concerns	few/some concerns	a lot
dairy products	27	42	31
vegetables	33	38	29
meat	25	40	35
medicines	38	41	21

**JAPAN**

	no concerns	few/some concerns	a lot
dairy products	16	66	18
vegetables	24	61	15
meat	14	67	19
medicines	22	59	19

source: D. Macer, 1994:199. N (Aus) = 201, N(Jpn) = 352.

Table 3

3a Genes from most types of organisms are interchangeable. Would potatoes made more nutritious through biotechnology be acceptable or unacceptable to you if genes were added from another type of plant, such as corn?

**AUSTRALIA**

acceptable	unacceptable	don't know
56	23	21

**JAPAN**

acceptable	unacceptable	don't know
39	25	36

3b Would such potatoes be acceptable or unacceptable to you if the new genes came from an animal?\*

acceptable	unacceptable	don't know
23	54	23

acceptable	unacceptable	don't know
11	40	49

3c Would chicken made less fatty through biotechnology be acceptable or unacceptable if genes were added to the chicken from another type of animal?\*

acceptable	unacceptable	don't know
40	40	20

acceptable	unacceptable	don't know
20	41	39

3d Would such chicken be acceptable or unacceptable if the genes came from a human?\*

acceptable	unacceptable	don't know
16	66	18

acceptable	unacceptable	don't know
6	53	41

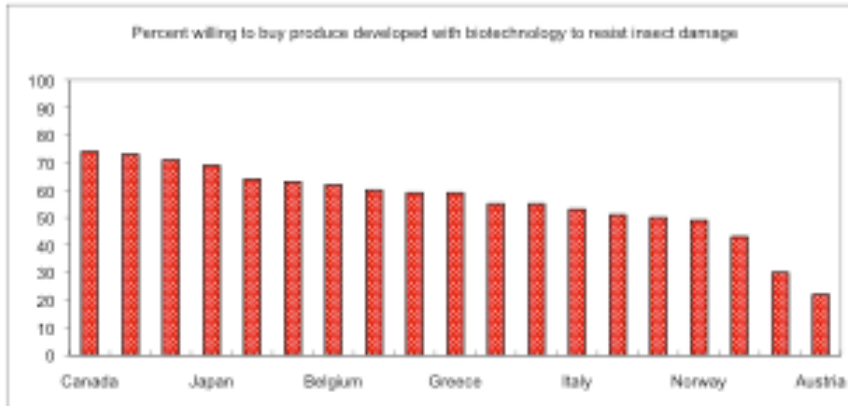
source: D. Macer, 1994:212. N (Aus) = 201, N(Jpn) = 352.

**BOX IIE-4B. WILLINGNESS TO BUY AND EAT GENETICALLY ENGINEERED FOOD**  
[percents]

Table 1

Percent of adults willing to buy produce developed with biotechnology to resist insect damage

60% +		50% +		< 50%	
Canada	74	Spain	59	Norway	49
USA	73	Greece	59	Luxembourg	43
Portugal	71	Finland	55	Germany	30
Japan	69	Denmark	55	Austria	22
Netherlands	64	Italy	53		
UK	63	Sweden	51		
Belgium	62	Ireland	50		
France	60				



Source: Hoban (1997)

Table 2

I personally would be happy to eat genetically modified food.

agreed	17
disagreed	67
neither	12
don't know	4

source: MORI/Greenpeace poll of adults in Britain, Denmark, Italy, Netherlands, and Sweden, Dec. 1996. N = 480. Cited in Macer, 1997.

Table 3

Genetically engineered food involves artificially changing the genetic make-up of a plant. For example, a vegetable might have a virus, bacteria or genetic material from another plant or animal inserted into it to make it tolerant to a pesticide or have a longer shelf-life. Genetically engineered food will shortly be available in New Zealand supermarkets. Would eating genetically engineering food cause you to worry, or not?

[5-point scale, where 1 = not worry at all, and 5 = worry a lot]

1	12
2	8
3	17
4	17
5	43

source: Macer, July 1997

chickens modified with human genes are much less acceptable than those modified with genes from other (non-human) animals.<sup>10</sup>

Table 1 in **IIE-48** suggests that majorities of all Western European countries except Austria, Germany, Luxembourg and Norway appear willing to buy produce “developed with biotechnology to resist insect damage.” In only five of these countries, however, does this “willingness to buy” represent greater than 60% of respondents.

Table 2 in that box shows considerably stronger reservations about genetically engineered food among Europeans than does Table 1. But the results of these two surveys are not necessarily in contradiction--a person could be unhappy about eating genetically modified food and still be willing to buy it.

Table 3 in IIE-47 suggests considerably stronger reservations about genetically engineered food among New Zealanders than do the results in Table 2. The survey that produced the results shown in Table 2 in IIE-48 was sponsored by Greenpeace. The author of the survey that produced the results shown in Table 2 in IIE-47, Darryl Macer of the Eubios Institute, charges that the prefatory material for the question shown in Table 3 is “leading.” (Macer, 1997). Macer’s survey contains little or no prefatory material. Since the general public has only a sketchy understanding of genetic engineering, it’s not obvious that the absence of prefatory material produces results that better reflect the public’s sentiments about these issues.

**Box IIE-49** shows some results from a survey of Wisconsin residents concerning Bovine Growth Hormone (BGH). The survey was taken shortly after dairy farmers could begin using BGH legally in February of 1994. At that time 64% of residents were still unsure about the safety of BGH. Among those who felt they were well-informed about the issue, 30% felt it was safe and 40% felt it was unsafe. As might be expected, 97% of those who believed BGH to be unsafe opposed its use in cows, as did 78% of those who were unsure about its safety.

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<sup>10</sup> Consumer resistance to foods that combine genes from life-forms far apart on the evolutionary tree has been attributed to the “yuk factor.”

**BOX IE-49. ATTITUDES REGARDING BOVINE GROWTH HORMONE**

[percent]

source: All tables are based on results of The Wisconsin Survey, Spring 1994, APO 1994:858.

1 How familiar are you with the Bovine Growth Hormone issue? Would you say you are Very Familiar, Somewhat Familiar, or Not At All Familiar?"

Very familiar	19
Somewhat familiar	64
Not at all familiar	17

2 Do you feel that dairy products from cows treated with BGH are generally safe for consumption, unsafe for consumption, or are you unsure of their safety?

	total	Familiarity		
		very	somewhat	not at all
Safe	21	30	23	6
Unsafe	16	40	12	6
Unsure of safety	63	30	65	89

3 Do you favor or oppose the use of synthetic BGH in cows?

	total	Dairy products from treated cows are...		
		safe	unsure	unsafe
Favor	15	56	5	1
Oppose	70	23	78	97
Not sure	16	21	17	1

4 Do you favor or oppose the mandatory labeling of dairy products so consumers like yourself would know if the product contained synthetic BGH?

	total	Dairy products from treated cows are...		
		safe	unsure	unsafe
Favor	88	62	95	95
Oppose	9	34	2	3
Not sure	3	4	3	2

5 If you knew that a dairy product did contain synthetic BGH, would this make you more likely to buy the product, less likely to buy the product or would it not have any affect on your decision to buy the product?

	total	Dairy products from treated cows are...		
		safe	unsure	unsafe
more likely to buy	1	2	1	0
less likely to buy	70	20	81	95
no affect	28	79	16	5
not sure	2	0	3	0

6 Since February 3rd, the date when farmers could legally begin using BGH, would you say your household's consumption of dairy products has increased, decreased or remained about the same?"

	total	Dairy products from treated cows are...		
		safe	unsure	unsafe
increased	1	0	0	1
remained the same	91	96	93	75
decreased	7	4	5	22
don't know	1	0	2	3

Interestingly, only 56% of those who believed BHG to be safe advocated its use. Thus the overall opinion of Wisconsin residents was 70% in opposition to the use of BGH. Further, fully 88% of residents, including 62% of those who felt it was safe, favored the mandatory labeling of dairy products made from milk produced by cows that had been treated with BGH. A lesser share--70%--declared that they would in fact tend to refrain from buying such milk. Despite these sentiments no labeling requirements were in force when farmers became eligible to use BGH, and only 28% of residents had clearly reduced their consumption of milk over the following few months.

Support for “strict” regulation of genetic engineering is strong, even in this anti-regulatory era, as can be seen in Table 1 of **IIE-50**. Table 2 of IIE-50 shows that 90% of Americans support labeling of foods produced by genetically engineered plants and animals. However, the definition of “strict,” and the detailed specification of labeling requirements, are matters of contention. Table 3 and Table 4 show the results of a survey sponsored by the International Food Information Council, a research and publicity arm of the food industry. Table 3 shows that 78% of Americans voice support for current FDA labeling requirements. When informed that critics are calling for stronger labeling requirements, the level of support for the FDA policy drops to 57% (and the point spread between support and opposition drops from 58 to 17 percentage points). The IFIC interprets this as a vindication of its position that Americans do not support changes in the FDA labeling policy. However, the prefatory material for the question that generated the results shown in Table 4 is clearly leading.

Table 1 in **IIE-51** shows strong opposition to the introduction of genetically modified food into Europe. Table 2 shows that the need for stronger regulation of biotechnology is supported by majorities of Europeans. However, some sense of fatalism or discouragement is suggested when 53% of Europeans say they *agree* with the statement that “irrespective of the regulations, biotechnologists will do whatever they like.”

**BOX IIE-50. ATTITUDES ABOUT BIOTECHNOLOGY AND GENETIC ENGINEERING POLICY**  
[percents]

Table 1

The potential danger from genetic engineering is so great that strict regulations are necessary.

	Agree	Disagree	Not sure
OTA 1987*	77	20	3
New Jersey 1995	65	28	7

\* The OTA question used the phrase "altered cells and microbes" rather than "genetic engineering."  
sources: Office of Technology Assessment (1987), table 60. New Jersey: Hallman and Metcalfe (1995).

Table 2

In your view, should food produced by genetically altered plants [animals] be labeled as such?

	yes	no	not sure
plants	90	7	3
animals	90	8	2

source: Time/CNN Poll, Dec. 6, 1993. APOI 1994:873.

Table 3

The U.S. Food and Drug Administration (FDA) requires that a label must indicate that biotechnology was used to produce a food under certain conditions: when biotechnology's use introduced an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is required. Would you say that you support or oppose this policy of FDA?

strongly support	45	
somewhat support	33	78
somewhat oppose	9	
strongly oppose	11	20
don't know/refused	1	

source: International Food Information Council/Within Group Quorum Survey, March 21-24, 1997. N = 1004.

Table 4

Some critics of the U.S. FDA policy say that any food produced through biotechnology should be labeled even if the food has the same safety and nutritional content as other foods. However, others, including the FDA, believe such a labeling requirement has no scientific basis, and would be costly and confusing to consumers. Are you more likely to agree with the labeling position of the FDA or with its critics?

agree with FDA	57
agree with critics	40
don't know, refused	3

source: International Food Information Council/Within Group Quorum Survey, March 21-24, 1997. N = 1004.

BOX IIE-51 OPINIONS ABOUT BIOTECH POLICY (OTHER COUNTRIES)

Table 1

Would you support or oppose the development and introduction of genetically modified food or food derived from genetic engineering? [asked of adults in Britain, Denmark, France, Italy, Netherlands, and Sweden]

would support it	22
would oppose it	59
neither	15
don't know	5

source: MORI/Greenpeace poll, Dec. 1996. (N = 4840)

Table 2 - EUROPE

Please tell me whether you tend to agree to disagree:

	Tend to Agree		Tend to Disagree		Don't Know	
	Europe	Japan	Europe	Japan	Europe	Japan
A. It is not worth putting special labels on genetically modified foods	17	8	74	82	9	10
B. The regulation of biotechnology should be left mainly to industry	19	6	63	73	18	21
C. Modern biotechnology is so complex that public consultation about it is a waste of time	27	15	61	66	12	19
D. We have to accept some degree of risk from modern biotechnology if it enhances economic competitiveness in Europe	29	12	55	71	16	18
E. Current regulations are sufficient to protect people from any risks related to modern technology	24	8	52	62	24	30
F. Irrespective of the regulations, biotechnologists will do whatever they like.	53	12	32	46	15	22

source: Eurobarometer 46.1, Fall 1996.

Table 3

Which of the following bodies do you think is best placed to regulate modern biotechnology?

	Europe		Canada	Japan		New Zealand	
	(choose 1 body)			(choose up to 2 bodies)			
A. international organizations: UN, WHO, etc.	35	40	40	62	62		
B. scientific organizations	21	28	28	24	40		
C. public bodies in (OUR COUNTRY)	12	13	13	62	21		
D. ethics committees	9	11	11	12	38		
E. don't know	8	-	-	10	3		
F. the European Union, public bodies in the EU	6	-	-	-	-		
G. our national parliament	5	5	5	3	14		
H. none of these (SPONTANEOUS)	3	3	3	1	1		
I. Maori organizations (NZ only)	-	-	-	-	9		

source: D. Macer, 1997:13.

Table 4

People who create something original can obtain financial reward for their efforts through patents and copyright. In your opinion, for which of the following should people be able to obtain patents and copyright?

	Australia			Japan		
	patenting acceptable	not acceptable	don't know	patenting acceptable	not acceptable	don't know
New inventions, such as consumer products	93	2	5	85	6	9
Books and other information	80	8	12	68	14	18
A medical treatment or drug to cure AIDS	60	26	14	60	21	19
New plant varieties	55	24	21	49	19	32
New animal breeds	45	29	26	41	26	33
Genetic material extracted from plants/animals	38	34	28	35	30	35
Genetic material extracted from humans	31	43	26	32	36	32

source: D. Macer, 1994:211.

Table 2 in IIE-51 shows that Japanese feel even more strongly than do Europeans that biotechnology needs to be regulated. Japanese differ, however, in strongly *disagreeing* with the statement the biotechnologists will do whatever they wish, irrespective of any regulations that might be passed. The difference of 39 percentage points between the Japanese and European responses to this question is the single largest difference shown between any two countries for any question reviewed in this exercise.

Table 3 in IIE-51 shows that people in Europe, Canada, Japan and New Zealand believe that effective regulation of biotechnology will require the leadership of multi-lateral institutions such as the United Nations and the World Health Organization, with strong support from the scientific community.

A currently controversial policy issue concerns the extent to which the products and processes of biotechnology and genetic engineering can be patented. Table 4 in IIE-51 shows that Australians believe that new plant varieties and medicines should be patentable, but that new animal varieties, and any genetic materials extracted from plants or animals, should not be. Table 4 also shows that Japanese evaluate the acceptability of patents for various categories of items in precisely the same rank order as do Australians. The patenting of human genetic materials is acceptable to more than 30% of both Australians and Japanese; whether this is a large number or not is a matter of interpretation.

### ***Summary and comments***

We've seen that people living in industrial countries are generally supportive of most biotechnological research, techniques, and applications involving the genetic engineering of micro-organisms, plants and animals. Majority support is lacking for particular processes and applications that appear to commingle genes from species that are phyletically distant, or that might pose some threat to human health. Majorities want assurances that genetic engineering activities will be subject to government oversight and regulation, and they want labeling that will allow consumer choice. In most instances neither the majorities supporting genetic engineering,

nor those opposing it, are particularly large. On many issues large portions of the publics surveyed are undecided. These technologies and their applications are new, and attitudes are likely still in the process of formation. In most of the regards just noted Germans and Austrians, and to a lesser extent Northern Europeans in general, are less supportive of genetic technologies than are people in other industrialized countries.

### ***II.E.3.c. Human Genetic Engineering***

In Section IIE.2.a we reviewed the many new and proposed applications of human genetic science. Adults and children can be tested for the presence of genes that may lead to health problems in later years. They can also be tested for the presence of genes which, if passed on to a child, can lead to health problems. Fetuses can be tested for the presence of genes that may lead to later health problems, allowing parents to seek pre- or post-natal therapy, prepare for post-natal care, or terminate the pregnancy. New techniques of somatic gene therapy can modify genes in the body cells of adults, children or fetuses to correct for defective genes. Proposed techniques of germline gene therapy would not remedy physiological defects in an adult, child or fetus, but would prevent those defects from being passed to future generations. In addition to addressing recognized health problems, the genetic techniques just noted could be used to enhance otherwise normal, healthy characteristics. New reproductive technologies can be used in conjunction with the genetic technologies just noted to expand the control that parents have over the biological characteristics of their children. These techniques include artificial fertilization, surrogacy, and human cloning.

Table 1 and Table 2 in **IIE-52** show strong approval of the general idea of using of genetic testing to help identify disorders that might appear in people or their children. Table 3 shows that this approval holds for the particular application of population screening.<sup>11</sup> Table 4

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<sup>11</sup> Genetic population screening is the practice whereby care facilities routinely offer pre- or post-natal tests for genetic defects. Mothers can decline these tests if they wish.

**BOX III-52. ATTITUDES CONCERNING GENETIC TESTING AND SCREENING**  
[percents]

Table 1

One goal of gene mapping is to identify the genes associated with serious diseases. This would permit early diagnosis of those diseases before symptoms begin to develop. How do you feel about using genetic information for early diagnosis of disease?

Approve	Disapprove	No opinion/dk
93	7	1

source: Nat'l Center for Genome Resources, 1996 p 2. N = 1039.

Table 2

If genetic tests become available that indicate whether or not a person is likely to develop a fatal disease later in life, would you personally want to take such a test?

	Yes	No	Don't know
1990	52	43	4

source: Singer, 1993; N = 1006.

Table 3

Genetic tests can also identify whether an individual carries a disease gene that their children will be likely to inherit. How do you feel about using genetic tests to indicate whether future children are likely to have a serious disease?

Approve	Disapprove	No opinion/dk
88	11	1

source: Genetic Needs Assessment, Washington State University, March 1993. N = 375.

Table 4

Now I'm going to read you a general definition: "POPULATION GENETIC SCREENING is testing of all people to find out whether they are at risk of developing or passing on a genetic disease. This kind of screening is or could be routinely offered, and can be refused by an individual." Population genetic screening can be done at different times of life. For each time, please tell me whether you favor or oppose population genetic screening at that time.

	favor	oppose	not sure/ refused
Newborn screening for genetic diseases like PKU	84	8	8
Screening children for genetic diseases or birth defects during the elementary years	85	10	6
Screening adults for genetic diseases	82	12	6
Screening future parents prior to pregnancy for genetic diseases	83	12	6
Screening an unborn fetus during pregnancy for genetic diseases or defects	74	20	6

source: Genetic Needs Assessment, Washington State University, March 1993. N = 375.

Table 5

Today, tests are being developed that make it possible to detect serious genetic defects before a baby is born. But so far, it is impossible either to treat or to correct most of them. If (you/your partner) were pregnant, would you want (her) to have a test to find out if the baby has any serious genetic defects?

	yes	no	don't know
1991	63	28	9

source: NORC, General Social Survey, 1991. Codebook variable GENESELF. N = 917

and Table 5 suggest that the number of persons who would personally want to make use of adult or prenatal genetic testing is less than the numbers that otherwise approve of these applications.

Table 1 in **IIE-53** shows that for the past quarter century over 80% of Americans have believed that a woman should be able to obtain a legal abortion if “serious defects” in the baby are anticipated. Table 2 shows that only 41% of respondents say that they would want to terminate a pregnancy in that situation, with another 21% unsure. Table 3 shows divided opinions as to whether a woman should abort a genetically defective fetus. Table 4 suggests that 10% of Americans support compulsory abortion of seriously genetically defective fetuses carried by poor women. Whether that value is considered to be large or small is a matter of interpretation.

People have different opinions about what constitutes a “serious” genetic defect. Table 1 in **IIE-54** suggests that less than 50% of British respondents support the “routine availability” of genetic testing even for such major genetic disorders as cystic fibrosis and early-onset cancer.

Table 1 in **IIE-54** also shows attitudes concerning testing and selective abortion for human characteristics not typically considered to be diseases, such as one’s sex, sexual preference or level of intelligence. It appears that only small percentages of respondents believe prenatal testing for these should be “routinely available.” But “routinely available” is an ambiguous descriptor, so it is difficult to know precisely what is being affirmed or rejected.<sup>12</sup>

The policy of the government of the People’s Republic of China is to discourage the birth of children with serious genetic disorders. Table 2 in **IIE-54** shows that this policy is endorsed nearly universally by Chinese geneticists. Table 2 also appears to imply that perhaps upwards of

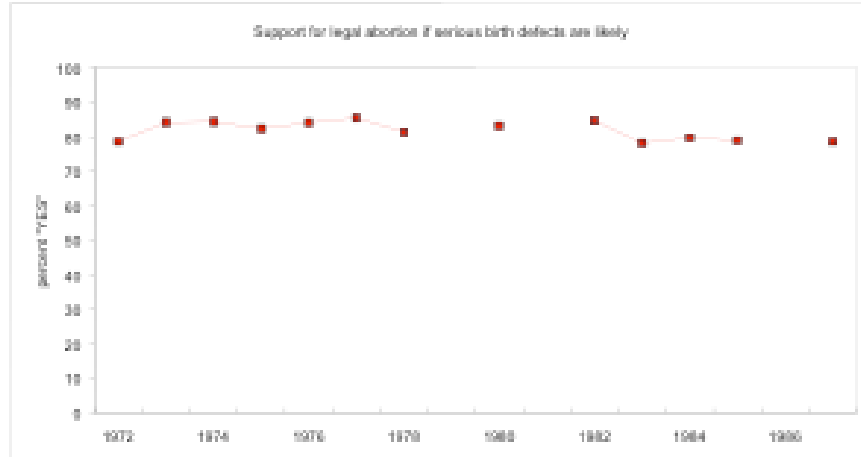
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<sup>12</sup> For example, the fact that 13% of the population is shown as agreeing that prenatal testing for “low intelligence”, with the possibility of abortion, should be *routinely* available doesn’t appear to exclude the possibility that additional respondents might support the legitimacy of prenatal testing of that sort, albeit not *routinely*.

**BOX IE-53. ATTITUDES TOWARDS PRENATAL TESTING AND SELECTIVE ABORTION (1)**  
[percents]

**Table 1**

Please tell me whether or not you think it should be possible for a pregnant woman to obtain a legal abortion if there is a strong chance of serious defects in the baby?



source: NORC, General Social Survey, 1972-1994. Codebook variable ABDEFET

**Table 2**

Suppose a test shows the baby has a serious genetic defect. Would you (yourself want to/want you partner to) have an abortion if a test shows the baby has a serious genetic defect?\*

	yes	no	don't know
1991	41	38	21

source: NORC, General Social Survey, 1991. Codebook variable GENLABRT. N= 917.

**Table 3**

Regardless of what you would want for yourself, do you think a woman should have an abortion if the baby has a serious genetic defect?

	yes	no	depends (vol)	don't know	refused/ no answer
1990	22	38	34	4	2

source: Singer, 1993 p 219. N = 1006.

**Table 4**

The care of children with serious genetic defects is often expensive. Suppose the parents are poor, and probably will not be able to pay for their child's care. Do you think in that case a woman should be required by law to have an abortion, or do you think the government should help pay for the child's care?

Required abortion	Gov. should help pay	neither (volunteered)	don't know	refused/ no answer
10	65	15	7	3

source: Singer, 1993 p 219. N = 1006.

**BOX II-E-54. ATTITUDES TOWARDS PRE-NATAL TESTING AND SELECTIVE ABORTION (2)**  
[percents]

Table 1

Imagine that reliable tests have been developed for each of the following diseases and characteristics. What are your views on testing with the possibility of ending the pregnancy? [Great Britain]

	% agreeing to routine availability	% who would or probably would use the test
Child of unwanted sex	9	3
Homosexuality	10	7
Low intelligence	13	3
Missing fingers	12	2
Cancer	34	16
Cystic fibrosis	47	32
Down syndrome	65	41
Anencephaly	71	63

Descriptions were added for the following:

Low intelligence: the child is able to attend regular school but needs extra help

Missing fingers: two missing fingers on the left hand.

Cancer: in early 30's that may be difficult to treat.

Anencephaly: the child will die soon after birth, usually within the hour.

Cystic fibrosis: the child has lung & digestive problems requiring daily treatment. The majority are likely to reach adulthood.

source: Manteau et al. 1995, Public attitudes towards the selection of desirable characteristics in children. N = 973.

Table 2

Survey of geneticists, People's Republic of China, 1996 (N = 402):

	agree
1. People at high risk for serious disorders should not have children unless they use prenatal diagnosis and selective abortion	95
2. An important goal of genetic counseling is to reduce the number of deleterious genes in the population	90
3. from the letter: "More than half opposed sex selection by any means."	

source: Xin Mao, West China University of Medical Sciences; letter to Nature, 5 Dec. 1996.

Table 3

As you may know, it is now possible to determine in advance, with considerable accuracy, the sex of a child before conception. In your opinion, will this prove to be a good thing or a bad thing for society generally, or do you think it will not have much of an effect at all?

good thing	15
bad thing	26
no effect	48
don't know	11

source: Canadian Institute of Public Opinion, April 1993. IPO 93-94, p 453. N = 1002.

Table 4

Tests during pregnancy also make it possible for parents to know ahead of time whether their baby will be a boy or a girl. Then, if it is not the sex they want, they can choose to have an abortion. Do you approve or disapprove of using prenatal testing for this purpose?

approve	disapprove	don't know	no answer
5	92	2	1

source: Singer, 1993. N = 1006.

Table 5

Suppose the parents already have three boys (girls), and would like to have a girl (boy). In that case, would you approve of using prenatal testing to find out a baby's sex before it is born?

	approve	disapprove	don't know	no answer
3 boys	39	56	4	2
3 girls	36	60	3	1

source: Singer, 1993. N = 1006.

40% of these geneticists apparently do not completely rule out abortion based on the sex of the fetus.

Table 3 in IE-54 shows that when Canadian respondents are asked, with little further elaboration, to evaluate the social impact of prenatal sex determination, 26% say they believe it will be bad for society and 48% believe there will be little impact. In Table 4 Americans are asked if they approve of prenatal sex determination, but now the option of selective abortion is made explicit. In this case fully 92% of respondents say they disapprove of prenatal sex determination. However, when these same Americans are presented with examples in which 3 children are of one sex and a fourth child, of the other sex, is desired, the share of respondents who disapprove of the use of sex determination and abortion to assure the desired outcome drops to 56-60%.

The next five boxes show attitudes concerning somatic and germline therapy and enhancement.

The tables in **IIIE-55** indicate that somatic gene therapy to address potentially fatal conditions enjoys the support of over 80% of the publics of the US, Great Britain and Australia, and in the neighborhood of 70% of Japanese.

Table 1 in **IIIE-56** shows the results of a 1992 survey conducted by the March of Dimes, and of a 1996 study, using many of the same questions, conducted by the National Center for Genome Resources (NCGR), an official unit of the Human Genome Project supported by the National Institutes for Health. The results appear to suggest that germline gene therapies for both fatal and non-fatal genetic diseases are supported by upwards of 70-80% of Americans, and that 35-40% of Americans approve of human germline engineering designed to “improve the physical characteristics/intelligence level that children would inherit.” However, the survey questions are worded in a way that appears intended to encourage positive responses. Rather than ask for opinions concerning “genetic engineering” or “changing human genes,” the survey asks about

**BOX IIE-55. ATTITUDES TOWARDS PERSONAL USE OF SOMATIC GENE THERAPY**  
[percents]

Table 1

Doctors frequently transplant organs such as the heart or liver from one person to someone else whose life is in danger. They may soon be able to treat some inherited fatal diseases such as cystic fibrosis by a similar process of transplanting genes to repair the body's own processes. How willing would you be to accept this treatment if it could save your life? [Great Britain].

very willing	70
somewhat willing	17
not very willing	3
not at all willing	4
don't know	5

source: Social Surveys (Gallup Poll) Ltd. "Gallup Political and Economic Index, Aug. 1993". IPO 93-4 p 455. N = 1000.

Table 2

If tests showed that you were likely to get a serious or fatal genetic disease later in life, how willing would you be to undergo therapy to have those genes corrected before symptoms appear?

	Australia	USA	Japan
willing	77	79	66
unwilling	10	18	21
not sure	13	2	13

source: Macer, D. p 205. USA results are from March of Dimes, 1992, Genetic Testing and Gene Therapy. N = 1000.

Table 3

If you had a child with a usually fatal genetic disease, how willing would you be to have the child undergo therapy to have those genes corrected?

	Australia	USA	Japan
willing	82	88	74
unwilling	4	9	11
not sure	14	3	15

source: Macer, D. p 205. USA results are from March of Dimes, 1992, Genetic Testing and Gene Therapy. N = 1000.

SCENARIOS FOR THE 21<sup>ST</sup> CENTURY

**BOX IIE-56 ATTITUDES ABOUT SOMATIC AND GERMLINE THERAPY AND ENHANCEMENT**  
[percenta]

Table 1

How do you feel about scientists changing the makeup of human cells to...	USA (1992)			USA ('96)
	approve	don't approve	don't know	
cure a usually fatal disease	87	12	1	85
reduce the risk of a usually fatal disease	78	19	3	84
prevent/stop children from inheriting a usually fatal genetic disease	84	13	3	86
prevent/stop children from inheriting a usually non-fatal genetic disease	66	32	3	72
improve the physical characteristics children would inherit	43	54	3	35
improve the intelligence level that children would inherit	42	55	3	

source: National Center for Genome Resources, National Survey, 1996. N = 1039.

Table 2

How do you feel about scientists changing the genetic makeup of human cells to...	AUSTRALIA			JAPAN		
	approve	don't approve	don't know	approve	don't approve	don't know
cure a usually fatal disease, such as cancer	89	8	3	83	5	12
reduce the risk of developing a fatal disease later in life	81	11	8	75	6	19
prevent children from inheriting a usually fatal disease	87	7	6	80	4	16
prevent children from inheriting a non-fatal disease, e.g. diabetes	79	13	8	62	17	21
improve the physical characteristics that children would inherit	28	63	9	28	51	21
improve the intelligence level that children would inherit	27	62	11	26	54	20
make people more ethical	34	44	22	24	53	23

source: D. Macer, 1994:202; N(Aus) = 201, N(Jpn) = 352. USA responses cited by Macer from March of Dimes, 1992; N = 1000.

“changing the makeup of human cells.” This phrase is misleadingly innocuous--getting a suntan or exercising regularly will “change the makeup of human cells.”

Table 2 in IIE-56 shows results of a survey of persons in Australia and Japan using questions similar to those used in the two American surveys shown in Table 1. Both the Australians and the Japanese appear to show roughly comparable levels of support for germline engineering to prevent diseases, including non-fatal ones, but show less support than do Americans for either physical or mental enhancement. Australians more explicitly disapprove of enhancement than do the Japanese, who show far higher levels of “don’t know.” Still, upwards of 25% of the populations of both Australia and Japan appear to support technologies of eugenic enhancement. However, the caveat just noted concerning the phrasing of the survey question must be kept in mind.

The 1996 NCGR survey that produced the results shown in IIE-56 also surveyed attitudes held by leaders of important social, political and professional groups. The results, shown in **IIE-57**, suggest that these leaders support all applications of human genetic engineering at very high levels, with the single exception of germline enhancement, in which case the levels of support drop to between 12% and 25%, with a weighted average of 17% for all 536 leaders surveyed. The significance of this level of support for germline enhancement is a matter of interpretation. On the one hand it can be understood as a clear rejection of such practices. But it also suggests that 1 of every 6 members of America’s professional class appears to endorse a particularly strong form of eugenics. These results also appear to show that only 10% of religious leaders (and a weighted average of 7% of all leaders) consider human genetic manipulation to be immoral (compared with the 22% of the general public who feel this way), and that fully 20% of all religious leaders approve of the strong eugenic practice of germline enhancement.<sup>13</sup>

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<sup>13</sup> Most official religious denominational bodies in the United States that have taken a position on genetic engineering are supportive of somatic gene therapy as a means to relieve suffering, oppose germline enhancement, and are unresolved concerning somatic enhancement and germline therapy.

**BOX IIE-57. LEADERSHIP OPINIONS CONCERNING HUMAN GENETIC ENGINEERING**  
[percents]

The 1996 survey of leadership opinions conducted by the National Center for Genome Resources included the questions shown here as A-F. Responses are shown in the accompanying chart.

- A Some people believe that genetic alteration of human cells to treat disease is simply another form of medical treatment. Other people believe that changing the genetic makeup of human cells is morally wrong, regardless of the purpose. On balance, do you feel that changing the genetic makeup of human cells is morally wrong, or not?
- B How do you feel about changing the makeup of human cells to cure a usually fatal disease?
- C How do you feel about changing the makeup of human cells to reduce the risk of developing a fatal disease later in life?
- D How do you feel about changing the makeup of human cells to prevent/stop children from inheriting a usually fatal genetic disease?
- E How do you feel about changing the makeup of human cells to prevent children from inheriting a usually non-fatal genetic disease?
- F How do you feel about changing the makeup of human cells to improve the physical characteristics children would inherit?

	A is morally wrong	B approve	C approve	D approve	E approve	F approve
doctors	8	90	89	90	79	28
patient representatives	8	97	96	94	84	25
religious leaders	10	92	88	88	76	20
industry leaders	10	91	86	86	79	18
media leaders	4	94	88	86	82	16
policy makers	9	87	86	89	71	16
insurers	6	93	87	88	80	14
scientists	0	96	96	82	63	12
general public	22	85	85	88	71	35

Sample populations:

1. Doctors: mailed questionnaires and telephone follow-ups to a list of physicians in general practice, family practice, practice, internal medicine, obstetrics/gynecology and pediatrics, compiled by the American Medical Association and the American Osteopathic Association. The response rate of 18% (521 completed questionnaires) was not considered to be large enough to avoid "substantial self-selection bias."

2. Telephone interviews were conducted with 527 representatives of national leadership groups, as follows:

leadership group	number of completed interviews	description
patient representatives	100	leaders of national patient-based health organizations
industry representatives	102	R&D directors from a national sample of pharmaceutical and biotech industries
religious leaders	50	national sample drawn from Who's Who in Religion
scientists	76	random sample of members of the American Society of Human Genetics
media representatives	50	medical science and health editors, columnists and writers
insurers	70	medical directors of a national sample of health and life insurers
policy makers	79	federal and state level policy makers

3. General public: telephone survey of 1,039 adult US residents.

source: National Center for Genome Resources, National Survey 1996. Chapters 7-9. Web site: [www.ncgr.org/gpi/survey](http://www.ncgr.org/gpi/survey).

Table 1 in **IIE-58** suggests that the number of Americans who believe that genetic engineering is morally wrong decreased dramatically between 1986 and 1996, from 44% to 22%.<sup>14</sup> On the other hand, Table 2a suggests that approval of eugenic enhancement in particular has declined from 44% to 35%, over that period. Table 2b suggests that approval for eugenic enhancement declines markedly with higher levels of education. This is the single instance in all the surveys reviewed thus far in which more education is correlated with *lesser* support of various forms of genetic engineering (cf. Table 3 in IIE-40, and IIE-41).

The TIME/CNN survey shown in **IIE-59** uses the phrase “genetic engineering,” and thus can be interpreted more straightforwardly than can much of the NCGR survey, but is itself ambiguous in other ways. Regarding the first three applications noted—concerning disease, appearance and intelligence—it is unclear whether respondents would interpret the questions as addressing somatic manipulation, germline manipulation, or both. The fourth question, concerning embryo banks, is also ambiguous, because the practice of producing multiple embryos *in vitro*, testing them for the presence of desired genes, and implanting them selectively does not require genetic engineering. The final application appears to be intended to refer to mass eugenic programs promoted by governments, although a completely voluntary eugenics could itself generate the results described. An inferred interpretation of the responses shown in IIE-59 might be that somatic therapy receives 79% support, somatic enhancement receives between 25-34% support, germline enhancement receives 18% support, and governmentally-sponsored eugenics receives 8% support. These levels of support are significantly below the levels for comparable

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<sup>14</sup> Note that the question that generated the results shown in Box IIE-58 does not make it clear if respondents who say “not morally wrong” are referring to *all* genetic engineering, or to particular applications of genetic engineering “to treat disease”. A question consistent with the prefatory material would have asked if respondents feel that genetic engineering *to treat disease* is or is not morally wrong. Further, the question does not distinguish between somatic and germline genetic technologies.

**BOX IIE-58. ATTITUDES ABOUT GENETIC ENGINEERING OVER TIME AND BY EDUCATION**  
[percents]

Table 1

Some people believe that genetic alteration of human cells to treat disease is simply another form of medical treatment. Other people believe that changing the genetic makeup of human cells is morally wrong, regardless of the purpose. On balance, do you feel that changing the genetic makeup of human cells is morally wrong, or not?

1a

	1986	1996
yes, it is morally wrong	42	22

1b

	yes, it is morally wrong (1996)
less than high school	38
college graduates	16

source: National Center for Genome Resource, 1996 National Survey, Chapter 5, p 2.

Table 2

How do you feel about scientists changing the makeup of human cells to improve the physical characteristics children would inherit?

2a

	1986	1996
approve somewhat	28	23
strongly approve	16	12
total approval:	44	35

2b

	% approve (1996)
less than high school	61
high school graduate	40
some college	27
college graduate	28

source: National Center for Genome Resource, 1996 National Survey, Chapter 5, p 6.

**BOX III-59 MORE OPINIONS ABOUT HUMAN APPLICATIONS OF  
GENETIC ENGINEERING**

[percents]

Table 1

Do you approve or disapprove of the use of genetic engineering to:

	approve	disapprove	not sure
1. Cure a disease	79	16	5
2. Improve a person's physical appearance	25	71	4
3. Improve a person's intelligence	34	62	4
4. Establish embryo banks from which prospective parents could select a child with genetic characteristics they desire	18	78	4
5. Make it possible for nations to produce large numbers of individuals with genetically desirable traits	8	88	4

source: Time/CNN poll, December 1993. APOI 1993 p 872.

applications described in the NCGR survey (cf. Table 1 in IIE-56; IIE-57; and Table 2a in IIE-58).<sup>15</sup>

The tables in **IIE-60** show attitudes in the United Kingdom concerning germline enhancement. The questions posed more clearly distinguish germline from somatic engineering than do those in the surveys of Americans just reviewed. Table 1 shows bare majority support (51%) for germline engineering that addresses a genetic disability. This contrasts with support levels of 72% or more suggested in Table 2. Table 1 of IIE-60 also shows very low support for either negative eugenics (7%) or positive eugenics (4%), which contrasts with the much higher level of support (35%) shown in Table 1 of IIE-54. However, the explicit characterization of the traits in question as “socially” undesirable and “socially” useful may be a factor in generating these low levels of support. Overall, it’s difficult to know how much the large differences regarding public support for germline engineering shown in the tables in IIE-56 and IIE-60 represent real differences between Britons and Americans, and how much they reflect the wording of the questions.<sup>16</sup>

Table 2 in IIE-60 goes beyond asking Britons about levels of “approval” and asks respondents whether they themselves would practice different types of germline manipulation. In 1993 78% of respondents said they would not engage in this practice “for any reason.” Between 1993 and 1994 positive sentiment for engaging in one or more of the germline manipulations listed appeared to increase from a mean of 5% to a mean of 12%. This is a large

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<sup>15</sup> On the other hand, if the first three applications—concerning disease, appearance and intelligence—were interpreted as referring to *germline* engineering, then the responses given would be comparable to those given in the NCGR survey. It is possible that the content or contexts of the full Time/CNN survey protocol sought to clarify the interpretation of the questions.

<sup>16</sup> Table 1 in IIE-44 shows that 39% of Britons and 21% of Americans perceive genetic engineering (in general) to be a health hazard. Table 1 in IIE-48 suggests that 63% of Britons and 73% of Americans would buy genetically engineered produce. A reasonable inference is that at least some of the surveyed differences between Britons and Americans regarding human germline manipulation may be real.

**BOX IIE-60. OPINIONS ABOUT HUMAN GENETIC ENGINEERING  
IN THE UNITED KINGDOM**

[percents]

Table 1

Do you believe it is right to select or to alter the genes for specific hereditary characteristics in the next generation of children?" (multiple answers)

	% yes
Yes, to relieve suffering or a disability	51
Yes, to prolong the life of somebody otherwise destined for an early death	29
Yes, to remove socially undesirable behavior characteristics	7
Yes, to breed socially useful behavior characteristics	4
No, all of these are wrong	35
Don't know	7

source: Social Surveys (Gallup Poll) Ltd. August 1993 N = 1000. IIPO 93-4 p 455.

Table 2

Science may some day enable parents to influence the appearance and behavior of a child by implanting selected genes or altering them. Would you do so?

If you could influence the appearance and behavior of a child by vitamin supplements would you do so?

Yes, if linked with:	implanting selected genes		vitamin supplements
	1993	1994	1994
Intelligence	7	11	41
Good looks	2	5	24
Specific skill	3	7	29
Aggression	7	18	41
Alcoholism	6	18	38
Homosexuality	6	10	22
No, not for any reason	78	n.a.	n.a.
Don't know	6	n.a.	n.a.

source: 1993 data from Social Surveys (Gallup Poll) Ltd. August 1993, N = 1000; IIPO 93-94 p 455.  
1994 data from Marteau et al, 1995, reporting Gallup Survey of that year, N = 973.

increase over such a short period. Marteau et al (1995) speculates that media coverage of the topic, or differing survey contexts, may be responsible.<sup>17</sup>

**Box IIE-61** shows the results of surveys concerning two human reproductive technologies—surrogacy and cloning--that in combination with genetic engineering could offer a large array of future human reproductive options. Table 1 shows that British opinion is fairly divided as to whether surrogacy arrangements in which a woman gives birth to her daughter's genetic children (i.e., to her own grandchildren) is a good idea or not.

Table 2 in IIE-61 shows the results of an early survey of American opinion concerning human cloning, taken four years before the first successful adult mammalian cloning in 1997. At that time 75% of respondents felt cloning was a “bad thing to do” and 58% felt it was morally wrong. After the cloning of “Dolly”, the percent of respondents who felt that human cloning was morally wrong increased to 89%, as shown in Table 3. Table 4 shows that the large share of persons who believe that human cloning is unacceptable hold that opinion very strongly.

### *Summary and comments*

The results of surveys of opinions about human genetic engineering are difficult to interpret. The technologies are new and changing rapidly, public understanding is undeveloped, and the topic engages many complex personal and social values. Under such conditions simple questionnaire surveys should be used only in conjunction with a mix of other sources of information about public opinion on a topic.<sup>18</sup>

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<sup>17</sup> The surveys reported in IIE-59 and IIE-60 raise many questions about public beliefs about the role that genetic factors play in influencing behavior, cognitive ability and sexual preference. Indeed, the way the questions are asked implies a far greater certainty regarding the links between genes and behaviors, and the eventual ability to influence certain behaviors via genetic manipulation, than most scientists in the field would endorse.

<sup>18</sup> Davison, Barns and Schibeci (1997) encourage the use of more dialogical instruments for assessing public attitudes about new, complex topics such as biotechnology. These instruments include public hearings, citizen review panels, small-scale group discussions, and consensus conferences.

**BOX IIE-61. ATTITUDES CONCERNING SURROGACY AND HUMAN CLONING**  
[percents]

Table 1

An English woman is carrying twins for her daughter who is unable to bear children. Eggs from her daughter were fertilized with sperm from her son-in-law and implanted in her. What about this particular case, where the mother will be bearing her daughter's children? Do you think this is a good or a bad idea?

	1991	1995
good idea	39	37
bad idea	47	43
don't know	14	20

source: Gallup Organization, July 1995. N = 1024. IPO 95-6 p 229.

Table 2

Time/CNN poll of Dec. 1993 (N = 872):

Table 27.2a In general, do you think cloning is a good thing or a bad thing to do?

Good thing	14
Bad thing	75
not sure	11

Table 2b Do you think cloning is morally wrong, or don't you think this way?

Yes, morally wrong	58
Don't feel this way	31
Not sure	11

Table 2c Do you think cloning is against God's will, or don't you think this way?

Yes, against God's will	63
Don't feel this way	26
Not sure	11

Table 3

Time/CNN Poll of March 1997 (N = 1005):

	yes	no	not sure
Are you willing to eat cloned fruits & vegetables?	49	40	11
Is it morally acceptable to clone animals?	66		
Are you willing to eat meat from cloned animals?	33	56	11
Is it morally unacceptable to clone humans?	89		
Is cloning humans against God's will?	74	19	7
Would you clone yourself if you had the opportunity?	7		
Would you participate in a demonstration against cloning humans?	29		

Table 4

On a scale of 1 to 5, where 1 is unacceptable and 5 is acceptable, how acceptable do you find the use of cloning to make copies of...

	humans	animals for food	plants for food
5 (acceptable)	2	14	29
4	1	7	11
3	3	16	19
2	6	9	9
1 (unacceptable)	86	54	30
don't know/refused	1	1	2

source: International Food Information Council/Wirthlin Group Quorum Survey, March 21-24, 1997. N = 1004.

If for the moment we take the results of the surveys just reviewed at face value, the following conclusions might be drawn. Americans appear to show consistently strong support for the use of somatic gene therapies for treating or preventing disease, with opposition limited to less than 15% of respondents. It is not clear from the surveys reviewed how Americans feel about genetic engineering for somatic enhancement. There appears to be general support for the use of germline therapy for preventing very serious diseases, although typically 20-30% of respondents are opposed. There is generally strong opposition to the use of germline engineering for enhancement, although typically 25-35% of respondents appear to support this. However, many of the questions that sought to assess opinions about germline engineering were worded in ways that might have suggested stronger levels of support than actually exist. Reproductive human cloning is very strongly opposed, with support limited to less than 10%.

None of the surveys reviewed explicitly sought to clarify differences of opinion that might be generated by giving different emphasis to individual and social frames of reference.<sup>19</sup> Many people might agree that a particular application of genetic engineering could be beneficial for an individual but harmful for society as a whole, and should for that reason be discouraged. As a case in point, none of the surveys reviewed addressed the equity dimensions of the new human genetic technologies.<sup>20</sup> On the other hand, even those who believe that a particular genetic technology could be socially harmful might be reluctant to advocate its prohibition if its use was asserted to be an individual right. In addition, none of the survey questions explicitly sought to explore attitudes towards “slippery slope” situations, in which the spread of certain applications

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<sup>19</sup> Davison et al. (1997) note that surveys of the sort reviewed here generate opinions constructed in accordance with consumerist values rather than citizenship values: “A consumer discourse constructs social activity in terms of individual preferences and thus narrows the range of recognized and legitimate concerns of ‘the public’ to matters which directly affect their won immediate health and welfare. It assumes that society is a market with individual consumers pursuing their immediate self-interest, with little or no interest in wide civic questions. The discourse of citizenship, on the other hand, involves the conception of the citizen as a member of a political community, with the rights and responsibility to participate in the development of common purposes.” (p 331)

<sup>20</sup> See Mehlman and Botkin (1998) for an extended discussion.

that are judged to be both individually beneficial and socially acceptable might nonetheless make it more difficult to prevent other, clearly undesirable applications. Finally, there were no efforts to assess opinions about the efficacy of opposition. This is especially important in the present instance because of the attempts by advocates of germline engineering and cloning to portray the use of these technologies as “inevitable.”<sup>21</sup>

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<sup>21</sup> Indeed, the Wellcome Foundation focus group study reported that although opposition to human cloning was “nearly universal,” a large number of respondents believed that scientists “were going to do it anyway.”

#### **II.E.4. ASSESSMENT**

The vision of the future advocated by the techno-utopians is one in which the entire natural world—plants, animals, humans and ecosystems—is reconstructed and transformed, continuously and forever. This process is either advocated as a desirable end in itself, or is pronounced to be inevitable regardless of human desires otherwise.

The case made by the techno-utopians is not a trivial one, and requires careful analysis if it is to be effectively refuted. Any attempts to curtail technological innovation as a general feature of human endeavor would require a revolution in social values, norms, beliefs, and institutions on a scale difficult to imagine.

Scenario 3 advocates steady economic growth for the next century and beyond, which, as we've seen, implies steady technological innovation. Without such economic growth, poverty remains and distributional equity becomes very difficult to achieve. Technological innovation is also needed to ensure that economic growth proceeds in a way that maintains ecological integrity.

As discussed in sections II.A.3 and II.E.1, technological innovation increases the specificity of control over natural processes. The complex of technologies that would allow economic growth to continue, and to do so without endangering natural processes, would give us the power to radically alter those processes, by choice or by accident.

If these assessments are accurate, what minimal conditions should we insist be adopted to ensure that the new technologies support rather than impede the achievement of Scenario 3?

We noted earlier the importance of adopting a generalized precautionary ethic concerning the new technologies. There are at least three guiding rules that such an ethic might support with respect to Scenario 3. One is that nothing is done that is irreversible. This is especially important with regard to fundamental natural processes and systems. A second is that no technologies should be developed that are judged likely to greatly increase economic inequality among persons, households or countries, unless compensatory actions are taken. And a third is that no

technologies are developed that erode human personhood, dignity and autonomy. Granted, unforeseen and unintended consequences are a commonplace of technological innovation. But we can raise the bar, both institutionally and culturally, on potentially problematic technologies, and then use our best judgment.

Note that these rules would still permit the vast number of innovations cited in Sections II.E.1 and II.E.2. Under the restrictions noted here, the world after another 150 years would still be far more technologically dense than it is now. If we have the strength and maturity to draw some minimal critical lines on the applications of the new technologies, the world of 150 years from now can be better than today's world. It can be a world of economic prosperity, ecological integrity and social equity. But if we cannot or do not draw those few lines, we run the strong risk of generating runaway dystopias of horrific consequence.