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Public Views of Gene Editing for Babies Depend on How It Would Be Used

Americans are more likely to anticipate negative than positive effects from widespread use of gene-editing technology

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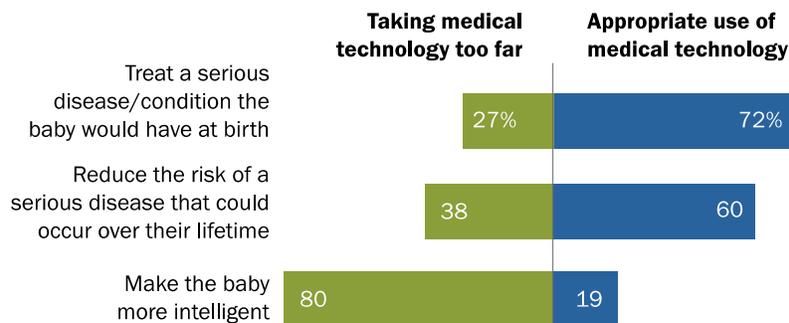
Public Views of Gene Editing for Babies Depend on How It Would Be Used

Americans are more likely to anticipate negative than positive effects from widespread use of gene-editing technology

Americans' views on the appropriateness of changing a baby's genetic characteristics depend in large part on the intended purpose and on whether or not human embryos would be used in testing these techniques. A majority of Americans support the idea of using gene editing with the goal of delivering direct health benefits for babies, but at the same time, a majority considers the use of such techniques to boost a baby's intelligence something that takes technology "too far."

A majority of U.S. adults says changing a baby's genes to a treat a serious congenital disease is appropriate

% of U.S. adults who say changing a baby's genetic characteristics for each of the following reasons is ...



Note: Respondents who did not give an answer are not shown.

Source: Survey conducted April 23-May 6, 2018.

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About seven-in-ten Americans (72%) say that changing an unborn baby's genetic characteristics to treat a serious disease or condition that the baby would have at birth is an appropriate use of medical technology, while 27% say this would be taking technology too far. A somewhat smaller share of Americans say gene editing to reduce a baby's risk of developing a serious disease or condition over their lifetime is appropriate (60% say this, while 38% say it would be taking medical technology too far). But just 19% of Americans say it would be appropriate to use gene editing to make a baby more intelligent; eight-in-ten (80%) say this would be taking medical technology too far.

These are some of the findings from a new Pew Research Center survey conducted April 23-May 6, 2018, among 2,537 U.S. adults.

While public discussions about potentially altering a baby’s genetic makeup have been ongoing for [decades](#), the development of a new gene-splicing technology – known as CRISPR – has accelerated the debate and brought new urgency to better understanding public opinion about gene editing as well as the broader social, ethical and policy implications ahead.¹

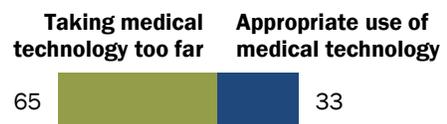
Previous Pew Research Center surveys have tracked public opinion about gene editing using different question wording and, in some cases, different polling methodologies. As such, those findings are not directly comparable to this new survey. However, the broad pattern – that public support for gene editing varies with its intended purpose – is consistent with a [2016 study](#) that explored public views about the possibility of using gene editing to “enhance” a baby’s health over the course of their lifetime and a [2014 survey](#).²

Regardless of the intended purpose of gene editing, experts acknowledge that further development of these techniques will likely involve [testing in human embryos](#). In August 2017, research scientists in the United States reported the [first successful use of gene editing in human embryos](#) to eliminate an inherited condition. When asked to consider the possibility that the development of gene editing would involve testing on human embryos, one third of Americans (33%) say this would be appropriate while about two-thirds (65%) say this would be taking medical technology too far.

The [2016 Pew Research Center survey](#) using different question wording found that most adults said testing on human embryos to develop gene editing would make gene editing less acceptable for them.

65% of Americans say if gene editing relies on embryonic testing, it would take technology too far

% of U.S. adults who say that if development of gene editing required testing on human embryos, it would be ...



Note: Respondents who did not give an answer are not shown.
Source: Survey conducted April 23-May 6, 2018.
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¹ The National Academies of Sciences and the National Academy of Medicine [launched](#) a consensus study and at least two international summits to consider these issues.

² Other research on public views of gene editing has also shown that the public distinguishes its intended purpose. [Scheufele et al. \(2017\)](#) found that Americans were more supportive of gene editing applications that treat medical conditions than those aimed at enhancing health. Similarly, [Whitman \(2018\)](#) also found stronger public support for gene editing to cure disease than gene editing to make people stronger or more intelligent.

Public views of gene editing vary by religious commitment, gender, levels of science knowledge and familiarity with gene editing

Several patterns emerge in public opinion about gene editing in these varying contexts. There are large differences in acceptance of gene editing between the highly religious and less religious. In addition, there is a gender gap in views about gene editing, with women less accepting of it than men. People with higher levels of science knowledge and greater familiarity with gene editing also tend to be more accepting of it.

Religious Americans are more likely to view gene editing negatively

Americans who are high in religious commitment – that is, those who attend religious services at least weekly, pray at least daily and say that religion is very important in their lives – are less inclined than those with either medium or low levels of religious commitment to say that gene editing is an appropriate use of medical technology.³ For example, those high in religious commitment are closely divided over whether it is appropriate to use gene editing to reduce a

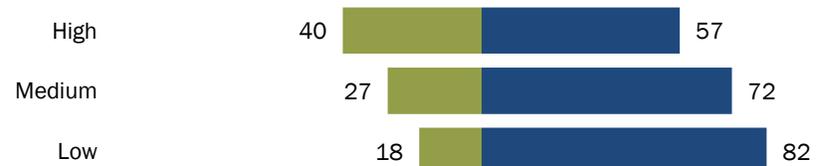
Highly religious Americans are more likely to see gene editing for babies as taking medical technology too far

% of U.S. adults in each religious commitment group who say changing a baby's genetic characteristics for each of the following reasons is ...

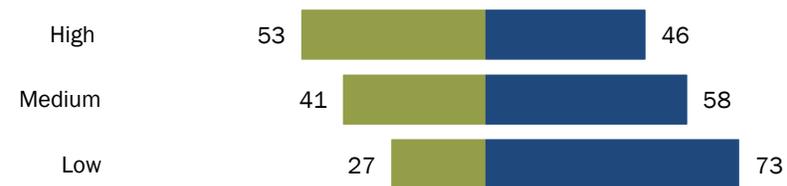
■ Taking medical technology too far ■ Appropriate use of medical technology

Treat a serious disease or condition the baby would have at birth

Among those ___ on the religious commitment index



Reduce risk of a serious disease or condition that could occur over their lifetime



Make the baby more intelligent



Note: Respondents who did not give an answer are not shown. See Methodology for details on index of religious commitment.

Source: Survey conducted April 23-May 6, 2018.

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³ A person is considered to have a high level of religious commitment if they attend religious services at least weekly, pray at least daily and say religion is very important in their life. People are classified as having low commitment if they say religion is not too or not at all important in their lives and that they seldom or never attend religious services or pray. All others are classified as having medium commitment.

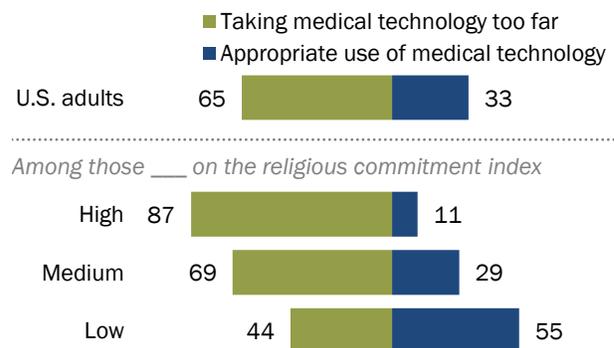
baby's risk of disease later in life; 46% say this is appropriate, while 53% consider it taking technology too far. In contrast, roughly three-quarters of those low in religious commitment (73%) say gene editing to reduce a baby's risk of developing a serious disease or condition is an appropriate use of medical technology. And, while a 57% majority of those high in religious commitment say gene editing to treat a congenital disorder in a baby is an appropriate use of medical technology, a much larger share of those with low religious commitment (82%) say this is appropriate.

Those with high levels of religiosity also stand out when considering the possibility that development of gene editing would entail testing on human embryos. An overwhelming majority of those high in religious commitment (87%) say this would be taking medical technology too far; just 11% of this group says this would be appropriate. In contrast, 55% of those low in religious commitment say that development of gene editing techniques that require testing on human embryos would be an appropriate use of medical technology.

The differences by religiosity in views on the appropriateness of gene editing tend to persist even when statistically controlling for other factors such as gender, race and ethnicity, age, and education that are related to religious beliefs and practices. See [Appendix](#) for details.

Most highly religious Americans consider testing gene editing on human embryos to be taking technology too far

% of U.S. adults who say that if development of gene editing required testing on human embryos, it would be ...



Note: Respondents who did not give an answer are not shown. See Methodology for details on index of religious commitment. Source: Survey conducted April 23-May 6, 2018. "Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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There are also differences in views about gene editing by religious affiliation, particularly if such techniques would involve embryonic testing. Just 11% of white evangelical Protestants say that if development of gene editing techniques required testing on human embryos, it would be an appropriate use of medical technology.

By contrast, about half of the religiously unaffiliated (52%), including 79% of atheists and 57% of agnostics, say that embryonic testing to develop gene editing techniques would be an appropriate use of medical technology.

See the [Appendix](#) for other views about gene editing by religious affiliation.

White evangelicals especially likely to say gene editing involving embryonic testing takes technology too far

% of U.S. adults who say that if development of gene editing required testing on human embryos, it would be ...

	Appropriate use of medical technology	Taking medical technology too far
U.S. adults	33%	65%
Religious affiliation		
Protestant	21	78
<i>White evangelical</i>	11	88
<i>White mainline</i>	31	67
<i>Black Protestant</i>	25	72
Catholic	30	69
<i>White Catholic</i>	29	70
<i>Hispanic Catholic</i>	27	73
Unaffiliated	52	47
<i>Atheist</i>	79	21
<i>Agnostic</i>	57	42
<i>Nothing in particular</i>	42	57
Race/ethnicity		
White	34	64
Black	29	68
Hispanic	28	71

Note: Whites and blacks include only non-Hispanics; Hispanics are of any race. Respondents who did not give an answer are not shown.

Source: Survey conducted April 23-May 6, 2018.

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Men are more accepting than women of using gene editing to change a baby's genetic makeup

Men are more inclined than women to view gene editing as an appropriate use of medical technology, regardless of its intent. About two-thirds of men (65%) believe that gene editing to reduce a baby's risk of developing a serious disease later in life is an appropriate use of medical technology, compared with 54% of women. And men (76%) are more supportive than women (68%) of using gene editing to treat a congenital disorder.

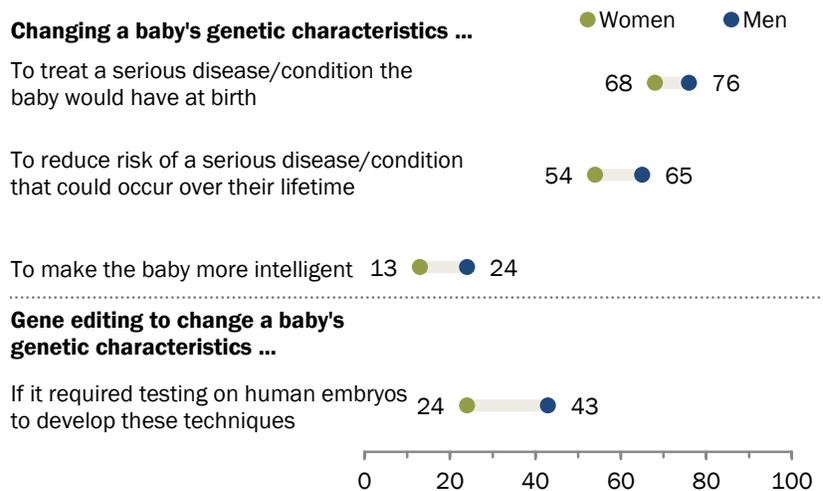
Similarly, more men (43%) than women (24%) are accepting of gene editing technology if it required embryonic testing to develop.

Women tend to have higher levels of [religious commitment](#), on average, but differences by gender tend to hold even when controlling for religiosity and other factors in statistical models. See the [Appendix](#) for details.

Previous Pew Research Center surveys in [2016](#) and [2014](#), while not directly comparable due to different polling methods and question wording, have also found that women tend to be less accepting than men when it comes to gene editing for babies.

Men are more likely than women to view gene editing for babies as appropriate

% of U.S. adults who say changing a baby's genetic characteristics for each of the following reasons is an appropriate use of medical technology



Note: Respondents who gave other responses or who did not give an answer are not shown.
Source: Survey conducted April 23-May 6, 2018.
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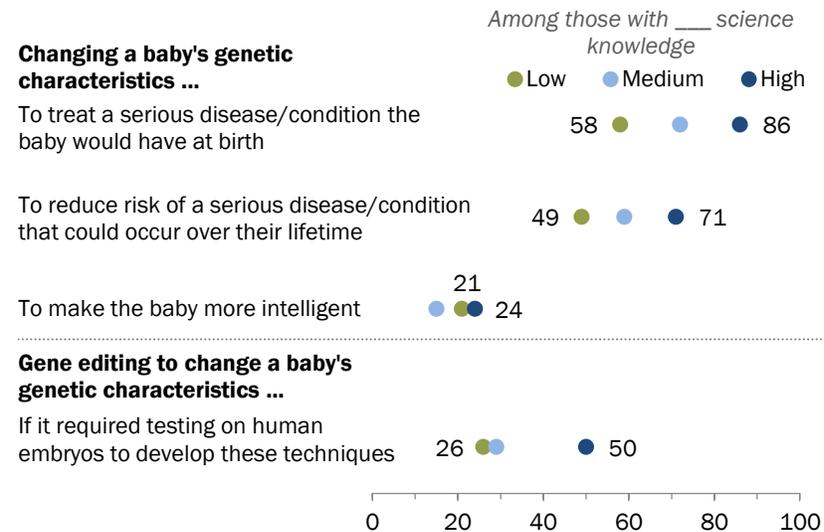
Americans with high levels of science knowledge are more likely to view gene editing in a positive light

People high in science knowledge – based on a nine-item index – tend to be more accepting of using gene editing for babies.⁴ Some 86% of those with high science knowledge believe it is appropriate to use gene editing to treat a congenital disorder, compared with 58% of those with low science knowledge. And, 71% of those with high science knowledge say it is appropriate to use gene editing to reduce a baby’s risk of disease that would occur later in life, compared with 49% of those with low science knowledge.⁵

However, few Americans say it is appropriate to use gene editing to make a baby more intelligent, regardless of their level of science knowledge.

Those with high science knowledge are more inclined to see gene editing techniques as appropriate

% of U.S. adults who say each of the following is an appropriate use of medical technology



Note: Respondents who gave other responses or who did not give an answer are not shown. See Methodology for details on index of science knowledge.

Source: Survey conducted April 23-May 6, 2018.

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Judgments on the appropriateness of gene editing also follow a similar pattern by education level, which is [closely linked](#) with science knowledge. Those with a postgraduate degree are more

⁴ See the [Methodology](#) for details on the science knowledge index.

⁵ These findings are in keeping with a 2017 study by [Scheufele et al.](#), which found Americans’ attitudes about gene editing varied depending on their knowledge level about genetics and gene editing, as well as their religiosity. A 2013 study by [Allum et al.](#) in the United Kingdom found the effect of science knowledge on support for using genetic testing to screen for serious diseases in an unborn baby was conditional on religious service attendance. In this survey, there is a tendency for the effects of science knowledge to be conditional with levels of religiosity in views about the use of gene editing to reduce the risk of disease and if it would require testing on human embryos. For example, among people with high religious commitment, science knowledge is not related to views on the appropriateness of gene editing for babies to reduce the risk of disease that could occur over their lifetime. This interaction between religious commitment and science knowledge holds even after controlling for other factors in statistical models but does not occur for other views about gene editing.

accepting of gene editing for treating or reducing the risk of a disease than those with a high school degree or less.

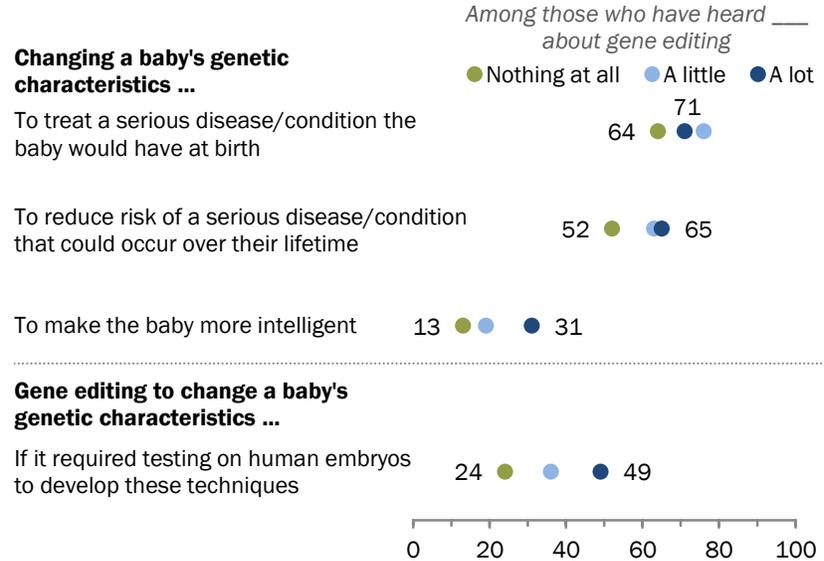
Americans who report familiarity with gene editing are more inclined to see it as appropriate

People who say they have heard at least a little about gene editing that can be used to change a baby’s genetic characteristics are more likely than those who have heard nothing at all to say gene editing would be appropriate in each of the circumstances considered in this survey.

A Pew Research Center survey [in 2016](#) found a similar tendency for those who report familiarity with gene editing to express more interest in and acceptance of using these technologies to enhance a baby’s health over the course of their lifetime.

Those familiar with gene editing are more inclined to see different uses as appropriate

% of U.S. adults who say each of the following is an appropriate use of medical technology



Note: Respondents who gave other responses or who did not give an answer are not shown.
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Americans are more likely to anticipate negative than positive effects from gene editing

Although gene editing for babies is still in development, a separate [April 2018 survey](#) found that about half of Americans (52%) believe it is likely that within the next 50 years, we will be able to eliminate almost all birth defects by manipulating the genes of an embryo before a baby is born. In the current survey, as people think about a future with possible widespread use of gene editing to change a baby's genetic makeup, more anticipate negative than positive effects on society.

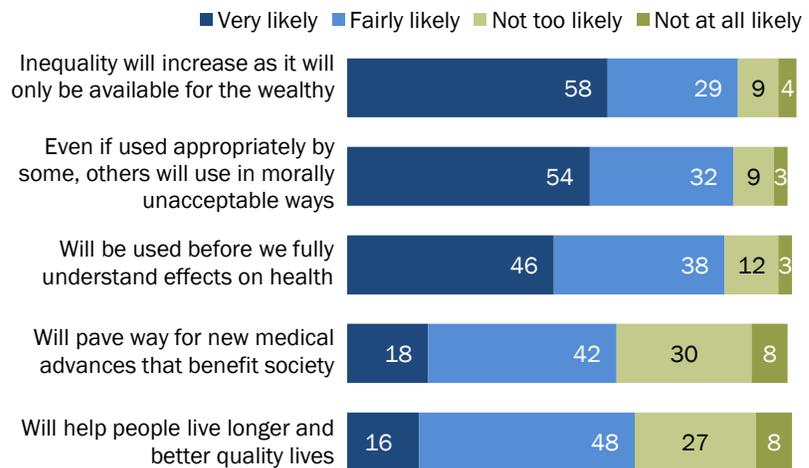
Specifically, a majority of Americans (58%) believe gene editing will very likely lead to increased inequality because it will only be available to the wealthy. Some 54% of Americans anticipate a slippery slope, saying it's very likely that "even if gene editing is used appropriately in some cases, others will use these techniques in ways that are morally unacceptable." And, 46% expect it is very likely that gene editing techniques will be used before we fully understand how they affect people's health.

Far smaller shares see positive outcomes as very likely if gene editing for

babies were to become widely available. Roughly two-in-ten Americans (18%) say it is very likely that development of these techniques will pave the way for new medical advances that benefit society as a whole. Another 42% say this is fairly likely to occur, while 38% consider this not too or not at all likely. Just 16% see the widespread use of gene editing as very likely to help people live longer and better quality lives. About half (48%) say this is fairly likely, while 34% say this outcome is not too or not at all likely.

Larger shares of Americans believe negative effects of widespread use of gene editing are very likely

% of U.S. adults who say each of the following would be _____ to occur if gene editing to change a baby's genetic characteristics becomes widely available



Note: Respondents who did not give an answer are not shown.

Source: Survey conducted April 23-May 6, 2018.

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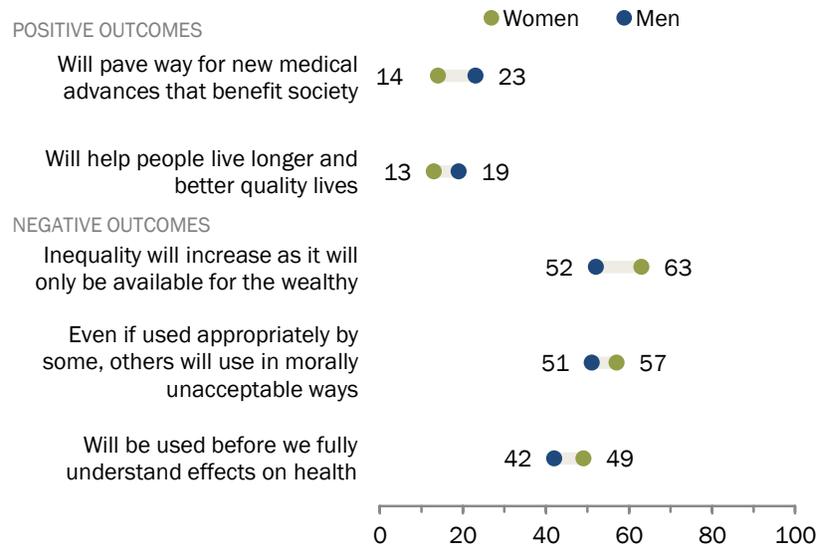
Women are more inclined than men to expect negative effects if gene editing becomes widely available, in keeping with gender differences over acceptance of gene editing. For example, larger shares of women than men say this technology will lead to an increase in inequality as it will only be available for the wealthy (63% say this is very likely vs. 52% of men) or say it will be used in morally unacceptable ways (57% vs. 51%). And although only minorities of men and women see positive effects as very likely, men are somewhat more inclined to anticipate positive outcomes.

Expectations also vary by self-reported familiarity with gene editing. Those who have heard a lot about gene editing to change a baby's genetic characteristics are more inclined to anticipate positive outcomes from its widespread use. Some 36% of this group thinks it is very likely that the widespread availability of gene editing would pave the way for new medical advances that are beneficial to society, compared with about half as many of those who have heard a little or nothing about gene editing (16%).

However, those most familiar with gene editing are more likely than those with no familiarity to also anticipate downsides. About two-thirds of those who have heard a lot about gene editing (64%) say it is very likely that widespread availability of gene editing will increase inequality because the technology will primarily be available only for the wealthy, compared with 53% of those who have heard nothing about using gene editing to change a baby's genetic characteristics. And, 65% of those who have heard a lot about gene editing think it's very likely that others will use

More women than men anticipate negative effects of gene editing

% of U.S. adults who say each of the following would be very likely to occur if gene editing to change a baby's genetic characteristics becomes widely available



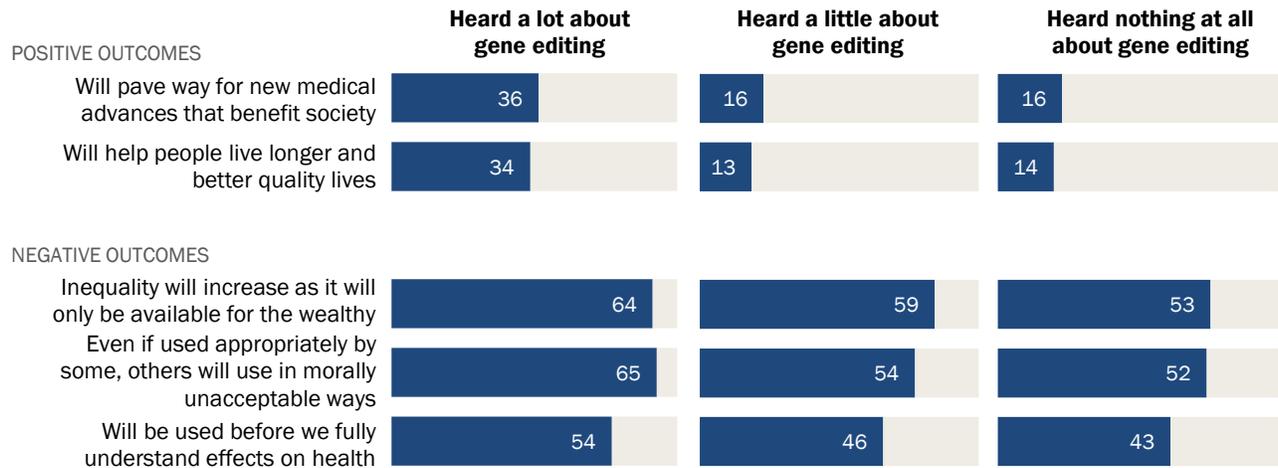
Note: Respondents who gave other responses or who did not give an answer are not shown.
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these techniques in morally unacceptable ways, while 54% of those who have heard a little and 52% of those who have heard nothing about gene editing say this.

Americans who are more familiar with gene editing are more inclined to anticipate positive as well as negative effects from widespread use of gene editing

% of U.S. adults in each group who say each of the following would be very likely to occur if gene editing to change a baby’s genetic characteristics becomes widely available



Note: Respondents who gave other responses or who did not give an answer are not shown.

Source: Survey conducted April 23-May 6, 2018.

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A similar pattern occurs with levels of science knowledge. A larger share of people with high science knowledge anticipate positive outcomes from the widespread availability of gene editing than those with low science knowledge. At the same time, those with high science knowledge are at least equally likely as those with low science knowledge to think negative effects from the widespread availability of gene editing are very likely.

The American public also tends to be skeptical about whether medical experts fully comprehend the health consequences of gene editing. A 36% minority of Americans believe that medical researchers understand the health effects of gene editing for babies either very (7%) or fairly well (29%), while 62% say medical researchers do not understand the health effects at all or not too well.

36% of Americans say medical researchers understand the health effects of gene editing at least fairly well

% of U.S. adults who say medical researchers understand the health risks and benefits of changing a baby's genetic characteristics ...



Note: Respondents who did not give an answer are not shown.

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Familiarity with gene editing is linked with beliefs about medical researchers' understanding of it. About half of those who have heard a lot about gene editing for babies (51%) say that medical researchers understand the health effects of gene editing for babies at least fairly well, compared with three-in-ten of those who have heard nothing at all (30%). However, level of science knowledge based on a nine-item index is not related to views on this issue; 36% of those with high science knowledge and 40% of those with low science knowledge believe that medical researchers understand the health effects of changing a baby's genetic characteristics at least fairly well.

There are no or only modest differences on this question by gender or religious commitment.

Acknowledgments

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Methodology

This report is drawn from a survey conducted as part of the American Trends Panel (ATP), a nationally representative panel of randomly selected U.S. adults living in households recruited from landline and cellphone random-digit-dial (RDD) surveys. Panelists participate via monthly self-administered web surveys. Panelists who do not have internet access are provided a tablet and wireless internet connection. The panel, which was created by Pew Research Center, is being managed by GfK.

Data in this report are drawn from the panel wave conducted April 23-May 6, 2018, among 2,537 respondents. The margin of sampling error for the full sample of 2,537 respondents is plus or minus 2.8 percentage points.

Members of the ATP were recruited from several large, national landline and cellphone RDD surveys conducted in English and Spanish. At the end of each survey, respondents were invited to join the panel. The first group of panelists was recruited from the 2014 Political Polarization and Typology Survey, conducted Jan. 23-March 16, 2014. Of the 10,013 adults interviewed, 9,809 were invited to take part in the panel and a total of 5,338 agreed to participate.⁶

Margins of error

	Sample size	Margin of error in percentage points
U.S. adults	2,537	+/- 2.8
Men	1,272	+/- 4.0
Women	1,265	+/- 3.8
<i>Race/ethnicity</i>		
White	1,519	+/- 3.3
Black	412	+/- 7.8
Hispanic	421	+/- 7.6
<i>Religious commitment index</i>		
High	440	+/- 6.7
Medium	1,291	+/- 3.8
Low	566	+/- 5.7
<i>Religious affiliation</i>		
NET Protestant	1,086	+/- 4.2
<i>White evangelical</i>	349	+/- 7.1
<i>White mainline</i>	282	+/- 7.7
<i>Black Protestant</i>	283	+/- 9.6
NET Catholic	459	+/- 6.5
<i>White Catholic</i>	254	+/- 8.0
<i>Hispanic Catholic</i>	168	+/- 11.8
NET Unaffiliated	703	+/- 5.1
<i>Atheist</i>	146	+/- 11.2
<i>Agnostic</i>	158	+/- 10.2
<i>Nothing in particular</i>	399	+/- 6.8

Note: The margins of error are reported at the 95% level of confidence and are calculated by taking into account the average design effect for each subgroup.

Source: Survey conducted April 23-May 6, 2018.

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⁶ When data collection for the 2014 Political Polarization and Typology Survey began, non-internet users were subsampled at a rate of 25%, but a decision was made shortly thereafter to invite all non-internet users to join. In total, 83% of non-internet users were invited to join the panel.

The second group of panelists was recruited from the 2015 Pew Research Center Survey on Government conducted Aug. 27-Oct. 4, 2015. Of the 6,004 adults interviewed, all were invited to join the panel, and 2,976 agreed to participate.⁷ The third group of panelists was recruited from a survey conducted April 25-June 4, 2017. Of the 5,012 adults interviewed in the survey or pretest, 3,905 were invited to take part in the panel and a total of 1,628 agreed to participate.⁸

The overall target population for Wave 34 was non-institutionalized persons ages 18 and older, living in the United States, including Alaska and Hawaii. The sample for Wave 34 consisted of 3,099 ATP members that were invited to Wave 33 and were still active. This subsample was selected using the following approach:

1. Panelists were grouped into three strata based on how underrepresented they are demographically. Then we analyzed response rates to the last five panel survey waves (W28-32) to project the number of panelists in each stratum who would respond to the W33 survey.
2. We then determined how many panelists we wanted to sample from each stratum in W33 in order to finish with around 2,500 completed interviews and have a responding sample that is as representative as possible.
 - Stratum A consists of panelists who are non-internet users, are black non-Hispanic, are Hispanic, or have high school or less education. There were 1,819 total panelists in this stratum and they are sampled at a rate of 100% for W33. 1,806 were active panelists.

⁷ Respondents to the 2014 Political Polarization and Typology Survey who indicated that they are internet users but refused to provide an email address were initially permitted to participate in the American Trends Panel by mail but were no longer permitted to join the panel after Feb. 6, 2014. Internet users from the 2015 Pew Research Center Survey on Government who refused to provide an email address were not permitted to join the panel.

⁸ White, non-Hispanic college graduates were subsampled at a rate of 50%.

Margins of error continued

	Sample size	Margin of error in percentage points
<i>Science knowledge index</i>		
High	679	+/- 5.2
Medium	1,274	+/- 3.9
Low	584	+/- 5.7
<i>Heard about gene editing</i>		
A lot	326	+/- 7.9
A little	1,449	+/- 3.6
Nothing at all	753	+/- 5.1

Note: The margins of error are reported at the 95% level of confidence and are calculated by taking into account the average design effect for each subgroup.

Source: Survey conducted April 23-May 6, 2018.

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- Stratum B consists of panelists who are ages 18 to 34 or are non-volunteers. The 1,684 total panelists in this stratum are subsampled at a rate of 63%, yielding 1,061 sampled for W33 (1,057 were active).
- Stratum C consists of the remaining 2,009 panelists not in stratum A or B. This group is subsampled at a rate of 12%, yielding 241 panelists sampled for W33 (239 were active).

The ATP data were weighted in a multistep process that begins with a base weight incorporating the respondents' original survey selection probability and the fact that in 2014 some panelists were subsampled for invitation to the panel. Next, an adjustment was made for the fact that the propensity to join the panel and remain an active panelist varied across different groups in the sample. The final step in the weighting uses an iterative technique that aligns the sample to population benchmarks on a number of dimensions. Gender, age, education, race, Hispanic origin and region parameters come from the U.S. Census Bureau's 2016 American Community Survey. The county-level population density parameter (deciles) comes from the 2010 U.S. decennial census. The telephone service benchmark comes from the July-December 2016 National Health Interview Survey and is projected to 2017. The volunteerism benchmark comes from the 2015 Current Population Survey Volunteer Supplement. The party affiliation benchmark is the average of the three most recent Pew Research Center general public telephone surveys. The internet access benchmark comes from the 2017 ATP Panel Refresh Survey. Respondents who did not previously have internet access are treated as not having internet access for weighting purposes. Sampling errors and statistical tests of significance take into account the effect of weighting. Interviews are conducted in both English and Spanish, but the Hispanic sample in the ATP is predominantly U.S. born and English speaking.

Margins of error tables shown here provide the unweighted sample sizes and the error attributable to sampling that would be expected at the 95% level of confidence for different groups in the survey taking into account the average design effect for each subgroup. Sample sizes and sampling errors for other subgroups are available upon request.

In addition to sampling error, one should bear in mind that question wording and practical difficulties in conducting surveys can introduce error or bias into the findings of opinion polls.

The April 2018 wave had a response rate of 82% (2,537 responses among 3,099 individuals in the panel). Taking account of the combined, weighted response rate for the recruitment surveys

(10.1%) and attrition from panel members who were removed at their request or for inactivity, the cumulative response rate for the wave is 2.3%.⁹

Religious commitment index

Survey respondents were classified into high, medium and low levels of religious commitment based on three indicators: frequency of religious service attendance, self-reported importance of religion in their lives and frequency of prayer. Those who attend worship services at least weekly, pray at least once a day and say religion is very important in their lives are classified as high in religious commitment. Those low in commitment say religion is not too or not at all important in their lives, that they seldom or never attend worship services, and seldom or never pray. All others are classified as exhibiting a medium level of religious commitment.

⁹ Approximately once per year, panelists who have not participated in multiple consecutive waves are removed from the panel. These cases are counted in the denominator of cumulative response rates. Note that for the March 2018 survey, we calculated the response rates by computing the mean rates for the subsampled respondents (based on the rates from the recruitment survey they joined the panel on).

Science knowledge index

The Pew Research Center survey included a set of nine questions to tap public knowledge of science across a range of principles and topics. Most respondents (n=1,901) completed these questions as part of a previous wave of the American Trends Panel, conducted May 10-June 6, 2016. Respondents who did not participate in the previous wave answered these questions in this survey (n=636). The following shows the measurement properties of the index for the combined set of 2,537 respondents.¹⁰

As shown in the accompanying table, the internal reliability or consistency of the scale as measured by Cronbach’s alpha is 0.75. Each of the items in the scale is at least moderately correlated with the other items.

An exploratory factor analysis finds one common factor explaining 76% of the common variance in the items. The factor loadings show that each of the nine questions is moderately correlated with the common factor. These indicators suggest a set of items is measuring a single underlying dimension.

Scale reliability and factor analysis

Knowledge index 9-items	Item-rest correlation	Alpha for scale	Common variance explained by first factor
		0.75	76%
		Alpha if item is dropped	Factor loadings
KNOSCT22. Use of a control group to determine whether a new drug is effective	0.39	0.74	0.46
KNOSCT23. Carbon dioxide is made as a consequence of burning fossil fuels	0.47	0.73	0.55
KNOSCT27. The probability of an old-bridge collapsing after a period of time	0.50	0.72	0.59
KNOSCT28. Only bacterial infections can be treated effectively by antibiotic medications	0.31	0.75	0.35
KNOSCT29. The use of a control “sugar pill” in a new drug trial is to rule out a possible placebo effect	0.43	0.73	0.50
KNOSCT31. The health benefits occurring when most people in a population get a vaccine is called herd immunity	0.45	0.73	0.52
KNOSCT32. An apple, salmon, corn and a mosquito can all be genetically modified.	0.47	0.73	0.55
KNOSCT33. Humans and mice share 50% or more of the same genetic makeup	0.43	0.73	0.50
KNOSCT34. Nitrogen makes up most of the Earth’s atmosphere.	0.44	0.73	0.52

Source: Surveys conducted May 10-June 6, 2016, and April 23-May 6, 2018. “Public Views of Gene Editing for Babies Depend on How It Would Be Used”

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¹⁰ In statistical models controlling for demographics and education, there were no significant differences between respondents who completed the science knowledge items in 2016 (W17) and those who completed them in 2018 (W34) on either the overall index measure or the individual questions.

Note that each of the science knowledge questions are coded as binary variables (correct/incorrect). Both Cronbach's alpha reliability analysis and the factor analysis are based on a Pearson's correlation matrix. Pearson correlations with binary variables are restricted to a limited range, underestimating the association between two variables when compared with tetrachoric correlations. We do not anticipate that the use of a Pearson's correlation matrix affects the unidimensional factor solution for the scale, however.

We also ran an item-response theory analysis (IRT) to check how well each question distinguishes between those who know relatively more or

less on the scale. This analysis fits a two-parameter logistic model, allowing discrimination and difficulty to vary across the items. Discrimination shows the ability of the question to distinguish between those with higher and lower science knowledge. Difficulty shows how easy or hard each question is for the average respondent. We did not include a guessing parameter in the model; the questionnaire offered respondents an explicit option of not sure on the survey.

The results show variation in difficulty across the items. The easiest item required respondents to identify that carbon dioxide as the gas that is made as a consequence of burning fossil fuels, while the most difficult item required respondents to identify nitrogen as the gas that makes up most of the Earth's atmosphere.

Two parameter item response theory analysis

	% Correct	Discrimination	Difficulty
KNOSCT22. Use of a control group to determine whether a new drug is effective	68	1.36	-0.73
KNOSCT23. Carbon dioxide is made as a consequence of burning fossil fuels	72	1.74	-0.82
KNOSCT27. The probability of an old-bridge collapsing after a period of time	62	2.14	-0.38
KNOSCT28. Only bacterial infections can be treated effectively by antibiotic medications	46	0.81	0.25
KNOSCT29. The use of a control "sugar pill" in a new drug trial is to rule out a possible placebo effect	59	1.60	-0.33
KNOSCT31. The health benefits occurring when most people in a population get a vaccine is called herd immunity	34	1.39	0.65
KNOSCT32. An apple, salmon, corn and a mosquito can all be genetically modified.	39	1.66	0.38
KNOSCT33. Humans and mice share 50% or more of the same genetic make-up	34	1.37	0.66
KNOSCT34. Nitrogen makes up most of the Earth's atmosphere.	31	1.55	0.74

Source: Surveys conducted May 10-June 6, 2016, and April 23-May 6, 2018.
"Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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Most of the questions also discriminate between those with higher and lower science knowledge. The item with strongest ability to discriminate was the question asking respondents to calculate the conditional probability of an old bridge over time. The question with the weakest ability to discriminate was the question about the effectiveness of antibiotics to treat bacterial, but not other kinds of infections.

The test information curve mirrors a normal curve centered around zero, suggesting that the science knowledge index provides the most information about Americans near the mean level of knowledge.

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Appendix: Detailed tables

Half or more from all religious groups consider gene editing to treat disease that would be present at birth to be appropriate

% of U.S. adults who say using gene editing to treat a serious disease or condition a baby would have at birth is ...

	Appropriate use of medical technology	Taking medical technology too far
U.S. adults	72%	27%
Religious affiliation		
Protestant	66	31
<i>White evangelical</i>	61	37
<i>White mainline</i>	79	20
<i>Black Protestant</i>	60	36
Catholic	72	28
<i>White Catholic</i>	72	28
<i>Hispanic Catholic</i>	74	26
Unaffiliated	78	22
<i>Atheist</i>	92	7
<i>Agnostic</i>	92	8
<i>Nothing in particular</i>	69	30
Race/ethnicity		
White	74	24
Black	62	35
Hispanic	74	26

Note: Whites and blacks include only non-Hispanics; Hispanics are of any race. Respondents who did not give an answer are not shown.

Source: Survey of U.S. adults conducted April 23-May 6, 2018. "Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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White evangelical Protestants among the least likely to consider gene editing to reduce lifetime disease risk appropriate

% of U.S. adults who say using gene editing to reduce the risk of a serious disease or condition that could occur over the course of a baby's lifetime is ...

	Appropriate use of medical technology	Taking medical technology too far
U.S. adults	60%	38%
Religious affiliation		
Protestant	51	47
<i>White evangelical</i>	45	54
<i>White mainline</i>	58	41
<i>Black Protestant</i>	51	43
Catholic	63	36
<i>White Catholic</i>	58	41
<i>Hispanic Catholic</i>	68	30
Unaffiliated	67	32
<i>Atheist</i>	85	15
<i>Agnostic</i>	81	19
<i>Nothing in particular</i>	57	41
Race/ethnicity		
White	60	39
Black	52	44
Hispanic	61	36

Note: Whites and blacks include only non-Hispanics; Hispanics are of any race. Respondents who did not give an answer are not shown.

Source: Survey of U.S. adults conducted April 23-May 6, 2018. "Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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Nine-in-ten white evangelical Protestants see gene editing for intelligence as taking technology too far

% of U.S. adults who say using gene editing to make a baby more intelligent is ...

	Appropriate use of medical technology	Taking medical technology too far
U.S. adults	19%	80%
Religious affiliation		
Protestant	12	86
<i>White evangelical</i>	8	91
<i>White mainline</i>	12	88
<i>Black Protestant</i>	14	81
Catholic	20	80
<i>White Catholic</i>	18	82
<i>Hispanic Catholic</i>	24	76
Unaffiliated	25	74
<i>Atheist</i>	36	64
<i>Agnostic</i>	22	77
<i>Nothing in particular</i>	23	77
Race/ethnicity		
White	16	83
Black	21	75
Hispanic	22	76

Note: Whites and blacks include only non-Hispanics; Hispanics are of any race. Respondents who did not give an answer are not shown.

Source: Survey of U.S. adults conducted April 23-May 6, 2018.

"Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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Statistical models predicting opinions about appropriate uses of gene editing

Difference in predicted probabilities for belief that changing a baby's genetic characteristics _____ is an appropriate use of medical technology

	To treat a serious disease or condition the baby would have at birth	To reduce the risk of a serious disease or condition that could occur over the course of his or her lifetime	To make the baby more intelligent	Requiring testing on human embryos
Women	NS	-0.08	-0.09	-0.15
Race Reference category: White, non-Hispanic				
Black, non-Hispanic	NS	NS	NS	NS
Hispanic	NS	NS	NS	-0.09
Other	-0.20	NS	NS	NS
Age Reference category: 18-29				
Ages 30-49	NS	-0.12	-0.08	NS
50-64	-0.10	-0.17	-0.12	NS
65+	NS	NS	-0.13	-0.12
Education Reference category: High school or less				
Postgraduate	+0.16	+0.13	NS	+0.10
College graduate	+0.14	NS	NS	NS
Some college	+0.09	+0.08	NS	+0.07
Science knowledge Reference category: Low science knowledge				
High	+0.16	NS	NS	NS
Medium	NS	NS	-0.09	-0.08
Religious commitment Reference category: Low religious commitment				
High	-0.14	-0.21	-0.14	-0.14
Medium	NS	-0.10	NS	-0.13
Religious affiliation Reference category: Unaffiliated				
Mainline Protestant	NS	NS	NS	NS
Evangelical Protestant	NS	NS	NS	-0.22
Catholic	NS	NS	NS	NS
Other Christian	NS	NS	NS	NS
Other religion	NS	NS	NS	NS
Heard about gene editing Reference category: Heard nothing at all about gene editing to change a baby's genetic characteristics				
Heard a lot	NS	NS	+0.15	+0.17
Heard a little	+0.06	NS	+0.07	+0.09
Number of respondents	2,237	2,232	2,241	2,223

Note: Figures shown are the difference in predicted probabilities with the reference category while other factors are held at their mean using binary logistic regression models. Positive and negative values indicated the direction of effects. NS indicates not statistically significant based on a two-tailed p value < 0.05.

Source: Survey conducted April 23- May 6, 2018.

"Public Views of Gene Editing for Babies Depend on How It Would Be Used"

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Survey questionnaire and topline

2018 PEW RESEARCH CENTER'S AMERICAN TRENDS PANEL
APRIL 23-MAY 6, 2018
TOTAL N=2,537

ADDITIONAL QUESTIONS PREVIOUSLY RELEASED OR HELD FOR FUTURE RELEASE

ASK ALL:

MED3 How much, if anything, have you heard or read about gene editing that can be used to change a baby's genetic characteristics?

April 23-
 May 6,
2018

12	A lot
56	A little
32	Nothing at all
1	No answer

ASK ALL:

MED4 Do you think each of the following is an appropriate use of medical technology or is it taking medical technology too far? **[RANDOMIZE ITEMS]**

	<u>An appropriate use of medical technology</u>	<u>Taking medical technology too far</u>	<u>No Answer</u>
a. Changing a baby's genetic characteristics to make the baby more intelligent April 23-May 6, 2018	19	80	1
b. Changing a baby's genetic characteristics to TREAT a serious disease or condition the baby would have at birth April 23-May 6, 2018	72	27	2
c. Changing a baby's genetic characteristics to REDUCE THE RISK of a serious disease or condition that could occur over the course of his or her lifetime April 23-May 6, 2018	60	38	2

TRENDS FOR COMPARISON

Pew Research Center survey conducted by telephone: Would you say that changing a baby's genetic characteristics to make the baby more intelligent is making appropriate use of medical advances OR is it taking medical advances too far?

Aug. 15-25,
2014

15	<i>Appropriate use of medical advances</i>
83	<i>Taking medical advances too far</i>
2	<i>Don't know/Refused (VOL.)</i>

Surveys conducted by telephone: Would you say that changing a baby's genetic characteristics to reduce the risk of serious diseases is making appropriate use of medical advances OR is it taking medical advances too far?

	Pew Research Center Aug. 15-25, <u>2014</u>	VCU Life Sciences Survey Sept. 3-26, <u>2003</u>
Appropriate use of medical advances	46	41
Taking medical advances too far	50	54
Don't know/Refused (VOL.)	4	6

ASK ALL:

MED5 Thinking about what you have heard or read, how well do you think medical researchers understand the health risks and benefits of changing a baby's genetic characteristics?

April 23-
May 6,
2018

7	Very well
29	Fairly well
45	Not too well
17	Not at all well
1	No answer

ASK ALL:

MED6 Thinking about society as a whole ...

How likely, if at all, do you think each of the following would be to occur if gene editing to change a baby's genetic characteristics becomes widely available? [**RANDOMIZE ITEMS**]

	<u>Very likely</u>	<u>Fairly likely</u>	<u>Not too likely</u>	<u>Not at all likely</u>	<u>No Answer</u>
a. Even if gene editing is used appropriately in some cases, others will use these techniques in ways that are morally unacceptable April 23-May 6, 2018	54	32	9	3	1
b. These techniques will help people live longer and better quality lives April 23-May 6, 2018	16	48	27	8	2
c. We will use these techniques before we fully understand how they affect people's health April 23-May 6, 2018	46	38	12	3	1
d. Inequality will increase because this option will be available only for the wealthy April 23-May 6, 2018	58	29	9	4	1

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MED6 continued ...

	<u>Very likely</u>	<u>Fairly likely</u>	<u>Not too likely</u>	<u>Not at all likely</u>	<u>No Answer</u>
e. Development of these techniques will pave the way for new medical advances that benefit society as a whole					
April 23-May 6, 2018	18	42	30	8	1

ASK ALL:

MED7 If gene editing to change a baby's genetic characteristics required testing on human embryos in order to develop these techniques, do you think this would be ...

April 23- May 6, <u>2018</u>	33	An appropriate use of medical technology
	65	Taking medical technology too far
	2	No answer

ADDITIONAL QUESTIONS HELD FOR FURTHER RELEASE**ASK ALL:**

BIO15 Have you seen a health care provider FOR AN ILLNESS OR MEDICAL CONDITION in the past 12 months, or not?

April 23- May 6, <u>2018</u>	64	Yes	May 10- June 6 <u>2016</u>	63
	36	No		36
	1	No answer		2

ASK ALL:

G1 Do you, or does anyone in your immediate family, have a gene that predisposes you to a serious disease such as Alzheimer's, cancer, heart disease or sickle cell anemia?

April 23- May 6, <u>2018</u>	26	Yes	May 10- June 6, <u>2016</u>	27
	40	No		43
	34	Not sure		30
	1	No answer		1

ASK ALL:

G2 Have you, or has anyone in your immediate family, ever had a genetic test, or haven't you done this?

April 23- May 6, <u>2018</u>		May 10- June 6 <u>2016</u>
14	Yes	10
65	No	70
20	Not sure	19
1	No answer	1

NOTE: RESULTS SHOWN FOR KNOSCT22-KNOSCT34 INCLUDE 636 RESPONDENTS WHO ANSWERED THESE QUESTIONS APRIL 23-MAY 6, 2018 COMBINED WITH 1,901 RESPONDENTS WHO ANSWERED THESE QUESTIONS IN A PREVIOUS WAVE FIELDED MAY 10-JUNE 6, 2016.

ASK ALL: Here's a different kind of question. (If you don't know the answer, select "Not sure.") As far as you know ...

KNOSCT22 Here's a different kind of question. (If you don't know the answer, select "Not sure.") As far as you know ...

Which is the better way to determine whether a new drug is effective in treating a disease? If a scientist has a group of 1,000 volunteers with the disease to study, should she ... **[RANDOMIZE OPTIONS 1 AND 2]**

Apr 23- May 6 <u>2018</u>	
68	Give the drug to half of them but not to the other half, and compare how many in each group get better (<i>Correct</i>)
32	NET Incorrect/Not sure/No answer
14	Give the drug to all of them and see how many get better
18	Not sure
<1	No answer

[RANDOMIZE ITEMS KNOSCT23 TO KNOSCT34; KNOSCT22 ALWAYS FIRST]

ASK ALL:

KNOSCT23

Which gas is made as a consequence of burning fossil fuels? Is it ... **[RANDOMIZE OPTIONS 1-4]**¹¹

Apr 23-
May 6
2018

72	Carbon dioxide (<i>Correct</i>)
28	NET Incorrect/Not sure/No answer
4	Hydrogen
1	Helium
3	Radon
20	Not sure
<1	No answer

NO QUESTION KNOSCT24, KNOSCT25 AND KNOSCT26**ASK ALL:**

KNOSCT27

If the chances that an old bridge will collapse starts at 1% in week 1 and doubles each week (as shown below), what is the chance that the old bridge will collapse during week 7?

Chances the bridge will collapse is...

1%	at Week 1
2%	at Week 2
4%	at Week 3
8%	at Week 4

Enter the % chance that the bridge will collapse at Week 7 (if the bridge is still standing after Week 6)¹²

April 23-
May 6,
2018

62	64% (<i>Correct</i>)
38	NET Incorrect/Not sure/No answer
20	All other numeric responses
17	Not sure
1	No answer

¹¹ In the Wave 17 May 2016 survey, the question had a minor wording difference: "What gas is made as a consequence of burning fossil fuels? Is it ..."

¹² The phrase "(if the bridge is still standing after Week 6)" was added for clarity in the April 23-May 6, 2018, wave.

ASK ALL:

KNOSCT28 Which of the following conditions can be treated effectively by antibiotic medications?

[Check all that apply] **[RANDOMIZE ITEMS WITH ITEMS e AND f ALWAYS LAST]**April 23-
May 6,
201846 Bacterial infection only (*Correct*)
54 NET Incorrect/Not sure/No answer**KNOSCT28 INDIVIDUAL ITEM RESPONSES**

	<u>Selected</u>	<u>Not selected</u> <u>/No answer</u>
a. Viral infections (such as a cold)	23	77
b. Fungal infections (such as athlete's foot)	28	72
c. Bacterial infections (such as strep throat infections)	83	17
d. Allergic reactions to insect bites	17	83
e. None of these [EXCLUSIVE PUNCH]	2	98
f. Not sure [EXCLUSIVE PUNCH]	9	91

ASK ALL:KNOSCT29 If a scientist wants to determine if a new drug is effective at treating high blood pressure by giving half of a group of 1,000 volunteers a new medication and the other half a "sugar pill" she wants to rule out ... **[RANDOMIZE OPTIONS 1-3]**April 23-
May 6,
201859 A placebo effect (*Correct*)
41 NET Incorrect/Not sure/No answer
4 A third person effect
16 A false consensus effect
20 Not sure
1 No answer**NO QUESTION KNOSCT30****ASK ALL:**KNOSCT31 Which of these terms refers to health benefits occurring when most people in a population get a vaccine? **[RANDOMIZE OPTIONS 1-3]**April 23-
May 6,
201834 Herd immunity (*Correct*)
66 NET Incorrect/Not sure/No answer
8 Population control
35 Vaccination rate
23 Not sure
1 No answer

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ASK ALL:

KNOSCT32 Which of the following can be genetically modified?

[Check all that apply] **[RANDOMIZE ITEMS WITH ITEMS e AND f ALWAYS LAST]**

April 23-
 May 6,
2018
 39
 61

Selected all (*Correct*)
 NET Incorrect/Not sure/No answer

KNOSCT32 INDIVIDUAL ITEM RESPONSES

	<u>Selected</u>	<u>Not selected</u> <u>/No answer</u>
a. An apple	61	39
b. Salmon	53	47
c. A mosquito	46	54
d. Corn	70	30
e. None of these [EXCLUSIVE PUNCH]	2	98
f. Not sure [EXCLUSIVE PUNCH]	20	80

ASK ALL:KNOSCT33 Humans and mice share the same genetic makeup by... **[RANDOMIZE ORDER LOW TO HIGH; HIGH TO LOW with NOT SURE ALWAYS LAST]**

April 23-
 May 6,
2018
 34
 66
 8
 14
 44
 1

About 50% or more (*Correct*)
 NET Incorrect/Not sure/No answer
 Less than 10%
 Between 11% and 49%
 Not sure
 No answer

ASK ALL:KNOSCT34 Which gas makes up most of the Earth's atmosphere? **[RANDOMIZE OPTIONS 1-4]**

April 23-
 May 6,
2018
 31
 69
 9
 9
 35
 15
 1

Nitrogen (*Correct*)
 NET Incorrect/Not sure/No answer
 Hydrogen
 Carbon dioxide
 Oxygen
 Not sure
 No answer

TOTAL NUMBER CORRECT KNOSCT22 THROUGH KNOSCT34:

April 23-
May 6,
2018

4	9 out of 9
10	8 out of 9
10	7 out of 9
13	6 out of 9
12	5 out of 9
13	4 out of 9
11	3 out of 9
12	2 out of 9
9	1 out of 9
6	0 out of 9

24	High science knowledge (7-9 correct)
49	Medium science knowledge (3-6 correct)
26	Low science knowledge (0-2 correct)