

Understanding Biotechnology:
Conceptualizing and Measuring US Public Concern

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Jenna Ann Lamphere
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DEDICATION

This thesis is dedicated to my parents, Gerald and Judene Lamphere, for their continuous support for my studies.

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ABSTRACT

Biotechnology has had a short but rather conflict-ridden history. The technology was commercialized in 1995 and since has become a volatile topic for international debate. Arguably, the United States is the biggest supporter of this technology. The United States conducted the first study using recombinant DNA, grows more biotech crops than any other country, and houses the vast majority of the largest biotech corporations. Proponents frequently claim that biotech crops are a way to improve crop production, lower food prices, decrease the need for petrochemical inputs, and alleviate international food security problems. Others see them as accelerating the loss of traditional agricultural techniques, raising the costs of agricultural production, increasing inequalities, and posing significant environmental and human health risks. The European Union has been more hesitant than the United States to adopt the use of biotechnology, which has resulted in open, international conflict. Given the novelty of and gross conflict over this technology, deeper analyses are needed before many of these concerns can be alleviated or substantiated.

Examining public concern can provide a rich description of the issues surrounding biotechnology. Since the emergence of biotechnology, the European Union, via the Eurobarometer, has frequently administered surveys to its members to measure public concern. Conversely, the United States has failed to systematically administer surveys to measure concern over biotechnology. Instead, US studies have tended to be ad hoc, atheoretical, and noncumulative, which has thwarted the evolution of a well-developed literature on US public concern for biotechnology. Therefore, the aim of this study is to examine US public opinion data to identify the dimensions inherent in the indicators of

social concern surrounding biotechnology. Questionnaires administered between 1993 and 2010 containing at least one measure of biotech concern were collected. To identify the dimensions of concern, a thematic content analysis was conducted on the opinion questions. Public concern was measured by the percentage of people that express concern in their responses to the questions. I also examine trends in concern, as they relate to the dimensions of concern proxied by the indicators.

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LIST OF ABBREVIATIONS

APHIS	Animal and Plant Health Inspection Service
Bt	Bacillus thuringiensis
CCNRE	Cabinet Council on Natural Resources and the Environment
DNA	Deoxyribonucleic Acid
EPA	Environmental Protection Agency
FD&C	Federal Food, Drug, and Cosmetic Act
FDA	Federal Department of Agriculture
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FNWA	Federal Noxious Weed Act
FPPA	Federal Pest Plant Act
IPR	Intellectual Property Rights
NIH	National Institutes of Health
PBR	Plant Breeder's Rights
PQA	Plant Quarantine Act
RAC	Recombinant DNA Advisory Committee
rbGH	Recombinant Bovine Growth Hormone
rDNA	Recombinant Deoxyribonucleic Acid
rRNA	Ribosomal Ribonucleic Acid
TSCA	Toxic Substance Control Act
TRIPS	Trade-Related Aspects of Intellectual Property Rights
USDA	United States Department of Agriculture
WTO	World Trade Organizations

CHAPTER 1

INTRODUCTION

Biotechnology is an ambiguous concept that cannot be easily defined (Peacock 2010). Since the birth of biotechnology in 1972, numerous definitions have been offered. The first US federal regulatory document on biotechnology states that it “includes recently developed and newly emerging genetic manipulation technologies, such as rDNA, rRNA, and cell fusion” (Office of Science and Technology 1986:3). The United Nations Convention on Biological Diversity offers a broader definition, defining biotechnology as “any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify productions or processes for specific use” (Peacock 2020:323). Defining biotechnology is further complicated by the numerous terms often used synonymously with it: genetic modification, genetic engineering, and genetic alteration (see Union of Concerned Scientists 2009). To illustrate why scholars have not agreed upon a single definition of biotechnology, Table 1 lists some of the various definitions that have been used.

The Pew Initiative on Food and Biotechnology (2001) offers a general definition of biotechnology, referring to it as “the use of recombinant DNA to transfer genetic material from one organism to another” (*P.i*). Recombinant or rDNA refers to the hybrid genetic material that results from the combination of different organism’s genetic material (Smith 2009). Often rDNA is derived from taking genetic material from different species; the resulting organism is referred to as transgenic (Grace 2006; Levine III 1999). Although there are numerous techniques used to extract, combine, and insert the genetic material (Food Insight 2009), the central aim of biotechnology is to produce new, improved organisms that can be used to make various products (Dudley 1990).

Table 1. Scholarly Definitions Offered for Biotechnology

<i>Source</i>	<i>Definition</i>
(Asian Development Bank 2001:195)	“Any technique that uses living organisms or substances from those organisms to make or modify a product, to improve plants or animals, or to develop microorganisms for specific uses. These techniques include the use of new technologies such as recombinant DNA, cell fusion, and other new bioprocesses.”
(Avisé 2004:202)	“The use of living entities or their components or products for industrial or commercial applications.”
(Dudley 1990:252)	“[T]he use of living <i>organisms</i> to manufacture products”
(Food and Water Watch 2011:1)	“[I]nvolves manipulating the genetic makeup of plants or animals to create new organisms.”
(Grossman 2003:86)	“[I]s any technological application that uses biological systems, or derivatives thereof, to make or modify products or processes for special use.”
(Persley 1993:477)	“[A]ny technique that uses living organisms or substances from those organisms to make or modify a product, to improve plants or animals, or to develop micro-organisms for specific uses.”
(Pew Initiative on Food and Biotechnology 2012:1)	“[A] set of biological techniques, particularly rDNA techniques, developed through basic research and now applied research and product development.”
(Herdt 2006:266)	“[R]efers to the DNA-based molecular techniques used to modify the genetic composition of agriculturally useful plants and animals.”
(Union of Concerned Scientists 2009:41)	“Technology related to the manipulation of living organisms. Often used interchangeably with genetic engineering and genetic modification.”
(Wheale and McNally 1995:261)	“[T]he application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services.”
(Secretariat of the Convention on Biological Diversity 2000:4)	“[T]he application of... in vitro nucleic acid techniques, including recombinant deoxyribonucleic acid (rDNA) and direct injection of nucleic acid into cells or organelles, or fusion of cells beyond the taxonomic family, that overcome natural physiological reproductive or recombination barriers and are not techniques used in traditional breeding and selection.”

To alleviate some of the ambiguity in defining biotechnology, some scientists have divided the field into red, green, white, and blue (Peacock 2010). Red, or medical biotechnology, entails the use of plants to produce medicinal compounds (known as *pharming*) and the use of animals to produce organs for transplant or vaccines. Green, or agricultural biotechnology, also entails the use of plants or animals but for improving food production (e.g. increasing yields and pest-resistance, nutritional quality, or drought-resistance). White, or industrial biotechnology, uses natural processes like fermentation or enzymes to create new products; bioplastics made from vegetable oils instead of petroleum is one example (Peacock 2010). Lastly, blue biotechnology utilizes aquatic organisms. For example, Aquabounty's AquAdvantage salmon combines genes from the ocean pout and the Chinook salmon to create a faster-growing breed of salmon (Food and Water Watch 2011). Breaking biotechnology into these different sectors aids in conceptualizing its various components.

The sheer volume of biotech products in the global food supply indicates the importance of understanding biotechnology. In 2009, 77 percent of soybeans, 49 percent of cotton, 26 percent of maize, and 21 percent of canola grown globally was bioengineered (International Service for the Acquisition of Agro-biotech Applications [ISAAA] 2010a). Currently, biotech crops are the fastest adopted crop technology (Penchlaner and Otero 2008), and in 2010, 336 million acres were grown in over 29 countries, which accounted for 10 percent of global cropland (Food and Water Watch 2011). Figure 1 illustrates trends in the global growth of biotech crops.

The rapid growth and widespread adoption of biotechnology gives rise to questions regarding the human and ecological safety of this technology. The United

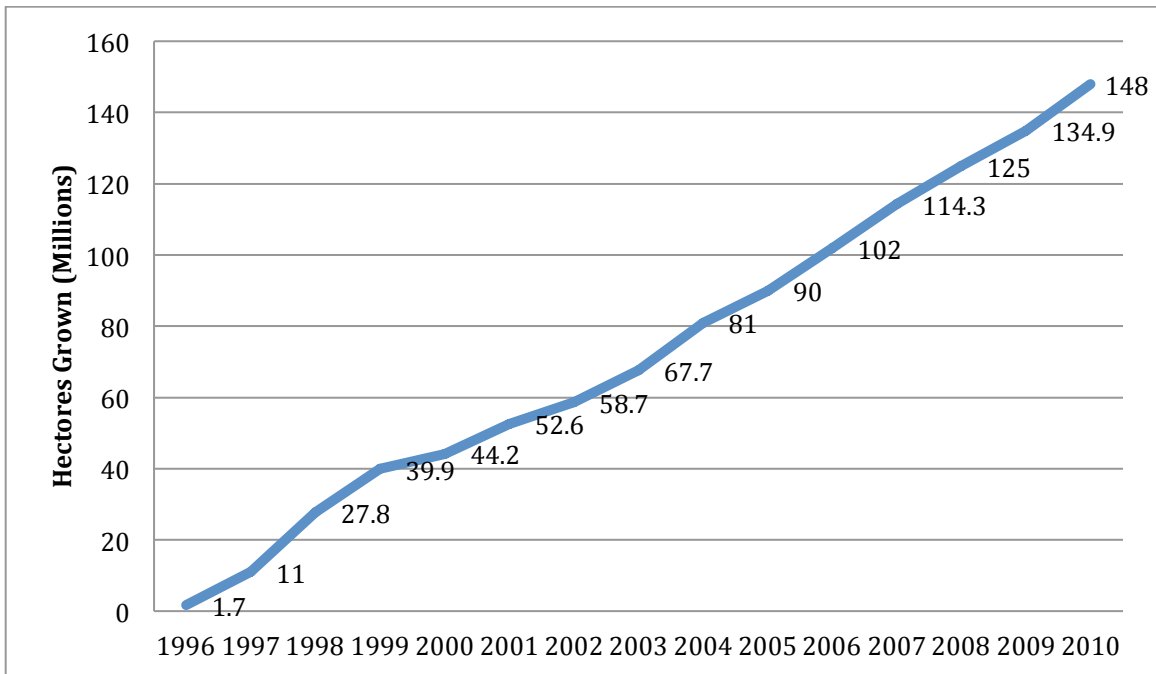


**Figure 1. Global Area of Biotech Crops Grown, 1996-2010
(ISAAA 2011)**

States is the largest supporter of biotechnology (Bhargava 2002; Peacock 2010; Penchlaner and Otero 2008). In 2009 the United States was responsible for 47 percent of biotech crops grown globally (ISAAA 2010b) and was ranked as the top country for biotech innovation (Scientific America 2009). Additionally, among the top 15 countries engaged in commercial biotechnology in 2007, the United States housed 29 percent of the biotech corporations (Peacock 2010).

In contrast to the United States' seeming embrace of biotechnology, the European Union contests the use of biotechnology. One-fourth of EU members currently have a ban on the sale and growth of biotech products, and in 2009 only .05 percent of EU fields cultivated biotech crops (Food and Water Watch 2011). Considering these stark differences, it is possible that Europeans are more concerned about biotechnology than US residents.

Since 1991, the European Commission (2010) has systematically studied EU member's concern for biotechnology via the Eurobarometer. Results have indicated that in Europe, food biotechnology is not perceived as just another technology but triggers unease and fears about long-term consequences (Barling et al. 1999). Unfortunately the United States has failed to undergo such a systematic study, which has thwarted the development of a coherent literature about US biotech concern (Lusk et al. 2005). The rich variety of biotech applications (Listerman 2010) has resulted the emergence of numerous ad hoc, atheoretical and non-accumulative studies. Due to the lack of formalization in the conception and measurement of US biotech concern, there is a need for a framework to unite the existing, fragmented studies.

THE AIMS OF THIS STUDY

In this study, I offer a framework to conceptualize and measure US concern for biotechnology. Specifically, the aims of this study are as follows:

Aim One: Identify the dimensions of biotech concern

Aim Two: Examine if and how concern varies across dimensions and over time.

To accomplish Aim One, I relied heavily on the framework to conceptualize and measure environmental concern set forth by Dunlap and Jones (2002). According to their framework, environmental concern is comprised of two components: the environmental and concern component. To conceptualize the concern component, they draw from attitude theory, and to operationalize it, they use a scale developed by Maloney and Ward (1973). In developing my framework, I retain their conceptualization and measurement of concern. Because biotechnology and the environment are different subjects, I could not rely as heavily on their conceptualization and measurement of the environmental component. Instead, I had to identify the various dimensions of biotechnology.

To aid in identifying the various dimensions, I conducted an extensive literature review on biotech concern. Chapters two and three are results of the literature review and examine the development of biotechnology and the controversy over its growth. These chapters aided in identifying the dimensions of biotechnology by providing an historical context and examining conflicting arguments over its development.

Along with the literature review, I collected and analyzed 22 US questionnaires that asked about biotechnology. The questionnaires were administered between 1993 and 2010, and all relied on a national, random sample of adults. I conducted a content analysis of the questions about biotechnology, identifying the object of study in each

question. In conjunction with the major divisions expressed in the literature, codes were developed for the objects identified. The codes came to represent the various dimensions of biotechnology. Chapter four provides a greater discussion on the framework I developed, Dunlap and Jones's (2002) framework, and the collection and analysis of US questionnaires.

To accomplish Aim Two, I examined how concern varied across the dimensions and over time. Not all questions used to identify the dimensions were used in this analysis. This is because not all question about biotechnology indicate concern. For example, a 1998 study conducted by Miller asked, "[H]ow well informed would you say you are about biotechnology?" A well-informed person may or may not be more concerned about biotechnology, and so the question was not taken to be an indicator of concern. Of those that were, the degree of concern was exemplified by the percent of respondents that expressed concern. Decision rules were developed to determine how concern is measured with each question type. For example, on a 7-point Likert scale, scores of 5-7 were taken to indicate concern, a score of 4 indifference or ambivalence, and scores of 1-3 a lack of concern. I used robust regression to determine if the percent concern expressed is greater, less, or the same if some dimensions are measured relative to others. I also examined whether or not concern has changed over time, when dimensions are controlled. This is expanded upon in chapter five. The concluding chapter discusses the results of the study, its strengths and weaknesses, and possible directions for future research.

CHAPTER II

THE RISE OF BIOTECHNOLOGY

Currently, the United States and the European Union have very different policies that regulate biotechnology. The United State's policies have been criticized for not being stringent enough, while the European Union's policies have been criticized for being too stringent (see McGiffen 2005; Sheingate 2006). The European Union's policies, however, have not always been as resistant to biotech development as often depicted today (see Vogel 2001). As early as 1986 (Dibner), Europe was cited as a top biotech developer, had numerous government-sponsored development programs, and strongly emphasized "the potential to become a strong competitor in the long run" (1372). Although both the United States and the European Union were top developers in the 1980s, their policies have since diverged (Kalaitzandonakes 2000). The intent of this chapter is to explore the development of US and EU policies to aid in understanding the roots of these differences.

The United States has a product-risk approach to policy, while the European Union adheres to the precautionary principle. At surface-value, the product-risk approach and the precautionary principle seem to have similar objectives (Kalaitzandonakes 2000). Both are based on scientific assessment and entail a similar methodological approach: hazard identification, evaluation of the likelihood and potential impact of adverse effects, and risk characterization (see Secretariat of the Convention of Biological Diversity 2000; Randall 2011; Sheldon 2003; Shelton, Zhao, and Roush 2002). Risk characterization entails a description of the nature of the adverse effects and the strength of the evidence supporting the characterization (Randall 2011:44). Although

both approaches apply a similar methodology to scientific assessment, the precautionary principle focuses more on *preventing harm*.

The EU approach is more risk-averse than the US approach (Vogel 2001). The US product-risk approach “consists of the identification of hazards and the analysis and evaluation of those risks associated with exposure to those hazards” (Fraser n.d.). Key elements of the precautionary principle, however, include taking precaution during scientific uncertainty, exploring less harmful alternatives, shifting the burden of proof to the developer, and employing democratic procedures to enforce the principle (Randall 2011). Although the US approach claims to contain the same elements, it has been criticized for simple approval procedures (see McGiffen 2005; Vogel 2001), fostering corporate growth and control over markets (Moses 1999; Sheingate 2006), and ignoring public concerns (see Alliance for Bio-Integrity 1999). Additionally, the US approach has been criticized as equating risk assessment with scientific assessment and using the label of science to legitimate marketing new products (Jasanoff 2005). The precautionary principle, however, has been criticized as a form of protectionism (Sheingate 2006).

Although biotechnology may have “began similarly on both sides of the Atlantic,” it “quickly took different paths” (Vogel 2001:3). The remainder of this chapter explores the birth, growth, and development of biotechnology in the United States and the European Union. Placing US and EU policy development within an historical context offers a greater understanding of current policies. See appendix A for a timeline of biotech development.

THE BIRTH OF BIOTECHNOLOGY

Paul Berg, a biochemist at Stanford University, conducted the first experiment using rDNA in 1972. Berg's previous work on enzymes, DNA, and ribonucleic acid molecules led him to wonder about transferring genes between species; it was his curiosity that compelled him to conduct this landmark experiment (Chemical Heritage Foundation 2010). Berg combined DNA from monkey virus SV40 with lambda, a bacteriophage. He intended to insert the new genetic material into a bacterium of E. Coli, but his colleagues convinced him to delay the experiment until a consensus was reached about how to proceed safely (Peacock 2010). Because Berg's experiment, as well as much of the early work using rDNA, involved viruses and bacteria, there was much concern about creating carcinogenic viral genes or new bacterial strains (Pew Initiative on Food and Biotechnology 2001).

To address these risks, Berg, in conjunction with the National Science Foundation's Human Cell Biology Steering Committee and the National Cancer Institute of the National Institutes for Health (NIH), organized the 1973 Asilomar Conference. At the conference, it was decided research should continue with caution and that potential risks should be quantified (Pew Initiative on Food and Biotechnology 2001). This conference also led to the creation of the Recombinant DNA Advisory Committee (RAC) in 1974. The RAC was established to assess and report to the director of NIH, "the state of knowledge and technology regarding DNA recombinants, their survival in nature, their transferability to other organisms, and their societal impact" (Pew Initiative on Food and Biotechnology 2001:5).

In 1975 Berg organized the second, better-known, Asilomar Conference. The focus of the previous conference was on carcinogenic risk; however, the focus of the second conference encompassed overall risk (Pew Institute on Food and Biotechnology 2001). Conference participants included lawyers, an international group of 150 scientists, and 16 journalists (US National Library of Medicine 2012). Conference discussions centered on establishing a containment categorization scheme that corresponded to estimated levels of risk (Barkley and Chase 1997). These discussions informed the 1976 guidelines published by the RAC, which recommended different containment levels for different experiments (Office of Technology Assessment 1986).

The RAC was responsible for regulating biotechnology until 1984. In 1982, scientists from the University of California, Berkeley submitted a proposal for the field-testing of Ice Minus, a bacterium engineered to slow the formation of ice crystals on strawberry plants, thus mitigating crop losses (Sheingate 2006). The application was narrowly approved in 1983, and in 1987 Ice Minus became the first biotech organism to be released into the environment (Peacock 2010). This highly controversial decision heightened public attention and concern over the use of biotechnology (Sheingate 2006).

In response to growing concerns, the Reagan Administration established the White House Cabinet Council on Natural Resources and the Environment (CCNRE), currently known as the Domestic Policy Council Working Group on Biotechnology. The CCNRE was created to determine if a new framework needed to be developed to regulate the production and research of biotechnology (Patterson 1999). Additionally, CCNRE asked the NIH to cease evaluating biotech organisms for release into the environment (Sheingate 2006). In 1984, the CCNRE published a proposal for the regulation of

biotechnology in the *Federal Register* and called for public comments, which were reflected in their 1986 policy statement, the Coordinated Framework for the Regulation of Biotechnology (Patterson 1999:19).

The 1986 Coordinated Framework for the Regulation of Biotechnology was the first US federal regulatory statement issued specifically about biotechnology. Although it was only a statement of policy and established no new regulations (Pew Institute on Food and Biotechnology 2001), it set the precedent for current regulations. The framework established two main principles: existing statutes are sufficient for regulation, and regulation is for the product, not the process (Pew Institute on Food and Biotechnology 2001). These two principles and the framework that established them are still the basis for the United State's regulation of biotechnology.

According to the framework, the Federal Food and Drug Administration (FDA) determines if biotech products are safe for consumption, the Environmental Protection Agency (EPA) ensures that the use of biotechnology is safe for the environment, and the US Department of Agriculture (USDA) decides whether biotech products are safe for use with animals. The NIH is still responsible for regulating biotech studies that receive federal research monies. Table 2.1 details the regulatory responsibilities allocated to these agencies.

Under the 1938 Federal Food, Drug, and Cosmetic Act (FD&C), the FDA was granted responsibility for the safety of food and drugs for both humans and animals (Pew Institute on Food and Biotechnology 2001). Despite the different processes involved in biotechnology and conventional breeding, the FDA stated that its “administrative review of products” should be “conducted in the light of the intended use of the product on a

Table 2.1 Descriptions of US Regulations

<i>Agency</i>	<i>Policy</i>	<i>Description</i>
Federal Food and Drug Administration (FDA)	1938 Federal Food, Drug, and Cosmetic Act (FD&C)	Required developers to demonstrate the safety of drugs prior to marketing, extended authority to include color additives and cosmetics, established labeling requirements, and set tolerance levels for risky substances
	1992 Statement of Policy: Foods Derived from New Plant Varieties	Clarification of interpretation of FD&C with regard to biotechnology
	2001 Premarket Notification Proposal	Required developers to submit scientific and regulatory assessment of biotech product 120 days prior to marketing
Environmental Protection Agency (EPA)	1938 FD&C	In 1970, relieved most of the FDA's responsibility for setting and enforcing tolerance levels for risky substances
	1972 Federal Insecticide, Fungicide, and Rodenticide Act	Aimed to protect consumers from risky products and deceptive labeling, established authority to oversee sale and use of pesticides
	1976 Toxic Substance Control Act	Aimed to limit or prohibit the manufacturing, processing, distribution, use, and disposal of risky industrial chemicals
US Department of Agriculture (USDA)	1912 Plant Quarantine Act	Regulated interstate trade of nursery stock and plants
	1957 Federal Plant Pest Act	Extended regulatory authority to include the foreign trade of nursery stock and plants
	1975 Federal Noxious Weed Act	Regulated the spread of noxious weeds by inspecting, seizing, and destroying plants or quarantining areas as necessary
	2000 Plant Protection Act	Consolidated 10 USDA laws, including the three listed above, established a premarket notification process
National Institutes of Health (NIH)	1986 Guidelines for Research Involving Recombinant DNA Molecules	Regulates institutions receiving federal research monies

case-by-case basis,” and that they “need not establish new administrative procedures to deal with genetic concerns about biotechnology” (Office of Technology Assessment 1986:22). Therefore, biotech products are not assessed according to the process by which they were produced, but are considered substantially equivalent and are regulated as all other foodstuffs.

Under the FD&C, the 1976 Toxic Substances and Control Act (TSCA), and the 1972 Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the EPA is responsible for establishing allowable levels of pesticides in food and for ensuring that pesticide-producing plants are not harmful. When the EPA was established in 1970, the agency assumed most of the FDA’s responsibility for setting and enforcing tolerance levels for chemicals. Specifically, the EPA is responsible for regulating pesticides used in the production of food, as well as residual levels on food products in the market (EPA 2012). The EPA recognized much of the uncertainty surrounding biotech organisms (see Office of Technology Assessment 1986). Accordingly, they made amendments to both TSCA and FIFRA that mandated premarket notification and review; the EPA established the Science Advisory Committee to conduct these reviews (Office of Technology Assessment 1986).

Under the 1912 Plant Quarantine Act (PQA), 1957 Federal Plant Pest Act, (FPPA) and the 1975 Federal Noxious Weed Act (FNWA), the USDA was granted regulatory oversight of biotech plants, animals, and plant and animal pathogens with respect to agriculture. The USDA, also recognizing the unique process of biotechnology, published guidelines for conducting research, modified existing policies, and established

the Office of Agriculture Biotechnology to implement and coordinate the new policies and procedures (Office of Technology Assessment 1986).

GROWTH AND DEVELOPMENT

In the late 1980s, the lure of commercial success led many members of the European Economic Community to collaborate in promoting the development of biotechnology (see Dibner 1986). Support was provided for academic programs, new companies entering the industry, partnerships between universities and industries, and collaborations between European and US corporations (Dibner 1986). Additionally, it became clear that there was a need to coordinate policies between member states. The lack of coordinated policies limited the ability for scientists, special interest groups, and the public to discuss important issues surrounding biotechnology (Patterson and Josling 2002). To enhance commercial development, there was a need to harmonize policies on the release of biotech products into the environment and markets (Guehlstorf and Hallstrom 2005).

In 1990, the European Union adopted their first coordinated policies on biotechnology. Directive 90/219/EEC regulated biotech research and development, and Directive 90/220/EEC regulated the deliberate release of biotech products into the environment or market. Both directives were primarily aimed at protecting the environment and were subjected to approval by each Member State (Bernauer and Meins 2003). Under this new system, 14 biotech products were approved, which included mostly corn, oilseed rape, soybeans, and tobacco (Sheldon 2003). However, not all EU members supported the approval of biotech products. Austria, France, Germany, Greece,

Italy, and Luxembourg banned several varieties of corn and oilseed rape (Sheldon 2003).

Table 2.2 summarizes the history of EU biotech regulations

Two years after the European Union established Directive 90/219/EEC, the FDA issued a statement of policy regarding their interpretation of existing law in regulating biotechnology. In this statement, the FDA reaffirmed the notion of substantial equivalence. Drawing off the FD&C, the FDA stated that all biotech foodstuff should be described using the same terminology used to describe their traditionally derived counterpart. More so, to avoid misleading labeling, all labels should detail only material facts (Sheldon 2003), and not details about the process of production. The policy statement also clarified the approval process prior to marketing biotech foodstuff. The FDA's statement of policy resulted in a voluntary assessment process in which the developer of the biotech product can submitted a scientific presentation about the safety and nutritional qualities of the product (Pew Initiative on Food and Biotechnology 2001).

In 1994, Calgene's Flav'r Savr tomato was approved and became the first biotech product to be commercially marketed in the United States. The Flav'r Savr tomato was engineered to slow the ripening process and to increase shelf life (Paul and Stenbrecher 2003). The tomato was taken off the market in less than a year. It was not popular, largely due to its odd consistency, but it raised consumer awareness that biotech foodstuff had entered the food supply (see Peacock 2010:56). In 1996, the first biotech product was approved and commercially marketed in the European Union. It was a tomato paste derived from Calgene's Flav'r Savr tomato.

In 1997, the European Union adopted Regulation No. 258/97, otherwise known as the Novel Foods Regulation. This regulation was established to address the human health

Table 2.2 Descriptions of EU Regulations

<i>Date</i>	<i>Policy</i>	<i>Description</i>
1990	Directive 90/219/EEC	Established a process for research and development
	Directive 90/220/EEC	Established a process for the assessment and approval of biotech products for release into the environment
1997	Regulation No. 258/1997	Simplified approval procedure, required labeling for all novel food products containing biotech ingredients
1998	Directive 98/44/EC	Established intellectual property rights for biotech inventions
2001	Directive 2001/18/EC	Replaced Directive 90/220/EC, established the safeguard clause
2003	Regulation No. 1829/2003	Required developers to submit application to be assessed by the European Food Safety Authority for intended use and risk
	Regulation No. 1830/2003	Required labeling for all food and feed containing biotech ingredients, mandated all businesses that handle biotech products to track them through the commercial food chain
2008	Environmental Counsel's Conclusion on GMOs	Clarified the implementation of the European Union's legal protection of biotechnological inventions

concerns that Directive 90/219/EEC and 90/220/EEC failed to address. It established an approval process in which the producer or importer had to show the food not to be harmful to human health (Bernauer and Meins 2003). Specifically, the regulation applied to new foods or food ingredients that had previously not been approved for human consumption (European Parliament and Council of the European Union 1997). Additionally, this regulation required both unprocessed biotech foods and those products that contained biotech ingredients to be labeled (Sheldon 2003).

In 1998, the limitations of the European Union's regulatory system became apparent. The European Union's approval of a British strain of biotech canola, Novartis's Bt corn, and Monsanto's Roundup Ready Soybeans led to disputes among member states, lengthy delays in the approval process, and bans on biotech products by certain member states (Bernauer and Meins 2003). By April of 1998, a *de facto* moratorium was placed on all new approvals. Only the European Commission, the United Kingdom, and the Netherlands voiced opposition to the moratorium (Bernauer and Meins 2003:651). In June of 1999, the European Union formalized the moratorium by amending Directive 90/220/EEC to include a more precautionary approach to the approval process (Sheldon 2003).

The European Union's shift to a more precautionary approach coincided with the rapid spread of "mad cow disease" in Europe. This lowered European public confidence in the government's ability to regulate the safety of food (Moses 1999). More so, it was preceded by as the ramped spread of dioxin-tainted meat or "foot in mouth disease" (Pew Institute on Food and Biotechnology 2005). The preexisting lack of public confidence hindered EU support for the support of biotechnology.

Concern was not only heightening in the European Union but in the United States as well. In the United States, the StarLink controversy greatly increased consumer awareness and concern. In 2000, Aventis CropScience engineered corn with a Bt bacterium that warded off the European corn borer moth, a common pest. The corn was only approved for use with animal feed, but shortly after its approval, it was found in taco shells manufactured by Kraft Foods. This episode caused much alarm, largely because it “showed that seeds planted on less than one percent of America’s corn acreage could easily spread from farm to farm, contaminate the nation’s grain handling system, and seep into global food supplies” (Peacock 2010:58).

Due to increasing public concern, the USDA sought to rework and clarify their regulatory stance by establishing the 2000 Plant Protection Act. This act consolidated and took the place of ten policies, including the PQA, FPPA, and FNWA. Additionally, the USDA’s Animal and Plant Health Inspection Service (APHIS) became responsible the safety of animal products, including food and drugs (Pew Institute on Food and Biotechnology 2001). The act also established a pre-market approval process that requires the developer to submit a petition, along with information on the biology and genetics of the organisms involved, experimental data, and field test reports (US Geological Survey 2011). Once approved, the organism can be introduced into the environment without further regulatory oversight (Animal and Plant Health Inspection Service 2007). The 2000 Plant Protection Act was established to alleviate public concerns by clarifying regulations and establishing a more ridged approval processes. Since then, nearly 11,600 applications have been submitted to APHIS, and 92 percent have been approved (Schneider and Schneider 2006).

The international controversy over biotechnology peaked in 2003 when the United States, in conjunction with Argentina and Canada, filed a formal complaint with the World Trade Organization (WTO) against the European Union. The US government claimed that the European Union's anti-biotech food policies and six-year moratorium on the approval of biotech products violated international trade agreements (Peacock 2010). The US government argued that the European Union was not only thwarting sales in its own countries, but had also influenced attitudes towards genetic modification in other countries (Schurman and Munro 2010). This claim stemmed from Africa's rejection of the World Food Program's aid in 2002; the aid was rejected because it contained biotech corn from the United States. The WTO ruled in favor of the United States and the European Union was forced to adjust their policies.

UNSETTLED SETTLEMENT

To meet the WTO demands, the European Union lifted the moratorium on biotech products and established new policies. Directive 2001/18/EC was established and replaced Directive 90/220/EEC. Revisions included "time limits on approval (maximum 10 years); explicit procedures and schedules for each stage of the approval process; public registers detailing the locations of GMOs release for trial or commercialization; stricter guidelines for risk assessment; the gradual elimination of antibiotic resistance markers in GMOs; and calls for new and stricter legislation on traceability, liability and labeling" (Bernauer and Meins 2003).

Additionally, the European Union adopted Regulation No. 1829 and Regulation No. 1830. Regulation No. 1829 is a stricter version of previous regulations on food and feed that provides a higher level of protection for human health (Europa 2011a).

Regulation No. 1830 established a framework for tracing food products throughout the entire food chain (Europa 2011b); products that contain biotech ingredients are traced from production to market. This not only applies to biotech foodstuff but to all types of products, including industrial products. According to the European Union, the framework aids in the surveillance of labeling, monitoring potential human and environmental health risks, and the removal of adverse products (Europa 2011b).

The WTO settlement may appear to have quelled the US and EU controversy over biotech regulation. The European Union was forced to readjust their policies and speed up their approval process. As of August of 2011, there were 39 biotech crops approved for commercial use in the European Union and 72 applications pending (EuropaBio 2011). However, the regulatory approach that the European Union adheres to is still fundamentally different than that of the United States. The European Union's regulations continue to adhere to the precautionary principle. Biotech products are still not approved until it can be demonstrated that no adverse effects will result, and labeling and traceability are still mandatory (Sheldon 2003). Although the WTO settlement did result in a speedier approval process, the European Union's approach to regulating biotechnology has remained much more preventative than the United State's product-risk approach.

CHAPTER THREE

BIOTECH CONTROVERSIES

Much of the literature on biotech concern focuses on the United States and the European Union. The US public is framed as being less concerned than EU members (see Bhargava 2002; Herdt 2006; Hoban 2004; Peacock 2010; Pechlaner and Otero 2008; Stone 2010). A variety of reasons have been offered to explain the difference in concern. As expanded upon in chapter three, the disparity has been explained by the different philosophies informing policy development. Other reasons offered include the difference in introductions to biotechnology, consumer group development, and cultural perceptions of food.

The United States and the European Union experienced the birth of biotechnology quite differently. The first study using rDNA techniques occurred in the United States (Peacock 2010) and development was heavily supported (see Dibner 1986). However, when biotechnology was introduced in Europe, public confidence in the ability of the government to regulate the safety of food was already shaken by the “mad cow disease” (Moses 1999), as well as the ramped spread of dioxin-tainted meat and the “foot in mouth disease” (Pew Institute on Food and Biotechnology 2005). The preexistent lack of public confidence hindered EU support for the adoption of biotechnology (Guehlstorf and Hallstrom 2005; Stone 2010).

Additionally, consumer groups in Europe developed differently than those in the United States. The EU public’s opposition towards biotechnology may be most strongly related to the efforts of the consumer groups that also oppose it. (Hoban 1997:233). EU consumer groups tend to have extensive memberships and work closely with the media to publicize their views (Barling et al. 1999). In the United States, however, consumer

groups have tended to form partnerships with industry, government, and universities to support biotech development (Hoban 1997). This has resulted in EU consumer groups having a more critical perspective towards biotechnology than US consumer groups.

Cultural differences have also been cited as a reason for the United States and European Union's conflicting perspectives. Europeans generally stress the *naturalness* of food (European Commission 2010; Moses 1999). In most European countries, cuisines are based on traditional foods that are connected with regional production practices, and supermarkets have not entirely replaced local, specialized food producers (Pew Initiative for Food and Biotechnology 2005). This sharply contrasts with the United States where large corporations own 75 percent of food production (Holt-Gimenez and Patel 2009). Europeans seem to have a deeper cultural connection with their food than US residents (Pew Initiative for Food and Biotechnology 2005:8).

Although discussing the United States and the European Union as aggregated units is useful, it masks the internal distinctions that exist. In the United States, for example, the use and sale of biotech products is banned in the state of Maine and the counties of Mendocino and Marin in California (Pechlaner and Otero 2008). In the European Union, nine member states currently have evoked the safeguard clause (WHO 2012). In the debate over biotech development, viewing the conflicting claims as fundamental components to the object of study, rather than as opposing sides, brings more clarity to the discourse surrounding the debate (see Garland 2012:14). The following discussion is intended to provide a description of the conflicting claims over various dimension of biotechnology, which has both thwarted and facilitated biotech development across the globe.

The debate over biotech development largely consists of conflicting claims over food and medicinal uses, human, environmental, and societal health effects, and regulation. Although biotechnology is increasingly being employed outside food production and medicinal use (e.g. chemical manufacturing, biofuel production, and environmental remediation), these uses have yet to become a large part of the biotech debate. Most people are simply unaware of them (see Bang, Foller, and Buttazzoni 2009). Potential health effects, however, are central to the debate. In the larger debate on genetics, the safety of biotechnology has been referred to as the *most* important issue being addressed (Reilly 2000). And as illustrated in the previous chapter, there is no consensus over the regulation of biotechnology.

CONFLICTING CLAIMS OVER USE IN FOOD PRODUCTION

The simultaneous growth in population, rise in malnourished persons, and threat of climate change has made food security an imperative issue. The world's population grows by one billion every 12 years (Population Reference Bureau 2010), and the number of malnourished persons has risen over the last 15 years from 788 million to 925 million (Food and Agricultural Organization 2010). The gravity of global food-security needs led world leaders to pledge at the 2000 Millennium Summit “to reduce extreme poverty and hunger by half by 2015” (Holt-Gimenez and Patel 2009:9). Biotechnology is touted as the solution to growing food demands (Food and Water Watch 2011); proposed benefits include enhanced nutrition in crops (i.e. bio-fortification) and productivity in crops and animals.

Golden rice is lauded as biotechnology's key achievement for crops with enhanced nutritional benefits. In countries where rice is the main mode of substance,

deficiency diseases are widespread (GMO Compass 2010). To help address this, Golden rice was bioengineered to produce beta-carotene, a significant source of vitamin A. A recent study conducted by Friends of the Earth, however, found 12 pounds of this rice would have to be eaten daily to get the espoused benefit and referred to the rice as “fools gold” (Cummings 2008:101). Although field-testing for Golden Rice began in 1998 (GMO Compass 2010), it has not been approved for commercial use (Food and Water Watch 2011).

Whether biotech crops actually do enhance productivity is highly contested (see Food and Water Watch 2011; Rodale Institute 2011). Some argue that high yields are not intrinsic to seeds but are a function of inputs (Gloklany et al. 2002; Shiva 1991). Meaning, when administered the same inputs (e.g. water, fertilizers, or pesticides), biotech crops do not have higher yields than traditional crops. A study conducted by the Rodale Institute (2011) found conventional and organic crops to produce yields up to four times higher than biotech varieties.

Biotechnology’s ability to enhance productivity in farm-animals used for food production is also contested. Animals are bioengineered to have shorter growth periods, produce a product faster (e.g. milk), and to have a more desirable composition (Webster 1995). Possibly the most controversial example is the approval of Monsanto’s recombinant bovine growth hormone (rbGH; Smith 2003). Approved for commercial use in the United States in 1994, rbGH was designed to mimic the cow’s natural hormone, Bovine Somatotropin, and to increase milk production. In 1998, a group of Canadian scientists published a report describing how cows injected with rbGH suffered from “birth defects, reproductive disorders, increased rates of mastitis [udder infection that

reduces milk quality], and other problems” (Smith 2003:88). This report spurred public concern about the harm bioengineering inflicts upon the *improved* animal (see Attfield 1995).

In animal agriculture, illness represents a major cause of death and suffering (Morrison 1995; Smith 2009). To treat mastitis, as well as a host of other infections, farmers have increasingly relied on the use of antibiotics. In the United States, 70 percent of all antibiotics are used on farm animals; concern over weakening the effects of antibiotics in livestock and in those that consume livestock amplified the debate over using biotechnology with animals to enhance productivity (Peacock 2010). Additionally, relying on bioengineering to prevent illness perpetuates the existence of the same farm conditions that engendered the illness (D’Silva 1995).

CONFLICTING CLAIMS OVER MEDICINAL USE

The use of biotechnology for medicinal purposes has evoked little controversy (Stone 2010). This is not because there is less concern over medical use, but rather because biotech medicinal products have entered into the marketplace with little public notice (see Avise 2004). Globally, bioengineering crops and animals for medicinal use is a \$100 billion dollar market (Avise 2004), and for those that have noticed, a highly controversial issue. Progress in bioengineering animals for medicinal purposes has been relatively slow, due to long breeding periods, low rates of success, and high costs (Herd 2006). Progress in bioengineering crops for medicinal purposes, however, saves millions of dollars compared to producing medicines in laboratories and is likely to continue (Cummings 2008:36).

Bioengineering animals for medicinal purposes have proceeded in two directions: for the production of vaccines and for growing human organs for transplants. Biotech vaccines are argued as safer than conventional vaccines because they are not prepared from dead microorganism, which are known to cause allergic reactions (Grace 2006; Smith 2009). Despite this, concerns about interspecies-transfer of diseases and viruses have been raised. Some claim that accidental gene transfer is highly unlikely due to natural incompatibility barriers (Persley and Peacock 1993). However in 1983, Barbara McClintock received the Nobel Prize in Physiology or Medicine for discovering “mobile genes” that move within the genome (Dart 1993), and in 1988, the World Bank published a report that recognized gene transfer in animals as a reality (Dart 1993). Numerous studies have affirmed this recognition (see McNally 1995; LeVine III 1999).

Interspecies-transfer is also a concern for using animals to grow organs for human transplants. This area of biotechnology involves a technique known as cloning, which is defined as “making identical copies of entities-- molecules, cells, or individuals” (Wheale and McNally 1995). Concern over cloning did not become widespread until the first successful animal cloning of a Scottish sheep named Dolly, in 1996 (LeVine III 1999). Out of 277 attempts at cell fusion, Dolly was the only lamb born; currently, only two percent of attempted clones are born healthy (Grace 2006). Since Dolly’s birth, other animals, including horses, deer, and bulls have been cloned (Peacock 2010). Much of the work in growing organs for transplants has been on pigs because their organs are similar in size and physiology to humans (Avisé 2004).

Pharming is the bioengineering of plants to produce substances useful for medicinal purposes (Peacock 2010). For those that have noticed the widespread use of

biotechnology in medical products, pharming has produced great alarm (McGiffen 2005). Concern is primarily over gene flow between pharmed and food varieties. According to McGiffen (2005), “It is not a question of whether contamination would happen but where and when” (P.79). In November of 2002, the first documented case of cross-contamination occurred in Iowa; corn biopharmed by ProdiGene Corporation to produce a pig vaccine contaminated soybeans intended solely for human consumption (Cummings 2008). After the USDA ordered the soy, valued at \$2.7 million, to be destroyed, it was discovered that the following year’s yields were also contaminated (McGiffen 2005). To mitigate gene flow, pharmed crops must be grown at least a half a mile away from food crops, but with bird and bees being documented as carrying pollen well over a half a mile, this regulation has been described as “laughable” (McGriffen 2005:79).

CONFLICTING CLAIMS OVER HUMAN HEALTH EFFECTS

In North America, 70 percent of processed foods in grocery stores contain biotech ingredients (Avisé 2004:31). In the United States, 80 percent of *all* foods in grocery stores contain biotech ingredients (Brown 2010). Despite the prevalence of biotech products in the food supply, a number of safety concerns about human consumption have been voiced. Although the safety of biotech food has been confirmed by numerous peer-review studies (Hirschler and Kelland 2012), many of these studies have been criticized as bad science (e.g. drawing premature results, neglecting significant health effects, and basing results off low doses of biotech food; Goldstein and Emami 2010).

For example, results from a recent study in France found that rats fed Monsanto’s top-selling biotech corn suffered adverse health effects. Rats fed on a diet of NK603, a corn bioengineered to be resistant to Monsanto’s Roundup herbicide, or given water with

Roundup consistent with US tolerance standards, suffered mammary tumors, severe liver and kidney damage, and died earlier than rats fed conventional foods (Hirschler and Kelland 2012). The study prompted widespread criticism from expert reviewers. The study has been criticized for using unconventional statistical methods, providing incomplete data on the amount of food fed to and the growth rates of the rats, and not having a large enough control group (Hirschler and Kelland 2012). The French government has called for further investigation.

Another concern over the consumption biotech food is potential allergies. According to the FDA's labeling policy, biotech products are to be labeled if their conventional counterpart is known to cause an allergy (International Food Information Council [IFIC] 2010). However, much of the established knowledge on allergies is based on historic analysis of individual case studies and therefore is not fully understood (Metcalf 2003). It is known, however, that genes create proteins, the source of allergies (Smith 2003). In the case of biotechnology, genes are combined in new ways that unpredictably create multiple proteins (Smith 2003). With no historical analysis of allergies to biotech products and no sound method to test allergic potential, there is concern that biotech foods will unknowingly cause allergic reactions in consumers.

Food contamination is another concern. There have been multiple incidents where biotech food only approved for use as feedstock was found in human food. The Starlink incident is a good example of how quickly biotech products can contaminate the human food supply. In 1998 StarLink, a variety of corn bioengineered by Aventis to produce its own pesticide, was approved by the EPA for only use as animal feed. In 2000, StarLink corn was first found in taco shells and later in other processed foods

(Schneider and Schneider 2006). Although Aventis spent \$150 million in cleanup, corn shipments to Bolivia, Japan, and South Korea were identified as contaminated as well (Cummings 2008). Most recently, in 2006 Bayer's Liberty Link rice that was not approved for commercial use was found in the US food supply (Cummings 2008).

CONFLICTING CLAIMS OVER ENVIRONMENTAL HEALTH EFFECTS

With over 600 registered chemicals releasing five-to-six billion pounds of pollution into the environment annually (Cummings 2008), pesticide use in agricultural production has become a salient issue. Of the 17,000 different pesticides for both agricultural and nonagricultural use currently on the market, the EPA has required the testing of less than one percent (Rodale 2011). Biotech proponents have argued that pesticide-resistant plants reduce the volume of pesticides released into the environment (Herdt 2006), but others have argued that because seeds only control for certain pests, the need for additional pesticides is not entirely eliminated (Quaim 2009). Additionally, pesticide-resistant plants have been linked to the evolution of 197 species of pesticide-resistant weeds (Rodale Institute 2011). These "super weeds" have contributed to farmers becoming "trapped in a revolving door" of reliance on biotech products, chemical use, and evolving pesticide resistance (Avisé 2004:74).

The use of petrochemicals in agriculture is problematic not only because petroleum is not renewable at rates even close to extinction rates (Cable 2010), but also because petrochemicals do not occur in nature and cannot be broken down naturally. Petrochemicals disrupt normal biochemistry, and can cause mutations, cancer, and defects in the nervous system of organisms (Cable 2010:65). Furthermore, recent research suggests that petrochemicals can provoke hormone changes that can be passed

onto offspring (Montague 2006). Petro-dependent agriculture literally poisons the environment and those living in it (Cable 2010).

Biodiversity is important for many reasons: it aids in water purification, mitigates soil erosion, reduces the severity of the effects of climate change, and offers the “multiplicity of interactions necessary to heal ecological disturbances” (Shiva 1991). Human induced environmental changes, however, are causing plants and animals to become extinct at rates 50 to 100-times faster than expected natural rates (Kate and Laird 2000). Globally, nearly 17,000 species are threatened with extinction (International Union for the Conservation of Nature 2009). Biotechnology has been claimed to preserve biodiversity by making biotech varieties of local varieties (Qaim 2009). Several studies, however, have linked biotechnology to the decline of a number of species, including lacewing larvae, monarch butterflies (Shelton, Zhao, and Roush 2002), and European songbirds (Cummings 2008).

Additionally, the increasing growth of large monocultures has been linked to adoption of biotech seeds that essentially breed uniformity in plants (Shiva 1991). Large monocultures, for which biotech products are designed, greatly contribute to the degradation of soil. Monocultures have been shown to damage land, leave crops vulnerable to pests and diseases, and require heavy applications of pesticides (Peacock 2010). Despite this, monocultures have been praised as having higher yields, producing more uniform crops, and easing crop maintenance (Peacock 2010). This praise, however, neglects broader environmental health issues. With five billion acres of degraded soil worldwide (Cummings 2008), attention on alternative agricultural techniques (e.g. intercropping and integrative pest management) is increasing.

Another concern is over the transfer of genetic material between biotech crops and natural varieties. According to the EPA and others, there is not a reasonable possibility of biotech varieties passing their traits to wild varieties (see Persley and Peacock 1993; Shelton, Zhao, and Roush 2002; The National Academy of Science 1990). Between 1990 and 2005, however, there were 115 *documented* cases of contamination *just* in the United States (Cummings 2008). Cross-contamination is only partially explained by wind, birds, bees, and the like. Because up to 10 percent of genetic material may remain in the soil after harvest (Dart 1993), DNA from biotech crops can remain in soil for several years after being introduced (Shelton, Zhao and Roush 2002). Open-field testing of biotech crops not yet commercially approved has significantly contributed to concerns over cross-contamination.

CONFLICTING CLAIMS OVER SOCIAL HEALTH EFFECTS

In 2008, the chief executive of Genetic Engineering Technology, Inc., better known as Genentech, called biotechnology “one of the biggest money-losing industries in the history of mankind... [having] lost something like \$100 billion since it was first invented” (Cummings 2008:53). Between 1999 and 2001, biotechnology cost the US economy \$12 billion in exports (Soil Association 2002). Overproduction of biotech food in the United States has greatly contributed to lowered commodity prices, reduced the value of land, and resulted in a loss of market shares (Brumby, Pritchard, and Persley 1993). This has caused farm subsidies to rise, costing taxpayers \$3 to \$5 billion annually (Cummings 2008:27). Due to massive financial loss, suicide became the number-one cause of death on American farms (Dyer 1998). This begs the question, who is benefitting from the increasing adoption of biotech practices?

Some claim agriculture is going through another revolution, a genetic revolution (Shelton, Zhao, and Roush 2002). The “Gene Revolution” posed an opportunity to catalyze a second Green Revolution (Schurman and Munro 2010), which was seized largely by the Rockefeller Foundation and the Gates Foundation (Cummings 2008). The Green Revolution was a Northern economic development model employed to industrialize the global South’s agriculture, which was also largely funded by the Rockefeller Foundation (Holt-Gimenez and Patel 2009). The Gene Revolution has been described as a Northern economic development model primarily being sold to the South through market transactions (Pingali and Raney 2005). The Green Revolution has been criticized for offering technological fixes “that were too large-scale, too expensive, and fundamentally inappropriate for the people they were ostensibly designed to help” (Schurman and Munro 2010:11). Similarly, the gene revolution has been criticized for thwarting the development of inexpensive, local, and sustainable agricultural solutions by heavily investing in and promoting biotechnology (Cummings 2008:108). Other similarities between the Green and Gene Revolution include increased reliance on artificial inputs, farmer dependence on corporate suppliers, and preference for cash crops over local varieties (McGiffen 2005). Although the Gene Revolution, like the Green Revolution, focused on breeding improved varieties and expanding the use of fertilizers and other chemical inputs, and irrigation (see Hazell 2003), the promotion of biotech varieties was novel. Table 3 compares characteristics of the Green and Gene revolution.

Friedmann and McMichael’s “food regime” concept can be used to understand biotechnology as a second Green Revolution. In 1987 Friedmann coined and defined the concept as a “linear representation of agricultural modernization, underlying the private

Table 3. Characteristics of the Green and Gene Revolution

<i>Characteristic</i>	<i>Green Revolution</i>	<i>Gene Revolution</i>
Key Investors	Rockefeller Foundation	Rockefeller Foundation, Gates Foundation
Stated Objective	Increase food production	Increase food production
Main Crops Affected	Cereals, rice	Cereals, vegetables, fruits, animals, fish
Regions Developed	Developing countries	Developed and developing countries
Affected Areas	Favorable or irrigated lands	Favorable, irrigated, or marginal lands
Primary Beneficiaries	Public sector	Private sector
Criticisms	Too expensive, too large-scale	Too expensive, benefits corporations

role of food in global political-economy, and conceptualizing key historical contradictions in food regimes that produce crisis, transformation, and transition” (McMichael 2009:140). According to McMichael (2009), the first food regime began in 1870 with Britain outsourcing food production to their colonies, the second began in the 1950s with the United States rerouting international food trade based on Cold War strategies, and the third in the 1980s with the consolidation of the petrochemical and food production industries. McMichael claims that biotechnology was pertinent to the emergence of the third regime, has ascended to the top in technology for capitalist agricultural development, and could be the basis of the next food regime (Pechlaner and Otero 2008:352). According to Buttel (2001), the Friedmann-McMichael “food regime” has proven to be one of the most resilient perspectives in agrarian studies since the 1980s.

Since biotech products first became commercially available in 1995, biotechnology has grown into a \$4.25 billion international market (McGriffen 2005). Research, developments, and profits, however, are increasingly being concentrated in a decreasing number of corporations (Asian Development Bank 2001). Five corporations (i.e. AstraZeneca, Aventis, DuPont, Monsanto, and Novartis) control nearly two-thirds of the global pesticide market, almost one-quarter of the commercial seed market, and virtually all of the genetically modified seed market (Johnson and Melkonyan 2003). Monopolization of the world’s food supply has resulted in unprecedented concentration of market power and thus, profits (Holt-Gimenez and Patel 2009). As Robert Fraley, executive vice-president of Monsanto in 1996, stated, “What you are seeing... [is] really just a consolidation of the entire food chain” (Paul and Steinbrecher 2003:23).

CONFLICTING CLAIMS OVER REGULATING BIOTECHNOLOGY

As discussed in the previous chapter, the global discourse over the regulation of biotechnology largely stems from two competing philosophies: product-risk assessment and the precautionary principle. The US product-risk approach has been criticized for equating risk assessment with scientific assessment (Jasanoff 2005) and supporting corporate growth and profits at the expense of human, environmental, and societal health (see Avise 2004). The precautionary principle has been depicted as repeatedly invoked “to support unwarranted restrictions of the safest, most intensively studied food products” (Paul and Steinbrecher 2003:70). Although the 2003 WTO settlement may have appeared to quell US and EU disputes over biotechnology, the regulatory approaches have remained fundamentally different.

This difference is reflected in US and EU patent systems in ways that “critically affect the [biotech] industry” (McGiffen 2005:82). The biotech industry greatly benefited from the inclusion of US, and increasingly international, intellectual property rights (IPR) among traditional property rights. Boyle (2008) has coined this “the second enclosure movement,” as it privatizes the commons of the mind. The catalyst for this enclosure was the 1980 US Supreme Court ruling in *Diamond vs. Chakrabarty* that deemed microorganisms patentable. In 1995, IPR went global with the establishment of the WTO and the Trade-Related Aspects of Intellectual Property Rights (TRIPS), which as Carruther and Ariovich (2004) point out, is enshrined in US standards. Strong IPR bolstered biotech corporations rights to the biotech process, the resulting gene, the host into which the foreign gene is inserted, and the end organism.

The establishment of strong IPR may benefit biotech corporations (see Schurman and Munro 2010:36), but ample evidence suggests that it hurts small business and individuals. For example, the development of a single biotech product may require at least a dozen patents, entail high costs, and licenses may have to be negotiated with multiple parties (Qaim 2009). This hinders not only developers, but smallholders as well. Another example of harm caused by strong IPR is the loss of the Plant Breeders' Rights (PBR) under TRIPS. Adopting TRIPS eliminated PBR's two main exemptions for utilizing patented varieties: smallholders' right to save seeds and breeders' right to make new plant varieties from patented varieties. This has rendered corporations considerable control over the global food supply and smallholders. According to a report published by the Center for Food Safety, Monsanto has an annual budget of \$10 million and a staff of 75 devoted solely to investigating and prosecuting farmers, has taken out radio ads to encourage farmers to inform on each other, and set up an informant hotline that receives about 500 tips a year (Cummings 2008:67-68). Strong IPR are espoused as protecting private ownership, but others claim that it privatized the commons of the mind.

Despite these numerous controversies, labeling is the most complex and contentious regulatory issue today (Hoban 2004). In the United States, polls repeatedly show that over 90 percent of US residents want biotech products labeled (Cummings 2008). Despite this, the United States only requires labeling when biotech food significantly differs from its counterpart or is known to cause an allergy. Proponents of mandatory labeling claim that consumers have a right to know what is in their food and that labeling would raise awareness and knowledge about biotechnology (Stilwell and Van Dyke 1999). Others view labeling as creating market segregation (Qaim 2009).

According to the FDA, mandatory labeling “would impermissibly interfere with manufacturers’ ability to market their products on a nationwide basis” (McGiffen 2005:69). Along with the United States, Argentina and Canada do not have mandatory labeling policies, whereas Austria, China, the European Union, and New Zealand do (Peacock 2010:45).

MAKING SENSE OF THE DEBATE

Central to the debate on biotechnology is its *naturalness*. Often the technology is framed as naturally progressing from conventional breeding techniques (Stone 2010). Humans modified organisms to meet needs for thousands of years (The National Academy of Sciences 1990), and biotechnology is part of the evolution of science (Persley and Peacock 1993). Because scientists can control genes in a less haphazard way, bioengineering is quicker than conventional breeding (Monsanto 1990). Additionally, conventional breeding can *only* occur between closely related species (Industrial Biotechnology Association 1990). Through scientific advancements, biotechnology developed as an improvement over conventional breeding techniques.

However, this narrative has been criticized for conflating technology with science. Viewing biotechnology as a natural progression in science, instead of dependent upon science, masks the dubious assumptions on which it is built (Barling et al. 1999). For example, it is assumed that genes are expressed in a consistent manner, affect nutrition and allergies in predictable ways, and can be controlled once introduced into a population (Smith 2003). Because science is the leading source of cognitive authority in modern society (McGinn 1991), biotechnology benefited from this conflation. By blurring

technology and science, the differences between natural and artificial life have blurred (Cummings 2008).

The naturalness of biotechnology is at the crux of the biotech debate. Framing biotech products as improved traditional products implies there is no reason to be concerned about the change; the change is progress. However, if biotech products are framed as resulting from a new technology, there is reason to be concerned about the science behind the technology. This fundamental divide in the debate is integral to the conflicting claims over food and medicinal uses, human, environment, and societal health effects, and the regulation of biotechnology.

CHAPTER FOUR

DATA AND METHODS

This chapter discusses the process of developing my framework to unite the fragmented studies on US biotech concern. I conducted a literature review on US public opinion on biotechnology, and I collected and analyzed 22 questionnaires that asked at least one question US public opinion data on biotechnology. I modeled my framework after the framework suggested by Dunlap and Jones (2002) for conceptualizing and measuring environmental concern. I then applied my framework to further analyze the 22 studies I had collected. The questions asked in the studies are my unit of analysis. This chapter provides a more detailed discussion of the collection and organization of the data, the development of my framework, and its application to the 22 questionnaires I collected.

COLLECTION OF DATA

Data from polls, reports, surveys, and questionnaires on US public opinion on biotechnology were collected. For simplicity, I refer to all of the data as coming from questionnaires. The questionnaires were obtained through a variety of methods. I searched databases available through the University of Tennessee (UT) Libraries and major research institutes, such as the Pew Research Center. I also used the Google Search Engine and consulted journal articles for data references. Questionnaires were included in my study if free for the public or UT students, methodology and the questions were explicitly stated, counts or percentages for the responses were provided, and biotechnology was specifically referred to in one or more questions. Additionally, all data was derived from national, random samples of adults. Twenty-two questionnaires, with publication dates ranging from 1993 to 2010, were identified using this criteria and

are listed, along with the number of questions included from each source, in Table 4.1. Descriptions of each study and a reproduction of my own notes can be found in Appendix B.

DEVELOPING MY FRAMEWORK

The framework I developed to make sense of the various questionnaires I collected was modeled off that suggested by Dunlap and Jones (2002) for understanding environmental concern. The rationale behind employing their framework is based on the similarities in conceptual and measurement issues in studying environmental and biotech concern. This similarity made their framework a good model for developing a framework to better understand US public concern for biotechnology.

The Rationale for Modeling Dunlap and Jones's Framework

One key similarity between environmental and biotech concern is the ambiguity of the subject matter. The environment is a particularly elusive concept, which Heberlein (1981) contributes to the multiple sub-objects that represent the environment in its entirety. Likewise, biotechnology has several dimensions that can be delineated by a variety of factors (e.g. variation in processes, products, or impacts). Variation can be real or perceived, and it is from this diversity in perspectives that concern results (see Denzin 1989). Because of the plurality of perspectives, Jones (1993) has argued that it is impossible to develop a universally accepted definition of biotechnology. Although a clear definition is not necessary for the study of biotechnology (see Heberlein 1981), formalization would minimize this ambiguity (see Shye, Elizur and Hoffman 1994).

Like US studies on biotech concern, many of the early studies on environmental concern were ad hoc, atheoretical, and noncumulative; for environmental concern studies,

Table 4.1 Descriptions of Study and Number of Questions Included

<i>Source</i>	<i>Year Conducted</i>	<i>Title of Report</i>	<i>Number of Questions (n=569)</i>
American Broadcasting Corporation	2003	Modified Foods Give Consumers Pause	15
Gallup Poll	2001	Biotech Food Remains Fairly Obscure to most Americans	20
Gallup Poll	2005	Britons Show Distaste for Biotech Foods	3
General Social Survey	2011	General Social Surveys: 1972-2010	18
Harris Poll No. 33	2000	Genetically Modified Foods: An Issue Waiting to Explode?	8
Harris Poll No. 35	1993	Jurassic Park Prompts the Thought that the Risks of Genetic Engineering Outweigh the Benefits	3
International Food Information Council (IFIC)	2010	Consumer Perceptions of Food Technology Survey	45
IFIC	2006-2008	Food Biotechnology: A Study of US Consumer Trends	35, 41, 40
IFIC	2001	US Consumer Attitudes Toward Food Biotechnology	61
Harris Interactive and the Chicago Council on Foreign Relations	2002	American Public Opinion and US Foreign Policy	3
International Social Survey Program	2000	Environment II	1
Inter-University Consortium for Political and Social Research (ICPSR) No. 3030	1997	United States Biotechnology Study	105
ICPSR No. 2874	1999	CBS News "CBS.Marketwatch.com Millennium Poll	1
ICPSR No. 6952	1993	Comparison of Risk Attitudes and Perceptions in Japan and the United States, 1993	2
Lake Research Partners	2010	Attitudes toward the FDA's Plan on Genetically Engineered Fish	2
National Public Radio (NPR)	2000	NPR/Kaiser/Kennedy School Technology Survey	2
Pew Initiative on Food and Biotechnology	2001	Public Sentiment About Genetically Modified Food	41

Table 4.1 Descriptions of Study and Number of Questions Included Continued

<i>Source</i>	<i>Year Conducted</i>	<i>Title of Report</i>	<i>Number of Questions (n=569)</i>
Pew Initiative on Food and Biotechnology	2003	An Update on Public Sentiment About Agricultural Biotechnology	55
Pew Initiative on Food and Biotechnology	2004	US Consumer Opinion Divided: Overview of 2004 Findings	62
Thomas Reuters and NPR	2010	National Survey of Healthcare Consumers: Genetically Engineered Food	7

this has been contributed to the ambiguity of the subject matter (see Dunlap and Jones 2002). Many of the early environmental concern studies focused on only one or a few of the sub-objects (see Heberlein 1981), and a wide range of measures were used (Dunlap and Jones 2002). The result was a disorganized and incoherent literature (see Heberlein 1981). As discussed in chapter one, there is no scholarly consensus on the definition of biotechnology, and a wide array of conceptualizations and measurements has been used in studying biotech concern; likewise, this has thwarted the evolution of a well-developed literature.

Applying Dunlap and Jones's Framework to Biotech Concern

The framework suggested by Dunlap and Jones (2002) was designed to address the complexity inherent in understanding environmental concern, and because of this, it addresses the multiple dimensionality of biotech concern especially well. Dunlap and Jones (2002) state that there are basically two components in the conceptualization of environmental concern: the environmental and concern component. They refer to these as the substantive and theoretical components, respectively. To transform their framework into that for the study of biotech concern, I used a variant of their environmental component but mostly retained their use of the concern component.

To clarify the meaning of environmental concern, Dunlap and Jones (2002) draw from facet theory. Facet theory integrates content design with data analysis (Shye, Elizur and Hoffman 1994) and is mainly used in the construction of systems for documentary classification schemes (Broughton and Slavic 2007). Facet theory provides guidance for mapping the conceptual space and empirical boundaries of research domains and for decomposing complex concepts into their key facets (Dunlap and Jones 2002:485).

According to Guttman, the founder of facet theory, and Greenbaum (1998), a facet is a set of attributes that together represent the underlying conceptual and semantic components of a particular research object. Facet theory offers a classification scheme that captures the “universe of environmental concern.” Concerning the environmental component, the universe encompasses the major dimensions that represent the object of concern; for concern, the universe is composed of forms of expression drawn from attitude theory (Dunlap and Jones 2002). Because facet theory is systematic and explicit, it facilitates the measurement of complex concepts such as biotech concern.

The concern component. The concern component draws from attitude theory and represents both the expression and operationalization of environmental/biotech concern. In the literature on attitude theory, attitudes are largely used synonymously with concern (Ester 1981), and it is generally agreed that they consist of both cognitions and affects (Heberlein 1981). The cognitive component is usually treated as beliefs and knowledge about the object of study, while the affect component involves an emotive and evaluative aspect (Dunlap and Jones 2002). Dunlap and Jones (2002) use a scale developed by Maloney and Ward (1973) to operationalize the concern component.

Maloney and Ward (1973) measure cognition as a function of the knowledge one has about the object of study and affect as the degree of emotionality or one’s attitude toward the object. Because behavior is often treated as an indicator of concern, Dunlap and Jones (2002) also included two measures of behavior in their scale. Verbal commitment measures what a person states he or she is willing to do, and actual commitment measures what a person self-reports as having done. Overall, Dunlap and Jones (2002) advocate for the use of four measures to get at concern: knowledge,

attitudes, conative behavior (i.e. verbal commitment), and actual behavior. For the purposes of my study, I differentiated objective knowledge from knowledge claims and created two separate measures, knowledge and belief, respectively. This resulted in five dimensions to the concern component in my framework: attitudes, conative behaviors, actual behaviors, beliefs, and knowledge.

Some examples may clarify the differences between the dimensions. Attitudinal questions may ask respondents to indicate their level of support for biotechnology on a Likert scale. Questions that ask respondents about the likelihood of purchasing biotech food products would be understood as asking for a verbal commitment. This is distinct from actual behaviors, which would include questions about past purchasing behavior. A question about beliefs may ask the respondents if they think biotechnology in food production will help mitigate the effects of climate change. This differs from knowledge questions, which may ask respondents if food products produced using biotechnology are available in markets now.

The environment/biotech component. Several of the facets that Dunlap and Jones identified in their study of the environmental component are applicable to the biotech component in biotech concern. The *spatial facet* distinguishes between geographical scales, such as local, national, and global levels (Dunlap and Jones 2002). For example, a question centered at the local level may ask about the availability of biotech products at the grocery store. The *temporal facet* distinguishes between the past, present, and future (Dunlap, Gallup Jr. and Gallup 1993). So, a question centered in the present may ask about the FDA's current regulations. Dunlap and Jones (2002) also delineate a *specificity facet*, which discerns concern ranging from very general to very specific. Questions may

be as general as, “Do you feel that biotechnology will provide benefits for you or your family?” (IFIC 2001), or they may elicit very specific details about the expected benefits. The biotech component also has a *content-specific facet*, which contains those dimensions that comprise the fundamental features of biotechnology. This facet could not be borrowed from Dunlap and Jones, so to construct one specific to biotechnology I engaged in sentence mapping.

Sentence mapping is a technique employed in facet theory that is used to express observations in an explicit and systematic way. To begin, three areas must be defined: the focus, sense, and image. Together the focus and sense comprise the domain and the image is referred to as the range. The domain consists of the essential features of the object of study and the range depicts all acceptable responses to the questions regarding the object of study (Shye, Elizur and Hoffman 1994). The domain and range for the content-specific facet are depicted in Table 4.2.

To determine the range, I conducted a content analysis of the questions in the questionnaires. Content analysis is essentially a coding operation (Babbie 2004). Codes are the basis for operationalizing the biotech component and represent the attributes that comprise biotechnology; because these attributes should be mutually exclusive and exhaustive, developing them was an onerous task. Using the questions in the questionnaires as the unit of analysis, the object or objects of inquiry in each question was coded and used in the construction of the range. The codes were also developed in conjunction with the major classifications and divisions expressed in the literature on biotechnology. Table 4.3 depicts all the codes or dimensions developed for biotech

Table 4.2 The Domain and Range of Content Specific to Biotechnology

<i>Focus</i>	<i>Sense</i>	<i>Image</i>
Concern	Greater	Food
	Less	Crops
		Animal Use
		Medical Use
		Human Health
		Environmental Health
		Regulation
		Labeling
		Economics
		Cloning
		Pesticide Use
		Human Hunger

concern as well as a brief description of each. For a more in-depth description of each code, see Appendix C.

After identifying the domain and range, a mapping definition was developed. A mapping definition provides a formal definitional framework that aids in hypothesis formation and testing (Guttman and Greenbaum 1998). Mapping definitions aid in distinguishing the elements of the object of study as well as possible interrelations between the elements, all of which is necessary to engage in sentence mapping. This includes the formal parts made up by the dimensions and the less formal parts made up by the phrases that link the dimensions together (Guttman and Greenbaum 1998). All possible sentence maps, which comprise the mapping definition of biotech concern, are depicted in Table 4.4.

Note Facet A. Since 1991 the European Union has used a split ballot to document the variation in reported concern based on the terminology used to depict the technology (European Commission 2010). To test if this variation is applicable to the United States, I introduced a *linguistic facet*. This facet, along with those belonging to the theoretical and substantive components, makes up the universe of biotech concern.

ORGANIZATION OF DATA

In my study, the questions in the questionnaires are my unit of analysis. Not all questions in the 22 questionnaires were included in my study. If the questionnaire focused specifically on biotechnology, all questions, except those on demographic characteristics, were included. However, if the main thrust of the questionnaire was on something other than biotechnology (e.g. technology in general), only those questions

Table 4.3 Descriptions of Dimensions

<i>Component</i>	<i>Facet</i>	<i>Sub-object</i>	<i>Description</i>
Biotechnology	Content-Specific	Biotech Food	Generally refers only to food
		Biotech Crops	Refers to crop production
		Animal Biotechnology	Refers to animal use
		Biotech Crops and Animals	Specifies crops and animal
		Medical Biotechnology	Refers to medical use
		Human Health	Health, excluding medical
		Environmental Health	Refers to biophysical aspects
		Regulations	Refers to government action
		Labeling	Refers to any labeling issue
		Economics	Refers to market values
		Cloning	References use of cloning
		Pesticide Use	Refers to pesticide use
		Human Hunger	Refers to reducing hunger
	Spatial	Local Level	Centered at local level
		National Level	Centered at national level
		Global Level	Centered at global level
	Temporal	Past	Concerned with past
		Present	Concerned with present
		Future	Concerned with future
	Linguistic	Biotechnology	States term or derivative
		Genetic Modification	States term or derivative
		Genetic Engineering	States term or derivative
		Genetic Alteration	States term or derivative
Concern	Theoretical	Belief	Refers to awareness
		Knowledge	Refers to the objective
		Affect	Concerned with emotions
		Conative Behavior	Refers to intentions
		Actual Behavior	Concerned with self-reports

Table 4.4 Sentence Map: The degree of concern expressed about...

<i>Facet A: Linguistic</i>		<i>Facet B: Theoretical</i>	
{1. Biotechnology} {2. Genetic Modification} {3. Genetic Engineering} {4. Genetic Alteration}	varies as an expression of	{1. Belief} {2. Knowledge} {3. Affect} {4. Conative Behavior} {5. Actual Behavior}	and as to whether the scope is
<i>Facet C: Spatial</i>		<i>Facet D: Temporal</i>	
{1. Local} {2. National} {3. Global}	and the temporal reference is	{1. Past} {2. Present} {3. Future}	for questions about
<i>Facet E: Content-Specific</i>			
{1. Food} {2. Crops} {3. Animal Use} {4. Crops and Animal Use} {5. Medical Use} {6. Human Health} {7. Environmental Health} {8. Regulation} {9. Labeling} {10. Economics} {11. Cloning} {12. Pesticide Use} {13. Human Hunger}			

pertaining to biotechnology were included. This resulted in the inclusion of 569 questions, each of which is listed by source in Appendix D.

After collecting the questionnaires, I compiled information about the sources, the questions posed, and the responses reported into a Microsoft Excel spreadsheet. Each question was assigned an identification number and a source-identification number. The year the study was conducted, the number of respondents, and the exact wording of each question were recorded. Codes were developed for the various collection methods: telephone, web, in-person interview, written survey, or mixed methods. The only study that used mixed methods was the 2002 *American Public Opinion and US Foreign Policy*; telephone and in-person interviews were employed. I also coded whether the question was asked to the full sample or a subsample, and each question was coded according to its type of measurement: dichotomous, trichotomous, scale, open-ended, multiple-choice, Likert, or Likert-type choices. Likert-type questions indicate levels of agreement similarly to Likert questions, but do not have the traditional seven levels. Each question was then coded to depict the type of response elicited (e.g. degree of favorability, level of support, amount of knowledge). See Table 4.5 for a list and examples of questions and response types. For more information on the codes developed, refer to the codebook in Appendix E.

The responses to each question were also recorded. Recording the plethora of response patterns afforded by the various questions was problematic in Excel. The following strategy was employed to alleviate the problems associated with using such a simple interface. Each question had a code for the number of responses possible, excluding “don’t know.” The next cell displayed the percent of participants that

Table 4.5 Examples for Question and Response Types

<i>Type</i>	<i>Description</i>	<i>Example</i>
Question Type	Likert or Liker-Type	Indicate level of Agreement: I would buy genetically modified food if it was nutritionally enhanced.
	Dichotomous	Are biotech foods currently available in your grocery store?
	Trichotomous	Indicate if the following statement has a positive, a negative or no effect on your opinion of biotechnology: biotechnology can increase farm efficiency.
	Open Ended	What, if anything, are you concerned about when it comes to human consumption?
	Ranked	Rank the following factors in order of importance to you: producing plants that require less water, petro inputs, tilling.
	Multiple Choice	Which of the following benefits, if any, do you expect to receive from biotechnology within the next five years?
Response Type	Scale	On a scale of one to ten, with one being uncomfortable and ten being comfortable, how comfortable are you with biotechnology?
	Degree of Confidence	How confident are you that the food we eat in the United States is safe?
	Safe or Not	Do you think genetically modified food is safe to eat?
	Yes or No	Do you feel that biotechnology will provide benefits for you and your family within the next five years?
	Likelihood of Phenomena	If cooking oil with reduced fat was produced via biotechnology, how likely would you be to buy it?
	Should or Should Not	Do you think Europe should be able to require the labeling of products that contain biotech ingredients?
	Amount of Information Obtained	How much would you say you have heard about biotechnology?
	Degree of Favorability	What is your overall impression of genetically modified foods?
	Positive or Negative Reaction to Statement	Does the following statement have a positive, a negative or no effect on your impression of biotechnology?
	Degree of Importance	How important is it to you that you purchase GMO-free food products?
	Degree of Danger	How dangerous for the environment is modifying the genes of certain crops?
	Greater Risk or Greater Benefit	Do you think the benefits outweigh the risks in biotechnology?

Table 4.5 Examples for Question and Response Types Continued

<i>Type</i>	<i>Description</i>	<i>Example</i>
	Level of Understanding	On a scale of one to five, how well do you understand biotechnology?
	Level of Agreement	Please indicate your level of agreement: biotechnology is morally acceptable.
	Level of Trust	How much trust do you have in the FDA's regulations for biotechnology?
	Support or Oppose	Do you support or oppose the use of biotechnology in agricultural production?
	Inheritance or Environmental	Is happiness hereditary or environmentally induced?
	Understand or Not	Do you understand the basic process involved in agricultural biotechnology?
	True or False	True or false: biotechnology results in the creation of novel genes?
	Frequency of Event	How often have you had conversations about biotechnology in the last few months?
	Right or Wrong	Do you think it is right or wrong to use scientific techniques to enhance flavors?
	Degree of Influence	How influential would a statement from the following sources be in assuring you the safety in biotech food production?
	Level of Responsibility	How much responsibility do you have for your household shopping decisions?
	Same as Conventional or Not	Is there a difference in safety between consuming GM or non-GM corn?
	Degree of Concern, Confidence, or Worry	Indicate your level of comfort with genetically modifying plants.
	Favor or Oppose	Do you favor or oppose scientific research into genetic modification?
	Good or Bad	Do you think modifying plants to reduce the need for pesticides is good or bad?
	Missing: Open-ended or Multiple Choice	What would you like to see labeled that currently is not?

responded with “don’t know” and the following 11 cells displayed the percentage of respondents that identified with each response. The percentages within each cell corresponded to the response pattern explicated in the questions. For example, a question centered on the level of support would result in the first cell depicting the percentage of respondents that reported the greatest level of support with the last cell depicting the lowest level of support. Not all questions had 11 response options. To distinguish the valueless cells from missing data, two separate codes were developed. Only valid responses, if they could be distinguished, were included, meaning “refusal to respond” were omitted.

To operationalize biotech concern, each question was coded according to the substantive and theoretical facets expanded upon above. Each dimension, or variable, within the facets were dummy coded with a one if it was expressed in the question and a zero if it was not expressed. To increase reliability, each variable was assigned key words to flag questions for the appropriate coding. Using the IF, SUM, and COUNTIF formulas, I wrote a function that coded questions according to my coding scheme. See Appendix F for a list of key words by dimension and a more detailed description of my Excel function. Along with coding for explicit content, I also coded underlying meaning in the questions. For example, a question may ask for the respondent’s level of support for the FDA’s labeling practices, and although not explicitly stated, this question refers to current labeling practices and would be coded as such. To code for this latent content, as well as to check the coding accuracy of my formula, all 569 questions were scrutinized multiple times.

DESCRIPTION OF DATA

This section examines information about the data source, the questions, and the responses, as well as provides a description of the dimensions for each facet of biotech concern. To calculate the following statistics, the Excel dataset was converted to a .dta file and used in Stata 11.

Examining the Sources

Table 4.6 displays the various information recorded about the sources of the questionnaires. The dates the questionnaires were administered ranged from 1993 to 2010, with 2003 as the mean. The average number of respondents is 1,068 per questionnaire, which is reasonable considering all questionnaires were nationally representative. The bulk of the questionnaires (67.1 percent) were conducted via telephone, followed by web-based (29.0 percent). This is consistent with the shift in popularity to web-based surveys in the mid-2000s (see Giesler 2012).

There was some consistency between the type of question asked and the type of response elicited. This is illustrated in Table 4.7, which depicts percentages for the question types by select response types. Most of the questions (60.1 percent) were either a Likert or Liker-type question, which provoked the greatest range of response types. Most of these questions asked about the likelihood of a phenomenon (24.3 percent) or for a level of agreement (11.7 percent); other common response types asked about the degree of favorability towards (9.7 percent), trust in (9.7 percent), and goodness of (8.5 percent) various issues about the dimensions. Slightly over 21 percent of the questions were dichotomous. Of those, over half (51.2 percent) elicited a “yes or no” and nearly a fifth (17.4 percent) elicited a “true or false.” There was no marked variation between ranked

Table 4.6 Descriptive Statistics of Source Information

<i>Information</i>	<i>Mean or Proportion</i>
Year Conducted	2002.91 (SD 4.29)
Number of Respondents	1068.27 (SD 607.95)
Method	
Telephone Interview	67.10
In-person Interview	3.30
Web-based Interview	29.00
Mixed	.40
Written Questionnaire	.20
Questions Asked to Full Sample	80.5

Table 4.7 Percentages for Question Types by Select Response Types

<i>Question Type</i>	<i>Degree of Concern, Comfort, or Worry</i>	<i>Degree of Importance</i>	<i>Likelihood of Phenomena</i>	<i>Level of Agreement</i>	<i>Reaction to Statement</i>	<i>All Types</i>
Dichotomous	0	0	9.09		0	21.30
Likert or Likert-Like	2.63	2.34	24.27	11.70	0	60.10
Multiple-Choice	0	0	0	0	0	3.00
Open-Ended	0	0	0	0	0	6.70
Ranked	0	100.00	0	0	0	3.9
Scaled	85.71	7.14	0	0	0	2.5
Trichotomous	0	0	0	0	80.00	2.6

n=569

questions and response type; all examined the degree of importance over issues for a particular dimension. Scaled and trichotomous questions exhibited a similar pattern. Most scaled (85.7 percent) questions asked about the degree of concern, comfort, or worry over a dimension, and most trichotomous (80.0 percent) questions asked for a reaction to a particular statement. The multiple-choice and open-ended questions did not have a standardized response, and since they constituted less than seven percent of the sample, I recoded the response type as missing (*See Note 1*).

Examining the Dimensions of Biotech Concern

Table 4.8 provides descriptive statistics for each dimension that comprise the universe of biotech concern. Recall the first three facets comprise the biotech component, the fourth the concern component, and that the linguistic facet was added to examine if concern expressed varied by the terminology used to depict biotechnology. The linguistic and the content-specific facets contain variables that are not mutually exclusive; that is, questions can identify with multiple variables in each facet. However, the spatial, temporal, and theoretical facets contain mutually exclusive variables.

Biotech Food, Crops, and Animals. A third of the questions inquired about biotech food in the most general context. That is, no attributes were given to distinguish between types of biotech food. These questions examined biotech food on the most basic level and do not account for variation in response to more specific aspects (e.g. use with crops or animals). However, even fewer questions distinguished between use with crops (17.2 percent) and animals (13.4 percent). About seven percent were double-barreled questions that asked about use with both animals and crops.

Table 4.8 Descriptive Statistics for the Dimensions of Biotech Concern

<i>Content-Specific Facet</i>	<i>Mean or Proportion</i>
Biotech Food	.33
Biotech Crops	.17
Biotech Animals	.13
Biotech Animal and Crops	.07
Medical Aspect	.12
Human Health	.23
Environmental Aspect	.08
Regulation	.15
Labeling	.07
Economic Aspect	.22
Cloning	.03
Pesticide Use	.04
Human Hunger	.02
Other	.34
<i>Spatial Facet</i>	
Local	.31
National	.09
Global	.02
Not Specified	.57
<i>Temporal Facet</i>	
Past	.14
Present	.70
Future	.16
<i>Theoretical Facet</i>	
Belief	.42
Attitude	.14
Conative Behavior	.14
Actual Behavior	.22
Knowledge	.07
<i>Linguistic Facet</i>	
Biotechnology	.47
Genetic Alteration	.01
Genetic Engineering	.08
Genetic Modification	.31

Medicinal Biotechnology. Over a tenth (11.8 percent) of the questions asked about the use of biotechnology for medicinal purposes. This included both questions about medicinal use with crops and animals. The small percentage of questions about the wide range of medicinal uses may be due to medical use being less controversial than use with food; prior research has indicated that public concern about the use of biotechnology for medical purposes is not as great as concern for food production (see Asian Development Bank 2001; Qaim 2009; Stone 2010).

Human and Environmental Health. Concern about the relationship between the consumption of biotech products and human health is salient in nearly a fourth of the questions (23.0 percent). Next to biotech food, this is the dimension most inquired about. According to Reilly (2000), many other studies have found human health issues to be at the forefront of biotech concern. Concern over human health sharply contrasts with concern over environmental health. Concerns about the effects of releasing biotech organisms into the environment are inquired about in less than a tenth (8.4 percent) of questions. This indicates that there is a greater focus on studying human health concerns than environmental health concerns.

Biotech Regulations and Labeling. Regulation is the fourth most inquired about dimension. About 15 percent of the questions focused on regulation, and 49 percent of these asked about labeling issues. This is not surprising as labeling is the most complex and contentious issue for biotech politics today (Hoban 2004); this is largely because mandatory labeling is a well-accepted idea that has not been implemented (see Shanahan, Scheufele, and Lee 2001). In my study, the demand for labeling varied widely according

to the wording of the question. For example, the Internal Food Information Council (IFIC) (2010:4) asked,

“The U.S. Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you strongly support, somewhat support, neither support nor oppose, somewhat oppose or strongly oppose this policy of FDA?”

This question mentioned only supporting arguments for the FDA's labeling policy (Shanahan, Scheufele, and Lee 2001), and only 12 percent of respondents expressed opposition (IFIC 2010). However, when asked straightforward questions about mandatory labeling, most respondents express support. For example, a 2010 study by NPR and Thomas Reuters reported that 93 percent of respondents supported labeling when asked, “Do you believe that foods should be labeled to indicate that they have been genetically engineered or contain ingredients that have been genetically engineered?” Other studies have reported similar findings (American Broadcasting Corporation 2003; Miller 1998; Pew Initiative on Food and Biotechnology 2004; Taylor 2000).

Biotechnology and Economics. A little less than a quarter (22.1 percent) of the questions were over the economic dimension of biotechnology. Although there were a variety of issues inquired about under the umbrella of economics, nearly half (49.2 percent) were centered at the local level and most asked about purchasing behavior. According to a meta-analysis conducted by Lusk and colleagues (2005), 26 percent of US consumers report a willingness to pay more for non-biotech foods; this is consistent with the findings in this study. Four questions (2.4 percent) asked about global policy issues; of these, all asked about EU policies (Harris Interactive and the Council on Foreign

Relations 2002; Pew Initiative on Food and Biotechnology 2003). Other topics include attitudes towards and knowledge of certain products.

Cloning. Only 2.8 percent of questions inquired about cloning. The small number of questions asking about cloning is not surprising. Public concern for cloning has primarily been over use with humans, and accordingly, US policy bans the use of federal funds to create or experiment with human embryos. Of the 16 questions included in this study that do ask, most (75.0 percent) asked for general impressions or willingness to purchase cloned meat products.

Biotechnology Pesticide Use and Human Hunger. Decreasing pesticide use and alleviating human hunger are often touted as benefits from adopting biotechnology (see Herdt 2006; Food and Water Watch 2011). Despite this, only four percent of questions asked about biotechnology in relation to pesticide use, and two percent in relation to mitigating human hunger. This is curious, as both dimensions are salient and widely contested. The majority (62.5 percent) of the questions about pesticide use were from the IFIC and asked about the likelihood of purchasing a product bioengineered to reduce the need for pesticides or to rank the importance of reducing use in sustainable farming. The questions about mitigating hunger only asked about increasing yields to produce less expensive foods, reducing the need for converting valuable land to farmland, or feeding a growing population.

Spatial and Temporal Dimensions. The majority of the questions in this study were primarily centered at the present moment (69.9 percent) and the spatial facet was unspecified (56.8 percent). However, both of these numbers may be inflated. If a question did not specify if it was concerned with the past, present, or future, it was

assumed to be concerned with the present moment. Slightly over 13 percent of the questions were centered in the past, of which the vast majority (96.3 percent) asked about past behaviors. Likewise, if a question did not specify if it was concerned with a local, national, or global biotech issues, it was coded as unspecified. Nearly the remainder (30.0 percent) of the questions was centered at the local level.

Theoretical Dimensions. Attitudes are evaluative or emotive. For the first decade of studying US biotech concern, much of the research indicated that the public generally reported positive attitudes about biotechnology (Hoban 1997). However, negative attitudes are becoming more prevalent over time (Shanahan, Scheufele, and Lee 2001). Much of the data in this study exemplifies this claim. For example, over time the IFIC has posed the question, “Do you feel that biotechnology will provide benefits for you and your family within the next five years?” In 1999, 79 percent of respondents reported yes, but in 2010 only 32 percent of respondents reported yes. Only 14.2 percent of the questions in this study measured attitudes.

The two behavioral measures included conative and actual behaviors. Over a tenth (12.8 percent) of the questions asked about conative behavior. Of these, nearly half (56.2 percent) asked about the likelihood to purchase a biotech product. Most assumed a similar form to this IFIC question, “All things being equal, how likely would you be to buy a variety of produce, like tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher?” In 1997, 55 percent of respondents indicated that they were likely to purchase the product, but when asked the same question in 2010, reported likelihood declined by 12 percent. Nearly twice as many (22.0 percent) of the questions asked about actual behavior. Of these, the issues asked about were quite

diverse. The most common (31.2 percent) asked respondents for the amount of information they have heard, read, or otherwise obtained about biotechnology. At the turn of the twenty-first century, around 50 percent of the public reported having obtained some information about biotechnology (see Gallup 2001; IFIC 2001; Pew Initiative on Food and Biotechnology; Taylor 2000), but shortly after, that percentage dropped by about 10 percent (see IFIC 2006; Pew Initiative on Food and Biotechnology 2004).

Beliefs and knowledge are often viewed as two points on a continuum and can be jointly understood as awareness. Much of the data in this study indicates that public awareness has declined. For example, in 1997 and again in 2010, the IFIC asked respondents, “As far as you know, are there any foods produced through biotechnology in the supermarket now?” In 1997, 68 percent of respondents reported yes, but only 28 percent responded yes in 2010. Interestingly though, US residents seem to be more aware of their lack of awareness (Hoban 2004). Considering the previous example, in 1997 only 23 percent of respondents reported that they did not know if there were biotech products available in the supermarket. However, by 2010 that number had rose to 64 percent. Despite US residents increasingly self-reporting less awareness, they still tend to report strong attitudes for a variety of biotech issues (see Legge Jr. and Durant 2010).

Linguistic Dimensions. Across measures, nearly half (45.3 percent) of the questions used the term biotechnology, and over a third (30.9 percent) used genetic modification. The Eurobarometer, through the use of a split-ballet, has shown the amount of concern expressed across the dimensions to differ according to the terminology used to depict biotechnology (e.g. genetic engineering, modification, or alteration: European Commission 2010). Previous research has indicated that like EU

members, the US public is much more accepting of biotechnology than genetic engineering (see Hoban 2004). Unfortunately, few of the questionnaires I collect used a split-ballet to measure if concern differed according to the terminology depicted. This issue is addressed in the next chapter.

Specificity Facet. Upon examining an individual question, it is difficult to gage the question's specificity. I struggled to understand how to measure a question's specificity and decided to measure it by the number of dimensions it expressed. This is why this facet is not included in the mapping definition for biotech concern. Figure 4 displays the distribution of questions by specificity across time. As can be seen by this distribution, the bulk of questions were neither very general nor very specific. However, the distribution was slightly skewed towards more general questions.

In sum, this chapter described the collection and organization of the data I collected, the development of my framework, and its application to the 22 questionnaires collected. The intent of this study was to generate findings not specific to a particular study, and the criteria used to select the questionnaires included were developed to foster more generalizable results. In conjunction with the literature review, the questionnaires were used to help identify the dimensions of US biotech concern and develop my framework. The framework I developed was then applied to the questionnaires to demonstrate its use in summarizing the otherwise fragmented findings reported in the individual studies.

NOTES

¹ Although the response type for multiple choice and open-ended questions was recorded as missing, the *actual* responses (i.e. the percentage of respondents that identified with

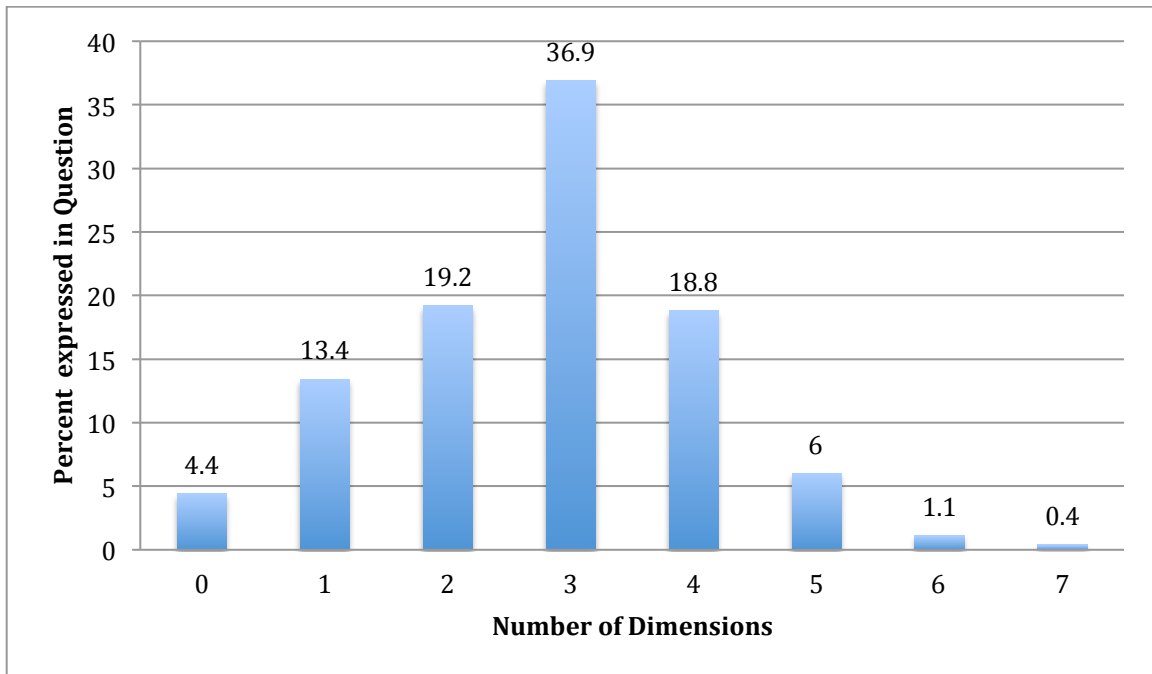


Figure 4. Distribution of Questions by Specificity Across Time (n=569)

each response option) were recorded, if possible. The actual responses for all multiple-choice questions were recorded, and if response patterns for the open-ended questions were developed post hoc and reported, they were also recorded.

CHAPTER V

ANALYZING PUBLIC CONCERN

In this chapter, I analyze the ways in which the various aspects of questions asked in the questionnaires are related to the percent of US residents that express concern over biotechnology. If couching biotech concern within the larger literature on environmental concern, it seems logical that reported concern will vary by the dimension(s) of biotech concern being tapped into by the question; previous research has found that concern expressed over environmental issues varies according to the different aspects of environmental concern being inquired about (see Dunlap and Jones 2002; Klineberg, McKeever, and Rothenbach 1998). The literature on environmental concern has also shown concern to vary over time (Dunlap and Jones 2002; Dunlap and Scarce 1991), which is a trend I expect to find in US concern expressed over biotechnology.

In the literature review I conducted on US biotech concern, several studies indicate that concern varies by dimension. For example, more concern has been shown to be expressed about red, rather than green, biotechnology (see Asian Development Bank 2001; Qaim 2009; Stone 2010). Labeling has been identified as an especially contentious issue (Shananan, Scheufele, and Lee 2001). Less concern has been shown to be expressed over questions using the term biotechnology instead of the terms genetic engineering or modification (Haban 2004). The literature review on US biotech concern discussed in greater detail in chapters two and three, as well as the greater literature on environmental concern, informed the following six hypotheses tested in this analysis:

Hypothesis 1: The percent of US concern reported has varied over time.

Hypothesis 2: The percent of US concern reported varies by the content-specific dimension of biotech concern measured in survey questions.

Hypothesis 3: The percent of US concern reported varies by the spatial dimension of biotech concern measured in survey questions.

Hypothesis 4: The percent of US concern reported varies by the temporal dimension of biotech concern measured in survey questions.

Hypothesis 5: The percent of US concern reported varies by the theoretical dimension of biotech concern measured in survey questions.

Hypothesis 6: The percent of US concern reported varies by the linguistic dimension of biotech concern measured in survey questions.

To test these hypotheses, only questions determined to be an indicator of concern were included in this analysis. Not all the questions included in the dataset could be taken as an indicator of concern. For example, Thomson Reuters and NPR (2010) asked, “On a scale of one to five, how well do you understand genetically engineered foods?” This question was not determined to not be an indicator of concern, nor was the following question, taken from a 2001 survey by the Pew Initiative on Food and Biotechnology: “How much would you say that you know about government regulation of genetically modified food?” Determining what indicated concern was largely subjective and I relied on a standard of face validity.

What constituted the percent of concern varied according to the type of response elicited by the questions. For Likert-type questions, any response greater than the midpoint was defined as concern. Concern for dichotomous questions was simple to discern because it typically entailed responses like “agree or disagree,” “yes or no,” and “should encourage or should not encourage.” Concern for trichotomous questions was also simple to discern because its format was similar to dichotomous questions, but typically included a “don’t know” or “unsure” response category, which were interpreted to mean that an overt indicator of concern was not expressed. Open-ended questions

were excluded from the analysis. Ranked questions were also excluded from the analysis because none were determined to be indicators of concern, and only one scaled question was determined to be an indicator of concern and was included.

Overall, the sample size was reduced from 569 cases to 269. Only 37.2 percent of the dichotomous, 58.8 percent of Likert or Likert-type, 47.1 percent of multiple choice, 93.3 percent of the trichotomous, and 7.1 percent of scaled questions were included. All knowledge questions were omitted because none were taken to indicate concern; almost all (81.5 percent) of the attitudinal questions were included, as well as about half (47.7 percent) of the questions about beliefs and 40.2 percent of behavioral questions. For example, the attitudinal question, “Do you feel biotechnology will provide benefits for you or your family in the next five years?” (IFIC 1999), was not taken as an indicator of concern; it is possible respondents could not be concerned about biotechnology but still not expect benefits. Table 5.1 provides the descriptive statistics for the various aspects of biotechnology, including only the questions determined to indicate concern.

It is important to note that some variables had to be combined to provide adequate statistical power. If the variables constituted less than 10 percent of the sample, they were combined in the catchall variable *other*. This included the environmental health, labeling, cloning, pesticide use, and human hunger variables. The *other* category included topics such as nanotechnology and sustainability. As for the spatial dimension, the national and global levels were collapsed to create a *national/global* variable. The past and present variables were combined to create a *present/past* variable, the conative and actual behavior variables were combined into one *behavioral* variable, and genetic

Table 5.1 Descriptive Statistics for Indicators of Concern, by Dimension

<i>Dependent Variable</i>	<i>Mean or Proportion</i>
Concern Expressed	34.35 (SD 22.46)
<i>Content-Specific Dimensions of Concern</i>	<i>Frequency</i>
Biotech Food	.29
Biotech Crops	.21
Animals and Crops	.12
Animal Aspect	.20
Medical Aspect	.12
Human Health	.35
Regulations	.19
Economics	.28
Other	.33
<i>Year Survey Conducted</i>	2003.41 (SD 4.08)
<i>Spatial Dimensions of Concern</i>	
Local Level	.25
National/Global Level	.12
Level Not Specified	.63
<i>Temporal Dimensions of Concern</i>	
Future	.23
Present/Past	.77
<i>Theoretical Dimensions of Concern</i>	
Belief	.42
Attitude	.25
Behavior	.30
<i>Linguistic Dimensions of Concern</i>	
Biotechnology	.48
Genetic	.33

n= 269

modification, genetic engineering, and genetic alteration were combined to create a generic *genetic* variable.

From table 5.1, it can be seen that on average, 34.35 percent of respondents reported concern across all questions, regardless of dimension. However the standard deviation is quite large (22.46), which indicates that when asked some questions, respondents expressed much concern and when other questions were asked, respondents expressed little concern. As for the content-specific dimension, human health issues were the most common aspect asked about (35.3 percent) among the survey questions deemed to indicate concern over biotechnology. This was followed by biotech food issues in general (29.4 percent), economic issues (27.5 percent), and issues involving use with animals (20.1 percent). Most questions (63.2 percent) did not specify a spatial dimension or were centered at the local level (24.91 percent), which indicates that most questionnaire designers were not interested in global biotech issues. About a quarter of the questions were centered on future issues (22.7 percent), with the majority of the questions (77.3 percent) centered on past or present issues. As for the theoretical dimension, most of the questions (42.0 percent) were aimed at respondents' beliefs, followed by behaviors (29.7 percent,) and attitudes (24.5 percent). Lastly, the terms biotechnology and genetic modification, engineering, or alteration show up in the questions pretty evenly. Biotechnology shows up in 48.3 percent of the questions, and genetic modification, engineering, and alteration shows up in 33.1 percent of the questions.

The Model

To test the six hypotheses, OLS regression models were developed. Each model

was tested to ensure that Gauss-Markov assumptions were met. One potential source of error in this analysis derives from the fact that each case of the dependent variable represents a point estimate, and each questionnaire's point estimates have a different amount of error due to differing sample sizes and sampling approaches. This variability introduces a potential violation of the Gauss-Markov assumption of identical variance. (In the case of the models presented in this chapter, this violation is confirmed by the results of a Cook-Weisberg test.) This difficulty is compounded by the fact that point estimates taken from subsamples (i.e. some cases of my dependent variable) can have even greater error than those taken from complete samples. The concern is that those respondents to the survey not included in the subsample represent missing data, and these missing data are a potential source of additional bias. Measures of concern taken from subsamples that are randomly drawn from the larger sample are not problematic, since those not in the subsamples are assumed to be missing completely at random (MCAR). They do not add additional error to the model. Measures of concern taken from subsamples in which respondents were asked questions or not depending on answers to previous questions creates conditions in which the missing data (those not asked the question) are missing not at random (MNAR). The MNAR condition adds error to the model.

There are three possible means of dealing with the non-identical error problem. One means to attempt to reduce error is to exclude cases from the model if data are taken from MNAR subsamples. This approach removes point estimates (i.e. cases of the dependent variable) with greater error. Unfortunately, removing these cases also increases error in the models I would ultimately produce since the stochastic component

of the overall model is increased by removing variability from the dependent variable (see Gordon 2012). Since it is impossible to determine if the amount of error being reduced by removing MNAR-afflicted cases is greater than the error introduced by delimiting the sample, and because delimiting the sample reduces statistical power, this approach was rejected. A second means to reduce error is to exclude cases taken from the MNAR subsamples if the total subsample does not meet a sample size threshold. This approach is predicated on the notion that larger subsamples should produce point estimates with less error. Although this is probably true for MCAR-affected cases, it is not necessarily true for MNAR-afflicted cases. Additionally, delimiting the sample increases the model's stochastic component, as mentioned previously. Given these problems with the second approach, I opted for a third approach which is to adjust the inflation of the error in the models arising from the inclusion of MNAR-afflicted cases by calculating sandwich estimators of the standard errors. Thus, the standard errors presented here represent Huber-White estimators, and the p-values are more conservative (reducing the chance of Type I errors). This approach is assumed to be superior to the other two approaches, since it also accounts for the violation of identical variance problem in the overall model and conserves statistical power.

Eight models were developed to test the six hypotheses. The first model tests the hypothesis one, the second hypothesis two, the third hypothesis three, the fourth hypothesis four, and the fifth hypothesis five. To test the sixth hypotheses, two models were developed; one model uses the term biotechnology and the other the genetic variable. Model eight is the full model. Table 5.2 presents the results for the eight models (*See note 1*).

Table 5.2 Effects of Dimensions on Concern Reported (robust standard errors in parentheses)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Year Survey Conducted	-.87 (.57)					
Biotech Food		12.31* (4.19)				
Biotech Crops		14.95* (6.44)				
Biotech Crops and Animals		14.33 (9.23)				
Animal Aspect		12.67* (5.23)				
Medical Aspect		.86 (4.02)				
Human Health		2.35 (2.35)				
Regulations		20.28*** (3.18)				
Economics		-4.49 (3.00)				
Other		4.93* (1.75)				
Local Level			-5.24* (2.35)			
National/Global Level			11.99* (4.51)			
Level Not Specified			---			
Future				.65 (3.83)		
Present/Past				---		
Belief					---	
Attitude					-10.22*** (2.40)	
Behavior					-7.34 (4.01)	
Biotechnology						-11.19* (4.31)
Genetic						
Constant	1786.10	17.69	34.23	34.20	39.04	39.76
R Squared	.03	.19	.05	.00	.04	.07
F	2.38	9.59***	6.80*	.03	9.91**	6.74*

	Model 7	Model 8
Year Survey Conducted		-1.56** (.45)
Biotech Food		16.64 (7.92)
Biotech Crops		17.45* (7.79)
Biotech Crops and Animals		8.69 (9.18)
Animal Aspect		25.43*** (5.16)
Medical Aspect		-3.77 (4.40)
Human Health		.28 (3.26)
Regulations		11.81 (8.38)
Economics		.98 (3.93)
Other		5.35 (2.89)
Local Level		-4.51 (5.80)
National/Global Level		3.05 (6.28)
Level Not Specified		---
Future		-.10 (6.61)
Present/Past		---
Belief		---
Attitude		-5.38 (3.57)
Behavior		-1.78 (8.24)
Biotechnology		-9.14 (8.81)
Genetic	12.16* (4.01)	2.53 (6.54)
Constant	30.33	3155.08
R Squared	.07	.31
F	9.21*	6.76***

* p<. 05; **p<. 01; ***p< .001 (n=269)

RESULTS

The bivariate relationship between percent concern expressed and time is examined in model one. Time is the year that the survey was administered, and I expected that US residents' concerns about biotechnology might increase or decrease with time. Either US residents might become more concerned with biotechnology as problems have become publicized and biotechnology has become more widespread, or US residents might become less concerned over time as biotechnology becomes more prevalent. The results of the t- and F- tests provide no support for Hypothesis 1. Biotech concern has not changed significantly over time, at least not in a discernible linear fashion.

In the second model, the relationship between concern expressed and the substantive dimension measured by the survey question were assessed. In this model, significantly more concern was expressed over questions about biotech food than questions not about biotech food ($b=12.3$, $p<.05$). The same is true for the relationships between concern and crops ($b=15.0$, $p<.05$; verses questions *not* about crops), concern and animals ($b=12.7$, $p<.05$; verses questions *not* about animals), and concern and regulation ($b=20.3$, $p<.001$; versus questions *not* about regulation). The coefficient of determination (R-squared) is .19, meaning 19 percent of the variance in concern expressed is explained by the substantive dimensions of the questions being posed. In other words, people express more or less concern about biotechnology depending on what element of biotechnology is being tapped by the question.

The third model assesses the relationship between concern expressed and the spatial dimension addressed in the survey questions. Significantly more concern was

expressed over questions not centered at the local level compared to when the level was not specified ($b = 12.0$, $p < .05$). Significantly less concern was expressed over questions centered at the local level compared to when the level was not specified ($b = -5.2$, $p < .05$). The coefficient of determination (R-squared) for this model is .05, which means that the spatial dimension explains five percent of the variance in concern expressed.

Model 4 examines the relationship between concern and the temporal dimension tapped by the survey questions, and Model 5 assesses the relationship between concern and the theoretical dimension (i.e. beliefs, attitudes or behaviors) captured by the research question. Significantly less concern is expressed over attitudinal questions ($b = -10.2$, $p < .001$) compared to questions asking for beliefs. No significant relationships were found in the temporal model.

The sixth model examines the relationship between concern expressed over questions using the term biotechnology and those using some term other than biotechnology to depict the technology. Interestingly, significantly less concern was expressed over questions using the term biotechnology than questions using a different terminology ($b = -11.2$, $p < .05$). That is, 11.95 percent less concern was expressed, on average, when questions used the word biotechnology instead of something else. The coefficient of determination (R-squared) for the model is .07. This finding is consistent with that of the 2010 Eurobarometer (European Commission 2010).

The relationship between concern expressed over questions using the terms genetic alteration, modification, or engineering and those using some other term was examined in Model 7. Significantly more concern was expressed ($b = 12.2$; $p < .05$), on average, when the question used one of these terms to depict the technology instead of

another term. The use of this terminology explains about seven percent of variance in concern expressed.

Model 8 reports the results of the full model, which includes all of the predictors in this study. The results of the final model support the first hypothesis, indicating that the percent of concern reported has significantly varied over time ($b=-1.6$, $p<.01$). That is, for each subsequent year of polling, the concern expressed has decreased by a 1.56 percent. Recall from model one that the results of the simple regression t-test indicate that time does not have a significant effect on concern expressed. According to MacKinnon and colleagues (2000), when a bivariate model becomes more significant when adding variables suppression is occurring. This indicates that omitted variables (i.e., the other variables in the full model) in the bivariate model are suppressing the effect of time on concern. Additionally, the magnitude of the coefficient for time increased, which also indicates that suppression is occurring (*See note 2: MacKinnon et al. 2000*).

The final model also indicates the concern expressed varies by the variables in the substantive dimension, when other factors are accounted for, which supports the second hypothesis. Use with animals was significant at the $p<.001$ level. Respondents expressed 25.4 percent more concern over questions about biotechnology use with animals than over questions not about animal use. Additionally, 17.5 percent more concern was reported for questions about crop use than questions not about crop use ($p<.05$). The remaining hypotheses were not supported when other dimensions were controlled; none of the variables in the spatial, temporal, theoretical, or linguistic dimensions varied significantly. Overall, as indicated by the coefficient of determination

(R-squared), the final model explained 31 percent of the variation in US public concern about biotechnology.

NOTES

¹ Previous research has indicated that attitudes, beliefs, and behaviors may vary in their predictive power (see Schahn and Holzer 1990; Schultz and Oskamp 1996; Wicker 1969). That is, attitudes, beliefs, and behaviors may not be equivalent indicators of concern. However, for models 5 and 8, the behavior variable is weighted the same as attitudes and beliefs.

² A possible alternative to a suppression effect is an interaction between time and another variable. To test this, I created and tested interaction terms of time and every other variable in the model (one at a time), but I found no significant interactions. This further confirms suppression due to omitted variable bias.

CHAPTER SIX CONCLUSION

In the debate over biotech development, US residents are framed as less concerned than EU members (see Bhargava 2002; Herdt 2006; Hoban 2004; Peacock 2010; Pechlaner and Otero 2008; Stone 2010). The European Union has systematically studied member concern since 1991 (European Commission 2010). There has been no comprehensive study on US public concern for biotechnology. Instead, US studies have tended to be ad hoc, a-theoretical, and non-accumulative (see Hoban 2004; Lusk et al. 2005). This has thwarted the development of a comprehensive literature and created a need to synthesize the fragmented studies. The goal of this work is to provide framework to organize extant work.

Because there is no standard conceptualization and measurement of and no clear consensus on US public concern for biotechnology (see Lusk et al. 2005), the literature had become difficult to summarize (Lusk et al. 2005). What are US residents concerned about when it comes to biotechnology, and how concerned are they? These questions guided the research in this project and informed the project's two aims: to identify the different dimension of biotech concern and examine if and how concern varies over time. To accomplish these aims, I conducted a literature review on the biotech debate, developed a framework to unite the fragmented studies, and applied the framework to 22 studies on US biotech concern.

The framework I developed for conceptualizing and measuring US public concern for biotechnology is modeled off the framework developed by Dunlap and Jones (2002) for conceptualizing and measuring environmental concern. The rationale for employing their framework is based off similarities in conceptual and measurement issues for

environmental and biotech concern: both have multiple sub-objects, lack a standardized definition and measurement, and resulted in a disorganized literature. Applying Dunlap and Jones' framework, there are two components to biotech concern: the biotech and concern component. To conceptualize and measure the concern component, I largely retained their use of attitude theory and the scale developed by Maloney and Ward (1973). To get at the biotech component, however, I could not as easily retain their conceptualization and measurement of the environment.

Although I adopted the temporal, spatial, and specificity dimensions, I had to identify the content-specific dimensions of biotechnology. To accomplish this, I conducted a content analysis of the questions asked in each study, identifying the object of interest; I also relied on the major divisions suggested in the literature. In the biotech debate, conflicting claims have largely been over food and medicinal uses, human, environment, and societal health effects, and regulation. Based off this, I developed 10 content-specific dimensions: biotechnology's use with *plants* and *animals* for *food production* or *medicinal purposes*, application to *cloning*, affect on *human, environmental, or social (i.e. primarily economic) health*, and as a solution to *world hunger* and a *petro-dependent* agricultural system.

WHAT DOES CONCERN THE US PUBLIC?

Much of the literature indicates that the US public is concerned about regulation (see Hoban 2004; Stilwell and Van Dyke 1999). The United States adheres to a product-risk approach that has been criticized for simple approval procedures (see McGiffen 2005; Vogel 2001), fostering corporate growth and market control (Moses 1999; Sheingate 2006), and equating risk assessment with scientific assessment (Jasanoff 2005).

The European Union adheres to the precautionary principle, which has been criticized as a form of protectionism (Sheingate 2006). Regulatory disputes peaked in 2003 when the United States, with Argentina and Canada, filed an official complaint with the WTO against the European Union. With so much international attention on regulation, it may not be surprising that the US public is concerned.

When it comes to regulation, the US public is especially concerned with labeling (Hoban 2004). The majority of the public has repeatedly reported support for mandatory labeling (ABC 2003; Peacock 2010; Pew Initiative on Food and Biotechnology 2004); however the United States has yet to adopt such a policy. Labeling has been called the most controversial regulatory issue in the United States (Hoban 2004), which may explain why nearly half (49 percent) of regulatory questions in this study were on labeling. Most relevant is Proposition 37, known as the *California Right to Know Genetically Engineered Food Act*. Proposition 37 represents the biggest step taken in the United States to mandate labeling (Huff 2012). Up for vote in November, if passed, all foods containing biotech ingredient sold at the retail level in California will have to be labeled. So far, Monsanto has donated \$4.2 million, DuPont \$1.2 million, and others (e.g. such as PepsiCo, Nestle, Coca-Cola, Bayer Cropscience, ConAgra, and Kellogg's Company) additional millions to defeat Proposition 37 (Huff 2012).

To understand the concern expressed over regulation and labeling, the various dimension of biotech concern, particularly human, environmental, and societal health effects from adopting biotech practices, need to be examined. In the literature on biotech concern, the *naturalness* of biotechnology is at the forefront (see Cummings 2008; Persley and Peacock 1993; Stone 2010). Some view biotechnology as a scientific

advancement over conventional breeding (Stone 2010), which constitutes progress and little concern. Others, however, view biotechnology as a technological advancement that warrants concern over its scientific basis (see Cummings 2008). Human health concerns range from biotech products causing developmental abnormalities (see Goldstein and Emami 2010; Hirschler and Kelland 2012) to biotech feedstock accidentally mixing with the human food supply (see Cummings 2008; Schneider and Schneider 2006). Key environmental concerns include biotechnology's contribution to widespread pesticide use (see Peacock 2010; Stilwell and Van Dyke 1999), the loss of biodiversity (see Shelton, Zhao and Roush 2002; Qaim 2009), increased rates of soil erosion (see Peacock 2010; Shiva 1991), and the evolution of super weeds (see Asian Development Bank 2001; Avise 2004). Social health effects are characterized by the question, "who benefits from the spread of biotechnology?" Many claim that the widespread adoption of biotechnology has resulted in a shift in power and wealth from the public to the private sector (see Asian Development Bank 2001; Cummings 2008; Food and Water Watch 2011). At the core of these concerns, however, is the naturalness of biotechnology (i.e. the conflation of biotech products with scientific advancements).

HOW CONCERNED IS THE PUBLIC?

The results from chapter five indicated that 34.4 percent of respondents in the questionnaires examined reported concern regardless of the dimension being tapped. It is important to note that the 34.4 percent of respondents that reported concern is an average, taken from a range. The standard deviation, however, was quite large (22.46), which means reported concern varied widely by the dimension(s) asked about in the question. With such a large standard deviation, it is useful to examine the actual levels of

concern elicited by the questions. Table 6 displays the range of concern reported for the content-specific dimension.

As can be seen from table 6, there is considerable variation in concern reported in each dimension. Although the results from the full regression model indicate that use with animals and crops are the only dimensions where reported concern is significantly different than concern reported for other dimensions, the literature review suggests that the US public's concern is much more varied. Since biotech products first became commercially available in 1995, a wide array of issues has been discussed in the biotech debate.

The results from the full regression model indicate that US public concern over biotechnology has decreased by about 1.6 percent per year. The rise in US residents self-reporting less awareness may contribute to declining concern. The likelihood to report strong concern may be mitigated by the recognition of one's own lack of knowledge. That is, studying concern about an issue most admittedly know little about, compared to an issue most are well informed about, may be more likely to find neutral results. It would be interesting to further examine the mechanisms contributing the decline in US public concern.

LIMITATIONS AND FUTURE RESEARCH

Although this study examines nearly 20 years of survey data, the bulk of data, including longitudinal data comes from the IFIC and the Pew Initiative on Food and Biotechnology (*See note 1*). Additionally, some years have few questions that were included in the analysis. For example, in 1993 only four questions were included. To

account for these limitations, the database should be expanded to include more data from a variety of sources and across time.

Table 6. Range of Concern Reported for Content-Specific Dimension

<i>Dimension</i>	<i>Question</i>	<i>Percent Concern</i>	<i>Source for Question</i>
Biotech Food	“Do you think the federal government should or should not require labels on the food saying whether it has been genetically modified or bioengineered?”	93	(International Food Information Council [IFIC] 2007)
	“Thinking about your diet over the last few months, are there any foods or ingredients that you have avoided?”	0	(IFIC 2007)
Biotech Crops	“Do you think the government should require the labeling of all packaged and other food products saying that they include corn, soy or other products which have come from genetically modified crops, or is that not important?”	86	(Taylor 2000)
	“What is your overall impression of using biotechnology to produce medicines from food crops such as corn and rice? “	6	(IFIC 2007)
Animals and Crops	“How likely do you think it is that animals, plants or bacteria which are produced by genetic engineering will pose a serious threat to human life or the environment?”	60	(Taylor 1993)
	“Now I’m going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants and animals. If you aren’t sure how you feel about a specific item, just say so and we’ll move on. To produce more affordable pharmaceutical drugs by using plants to produce pharmaceutical compounds.”	14	(Pew Initiative on Food and Biotechnology 2004)

Table 6. Range of Concern Reported for Content-Specific Dimension Continued

<i>Dimension</i>	<i>Question</i>	<i>Percent Concern</i>	<i>Source for Question</i>
Animal Aspect	“If the FDA approves this genetically engineered salmon it will be the first time any genetically engineered fish or animal has been approved and allowed into the American food supply. Research is already underway to put engineered pigs, chickens, and cattle into the food supply once salmon is approved, even though the FDA has conducted no safety tests of its own. What do you think? Should the FDA ALLOW these genetically engineered meats and fish into the market before the FDA performs its own studies, or should it NOT allow it until the FDA performs its own studies?”	91	(Lake Research Partners 2010)
	“Now Please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can improve the quality and safety of food.”	12	(IFIC 2007)
Medical Aspect	“Do you think the federal government should or should not require labels on food saying whether it’s from farm animals that have been fed antibiotics or hormones?”	85	(American Broadcasting Corporation [ABC] 2003)
	“Do you support or oppose the use of biotechnology to develop new medicine to treat human diseases?”	5	(Miller 1998)

Table 6. Range of Concern Reported for Content-Specific Dimension Continued

<i>Dimension</i>	<i>Question</i>	<i>Percent Concern</i>	<i>Source for Question</i>
Human Health	“I’m going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we’ll move on. Food freshness.”	85	(Pew Initiative on Food and Biotechnology 2001)
	“What if anything concerns you when it comes to food safety?”	2	(IFIC 2010)
Regulations	“Do you believe that foods should be labeled to indicate that they have been genetically engineered or contain ingredients that have been genetically engineered?”	93	(National Public Radio and Thomas Reuters 2010)
	“Can you think of any information that is not currently included on food labels that you would like to see on food labels?”	1	(IFIC 2007)
Economic	“I’m going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we’ll move on. Chemicals and fertilizers being used in the production of food.”	78	(Pew Initiative on Food and Biotechnology 2001)
	“What is your overall impression of using nanotechnology in food production or packaging for such purposes as extending freshness, decreasing the risk of foodborne illness, and improving nutrition?”	8	(IFIC 2010)

Additionally, it may be more accurate to use hierarchical analysis to replicate this study. The data could be viewed as clustered in questionnaires by year. Historic events have greatly impacted public concern, and by using OLS regression that those event-specific impacts may be lost.

Lastly, expanding this study to include an analysis comparing US and EU public concern is a logical direction for this work to proceed. The Eurobarometer measures concern using a number of similar variables (e.g. attitudes, beliefs, and knowledge) as the framework suggested here. It also provides the actual questionnaire and counts or percentages for the responses provided. The database could be expanded to include EU data rendering a comparable analysis quite feasible.

NOTES

¹ The IFIC is one of the oldest and few organizations to study the US biotech concern in a consistent manner over time; it has been criticized, however, for the bulk of its support coming from corporate funders (e.g. Aventis, Cargill, Inc., Coca-Cola Company, Dow AgroSciences, LLC. and DuPont; Branden 2002).

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APPENDICES

Appendix A. Timeline for International Development of Biotechnology

<i>Year</i>	<i>Event</i>	<i>Description</i>
1972	First experiment using rDNA	Conducted by Paul Berg at Stanford University
1973	Invention of first procedure to transfer genes from one organism to another	Invented by Stanley Cohen and Herbert Boyer, called the process “rDNA”
	First conference about using rDNA	Organized by the National Science Foundation’s Human Cell Biology Steering Committee and the National Cancer Institute to discuss carcinogenic risks
1974	Recombinant DNA Advisory Committee formed	Division of the National Institutes of Health formed to ensure the safety of experiments using rDNA
1975	Asilomar Conference held in California	Organized by Paul Berg to establish guidelines to ensure the safety of experiments with rDNA
1976	First biotechnology firm established	US-based Genentech
	First guidelines for using rDNA established	RAC issued a set of guidelines governing work using rDNA
1980	<i>Diamond v. Chakrabarty</i>	First US Supreme Court ruling that permitted the patenting of life, a biotech bacteria that digests petroleum
	First rDNA procedure patented	Awarded to Cohen and Boyer
1982	First biotech medicine became commercially available	Synthetic human insulin, engineered by Genentech, marketed by Eli Lilly
	First successful transgenic animal created	Richard Palmiter and Ralph Brinster implanted a rat growth hormone into a mouse
1983	RAC approved first biotech organism to be released in environment	Application from the University of California, Berkeley for the field-testing of Ice Minus approved
1984	The White House Cabinet Council on Natural Resources is established	Established by the Reagan Administration, determined the current regulatory framework is suitable to regulate biotechnology, currently known as the Domestic Policy Council Working Group on Biotechnology
1985	First biotech seed developed	A Bt tobacco plant, developed by the Belgian Plant Genetic Systems
1986	US Coordinated Framework for the Regulation of Biotechnology established	First federal policy statement specific to biotechnology, established all biotech varieties as GRAS and thus regulated by existing framework
	The Toxic Substances Control Act amended	Amended to include regulation over biotech organisms
1987	First biotech organism released into the environment	Ice Minus bacteria, developed at the University of California at Berkley, released
	The Plant Pest Act is passed	Granted the USDA the right to regulate biotech

		products that are considered pests
1988	First biotech animal patented	Known as the Oncomouse, patented by Harvard, used in cancer research
	First biotech crop commercially grown	Tobacco plant modified to resist the tobacco mosaic virus, adopted in China
1989	First biotech genes inserted into human	Steven A. Rosenberg inserted genes to treat cancer
1990	Human Genome Project launched	Spearheaded by the National Center for Human Genome Research, headed by James D. Watson
	EU's Directive 90/220/EEC took force	Established a process for the assessment and approval of biotech products
1992	FDA's Statement of Policy: Foods Derived from New Plant Varieties issued	FDA stated their interpretation of the FFDCA in relation to biotechnology in foods and feed
1994	Palmiter and Brinster awarded the Charles Leopold Mayer prize	Due to their 1982 creation
	First biotech food marketed to US consumers	Calgene's Flavor Savr tomato; unsuccessful yields led to discontinuation
	Germany passed Genetic Engineering Act	Protects farmers whose crops have become contaminated with biotech seed
1995	World Trade Organization's TRIPS goes into effect	Article 27.1 states that patents should be available for any invention or process in all fields of technology; Article 30 extends intellectual property rights to plants
1996	Roundup-Ready Soybeans launched	Monsanto's seeds that are bioengineered to withstand the company's Roundup herbicide
	Hamburg dockworkers protest	Refused to unload 200,000 tons of Monsanto's biotech soybeans that were approved for import by the European Commission
	Introduction of the first commercial biotech product in Europe	A tomato paste derived from Calgene's Flavr Savr tomato
1997	First organism, a sheep named Dolly, cloned	Ian Wilmut of the Roslin Institute in Scotland announces in <i>Nature</i> that he has cloned Dolly
	EU's Regulation No. 258/1997 entered into force	Requires labeling of novel food products containing biotech ingredients; simplified the approval procedure for biotech food products
	South Africa passed the Genetically Modified Organism Act	Regulates the planting of biotech crops
1998	Mexico banned the growth and sale of	Banned due to concern about gene flow

	biotech maize	
	<i>Alliance for Bio-Integrity, et al. vs. Shalala</i>	A coalition of interest and religious groups filed a lawsuit in the District of Columbia against the FDA to obtain mandatory safety testing and labeling; court ruled in the FDA's favor
1999	Creation of Golden Rice	Invented by Ingo Potrykus and Peter Beyer to help children in developing countries alleviate malnutrition
	First biotech animal marketed as a pet	A fluorescent zebrafish that contains a jellyfish gene for phosphorescence, known as GloFish, originally developed to glow in the presence of pollution
	Commencement of EU's six-year moratorium on biotechnology	Resulted in EU not permitting the sale or use of biotech products or processes
	First large US company refused to sell biotech food products	Pledge made by Hain Food Group
	Monsanto merged with Pharmacia	Created a agrochemical and biotech subsidiary
2000	StarLink Incident	Bt corn manufactured by Aventis Crop Science, only approved for livestock feed, found in US taco shells
	US Plant Protection Act	Consolidated ten USDA policies into one
2001	President's Council on Bioethics established	Addresses ethical issues raised by biomedical science and technology; established under George W. Bush
	Germany establishes Bio-Seigel	A seal of approval to certify organic products
	The Human Proteome Organization is founded	Founded to build upon the findings of the Human Genome Project with a focus on customized medical treatment
	Chapela and Quist discover biotech corn growing in Oaxaca, Mexico	Published study in <i>Nature</i> , states that biotech corn has contaminated native varieties despite national ban
	EU's Directive 2001/18/EC took force	Instituted the safeguard clause, allowing member-states to impose national bans
	FDA's Premarket Notification Proposal	Requires developers to submit scientific and regulatory assessment of biotech product 120 days prior to marketing
2002	Japan's Biotechnology Strategy Council adopted Biotechnology Strategy Guidelines	Developed and adopted a guide to economic development
	Africa rejects World Food Program (WFP) aid	Rejected because it was contaminated with biotech corn; WFP responded that it was impossible to discern biotech from non-biotech corn and that it did not matter anyway because biotech corn is safe for consumption
2003	United States, along with Argentina	Stated that the EU anti-biotech food policies violate

	and Canada, filed complaint with WTO	international trade agreements
	Cartagena Protocol on Biosafety entered into force	International agreement aimed at protecting native varieties from being contaminated with biotech varieties; promotes precautionary principle; allows individual countries to ban use or sale of biotech processes or products
	EU's Regulation No. 1829/2003 entered into force	Established a regulatory system for developers; ran by European Food Safety Authority
	EU's Regulation No. 1830/2003 entered into force	Requires labeling of all food and feed containing over .9 percent of biotech ingredients; mandates businesses to track all biotech products through the commercial food chain
	Monsanto successfully sues Oakhurst Dairy in Maine	Dispute over Oakhurst Dairy labeling its milk as having come from cows not treated with rBGH
2004	<i>Monsanto Canada, Inc. v. Schmeiser</i>	Supreme Court of Canada ruled that farmer Percy Schmeiser has violated Monsanto's patent on canola seed by inadvertently planting and storing Roundup Ready canola on his fields
	Monsanto had filed over 90 lawsuits	All against farmers for patent violations
2005	Half of world seed sales owned by six agricultural corporations	This included: Bayer, Advanta, Limagrain, Syngenta, Monsanto, and DuPont
	Inspector General cites USDA's Animals and Plants Health Inspection Services	Cited for failure to adequately regulate biotechnology
2006	Rice shipments to Europe contaminated with biotech rice	Biotech rice was not approved to be commercially sold in United States
2007	Complete human genome published	Published by Celera Genomics
2008	Svalbard Global Seed Vault in the Arctic Circle opened	Housed in Norway, is the largest seed repository in the world
	India's Prime Minister Manmohan Singh called for a second Green Revolution	Called on biotechnology to increase crop yields and eliminate hunger
2010	One billion hectares of biotech crops grown worldwide	Biotech crops planted by 15.4 million farmers in 29 countries

Appendix B. Description of and Notes on Data Sources

<i>Source</i>	<i>Description of Source</i>	<i>Notes</i>
American Broadcasting Corporation	Telephone poll conducted in 2003 on confidence in US regulation of biotech foodstuff	Supplemented findings with data from a 1997 Wirthlin Group study that was omitted from analysis, n was undefined in their own 1997 study that was also reported
Gallup Poll	Telephone survey conducted in 2001 on US attitudes and reactions towards the use of biotechnology in food production	Also included data from same questions asked in a separate 1999, 2000, and 2001 survey for all of which n was undefined
Gallup Poll	Telephone survey conducted in 2005 centered on biotech support in Britain, Canada, and the United States	Only US data were included
Harris Poll No. 33	Telephone poll conducted in 2000 about the labeling, risks, and knowledge of biotechnology	Reported and recorded a combined percentage for “don’t know” and “refused”
Harris Poll No. 35	Telephone poll conducted in 1993 centered on the attitudes and risks associated with biotechnology and the movie Jurassic Park	Omitted question two because it only pertained to the movie
International Food Information Council	Web-based survey conducted in 2001, 2006-08, and 2010 that focused on many of the dimensions of biotech concern	2006: Switched from telephone-based survey to web-based; reported and recorded a combined percentage for “don’t know” and “refused” 2008: Reported data for 8a, but not 8b 2010: Nanotechnology first included under “other”
Harris Interactive and the Chicago Council on Foreign Relations	Combination of telephone and in-person survey focusing on foreign-policy issues in 2002	Only included two questions from data collected on the general public and one from that collected from official leaders
International Social Survey Program	International survey on major environmental problems conducted in 2000	Only included one question
Inter-University Consortium for Political and Social Research (ICPSR) No. 3030	Telephone-based survey conducted in 1996-1997 aimed at capturing consumer trends in biotechnology	Last year of the two year study was recorded as year conducted; first 48 questions were omitted because they were unrelated to biotechnology
ICPSR No. 2874	Web-based poll conducted in 1999 that focused on anticipation of life in 21 st century	Only included on question
ICPSR No. 6952	Written survey administered in	Only included one question from US data

	the United States and Japan in 1993 that was centered on attitudes and risk perception	
Lake Research Partners	Report issued in 2010 on attitudes towards genetically modified foods	---
National Public Radio (NPR)	Telephone survey conducted in 1999 on knowledge about, attitudes towards, and access to technology	Only included two questions; only included responses from adults 18 or older
Pew Initiative on Food and Biotechnology	Telephone surveys conducted in 2001, 2003, and 2004 about public opinion on biotechnology	---
Thomas Reuters and NPR	Telephone survey conducted in 2010 on consumer attitudes towards genetically modified food	For question four, had to interpret responses based on measurements in previous scales

Appendix C. Description of Codes

<i>Code</i>	<i>Description</i>
Biotech Food	Addresses need to specify within the data between biotech food, crops, and animals; concerned with biotech food that was not specified as pertaining to crops or animals
Biotech Crops	Refers to plants grown to produce food for human consumption or feedstock; is one of three major divisions in biotechnology
Animal Use	Concerned about issues specific to animal biotechnology; is one of three major divisions in biotechnology
Biotech Crops and Animals	Indicates if both biotech crops and animals are both expressed in the question
Medical Use	Concerned with issues specific to medical biotechnology; is one of three major divisions in biotechnology
Human Health	Concerned with human health issues other than those specific to medical use, many of which are concerned with only the general application of biotechnology
Environmental Health	Concerned with disrupting the atmosphere, biosphere, hydrosphere, or lithosphere and associated consequences
Regulations	Centered on biotech regulation at all spatial levels; includes labeling
Labeling	Differentiated from regulations because of prominence in biotech literature and studies
Economics	Concerned with private and public market sector; includes consumer preferences
Cloning	Concerned with issues specific to animal or human cloning; one of top reported concerns in biotechnology
Pesticide Use	Concerned with pesticide use; petrochemical use has been increasing since 1970s, and biotech products are often touted as reducing the need for pesticides
Human Hunger	Concerned with alleviating human hunger; has been used as a justification for the international proliferation of biotech practices and products
Other	Concerned with issues other than those mentioned above; the “catch-all” category

Appendix D. Questions Included by Source and Percent Concern Expressed

<i>Source</i>	<i>Question</i>	<i>Percent Concern*</i>
(American Broadcasting Station 2003)	How confident are you that the food we eat in the United States is safe...very confident, somewhat confident, not very confident or not at all confident?	12
	How confident are you that the food we eat in the United States is safe...very confident, somewhat confident, not very confident or not at all confident?	16
	Scientists can change the genes in some food crops and farm animals to make them grow faster or bigger and be more resistant to bugs, weeds and disease. Do you think this genetically modified food, also known as bioengineered food, is or is not safe to eat?	46
	Do you think the federal government should or should not require labels on food saying whether it has been genetically modified or bioengineered?	92
	If you saw a label on food at your market saying it had been genetically modified or bioengineered, would you be more likely to buy it, less likely to buy it, or would it make no difference in your buying decision?	55
	If you saw a label on food at your market saying it had not been genetically modified or bioengineered, would you be more likely to buy it, less likely to buy it, or would it make no difference in your buying decision?	51
	Currently do you try to avoid buying genetically modified or bioengineered foods, or is that not important to you?	34
	Some livestock and poultry are fed antibiotics and hormones to make them disease resistant and faster growing. Do you think food from farm animals that are fed antibiotics and hormones is or is not safe to eat?	42
	Do you think the federal government should or should not require labels on food saying whether it's from farm animals that have been fed antibiotics or hormones?	85
	If you saw a label on food at your market saying it's from farm animals that have been fed antibiotics or hormones, would you be more likely to buy it, less likely to buy it, or would it make no difference in your buying decision?	47
	If you saw a label on food at your market saying it's from farm animals that have not been fed antibiotics or hormones, would you be more likely to buy it, less likely to buy it, or would it make no difference in your buying decision?	46
	Do you try to avoid buying foods from farm animals that have been fed antibiotics or hormones?	32
	Scientists can change the genes in some food crops and farm animals	52

	to make them grow faster or bigger and be more resistant to bugs, weeds and disease. Do you think this genetically modified food, also known as bioengineered food, is or is not safe to eat?	
	Do you think the federal government should or should not require labels on food saying whether it has been genetically modified or bioengineered?	93
	If you saw a label on food at your market saying it had been genetically modified or bioengineered, would you be more likely to buy it, less likely to buy it, or would it make no difference in your buying decision?	57
(Central Broadcasting Station1999)	Genetic engineering can also be used to alter the make-up of plants, fruits and vegetables. Do you think it's right or wrong to use scientific techniques to do things like enhance the flavor and nutrients, or prolong the freshness of food?	29
(Gallup Poll 2001)	Do you feel confident or not confident that the food available at most grocery stores is safe to eat?	10
	Do you feel confident or not confident that the food available at most grocery stores is safe to eat?	18
	Do you feel confident or not confident that the food available at most grocery stores is safe to eat?	18
	Do you feel confident or not confident that the food available at most grocery stores is safe to eat?	19
	Do you feel confident or not confident that the food served at most restaurants is safe to eat?	21
	Do you feel confident or not confident that the food served at most restaurants is safe to eat?	29
	Do you feel confident or not confident that the food served at most restaurants is safe to eat?	30
	How much confidence do you have in the federal government to ensure the safety of the food supply in the U.S., would you say you have -- a great deal, a fair amount, not much, or none at all?	17
	How much confidence do you have in the federal government to ensure the safety of the food supply in the U.S., would you say you have -- a great deal, a fair amount, not much, or none at all?	20
	How much confidence do you have in the federal government to ensure the safety of the food supply in the U.S., would you say you have -- a great deal, a fair amount, not much, or none at all?	24
	As you may know, some food products and medicines are being developed using new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering and genetic modification of food. How much have you heard or read about this issue -- a great deal, some, not much or nothing at all?	

As you may know, some food products and medicines are being developed using new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering and genetic modification of food. How much have you heard or read about this issue -- a great deal, some, not much or nothing at all?

As you may know, some food products and medicines are being developed using new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering and genetic modification of food. How much have you heard or read about this issue -- a great deal, some, not much or nothing at all?

As you may know, some food products and medicines are being developed using new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering and genetic modification of food. How closely have you been following the news about this issue --very closely, somewhat closely, not too closely, or not at all?

Overall, would you say you strongly support, moderately support, moderately oppose or strongly oppose the use of biotechnology in agriculture and food production? 38

Overall, would you say you strongly support, moderately support, moderately oppose or strongly oppose the use of biotechnology in agriculture and food production? 41

Overall, would you say you strongly support, moderately support, moderately oppose or strongly oppose the use of biotechnology in agriculture and food production? 41

From what you know or have heard, do you believe that foods that have been produced using biotechnology pose a serious health hazard to consumers, or not? 30

From what you know or have heard, do you believe that foods that have been produced using biotechnology pose a serious health hazard to consumers, or not? 30

From what you know or have heard, do you believe that foods that have been produced using biotechnology pose a serious health hazard to consumers, or not? 27

(Gallup Poll 2005)

As you may know, some food products and medicines are being developed using new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering and genetic modification of food. How closely have you been following the news about this issue--very closely, somewhat closely, not too closely, or not at all?

Overall, would you say you strongly support, moderately support, moderately oppose or strongly oppose the use of biotechnology in agriculture food production? 45

From what you know or have heard, do you believe that foods that 33

	have been produced using biotechnology pose a serious health hazard to consumers, or not?	
Harris Interactive and the Chicago Council on Foreign Relations 2002)	Overall would you say you strongly support, moderately support, moderately oppose, or strongly oppose the use of biotechnology in agricultural production?	45
	Do you think that the European Union (EU) and Japan should be able to require labeling of genetically modified food, even if this might keep consumers from purchasing food imported from the U.S., or don't you think the European Union and Japan should be able to do this?	
	Do you think that the European Union (EU) and Japan should be able to require labeling of genetically modified food, even if this might keep consumers from purchasing food imported from the U.S., or don't you think the European Union and Japan should be able to do this?	
(International Food Information Council [IFIC] 2010)	Thinking about your diet over the past few months, are there any foods or ingredients that you have avoided or eaten less of? [Biotech food]	0
	[If yes] What food or ingredients have you avoided?	
	Can you think of any information that is not currently included on food labels that you would like to see on food labels?	3
	If yes, what types of information would that be?	
	How confident are you about the safety of the US food supply? Would you say...?	12
	What if anything concerns you when it comes to food safety? [Biotech food]	
	As you may know, some food products and medicines are being developed with the help of scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology? Would you say you have read or heard...?	
	What is your overall impression of using biotechnology with plants that produce food products? Would you say you are...?	19
	As far as you know, are there any foods produced through biotechnology in the supermarket now?	
	[If yes] Which foods would those be?	
	Do you feel that biotechnology will provide benefits for you or your family within the next five years?	
	[If yes] What benefits do you expect?	
	All other things being equal, how likely would you be to buy a variety of produce, like tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher?	33

All other things being equal, how likely would you be to buy a variety of produce, like tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and required fewer pesticide applications?	24
All other things being equal, how likely would you be to buy a food product made with oils that had been modified by biotechnology to avoid trans fats?	26
All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to provide more healthful fats, like Omega-3, in the food?	23
What is your overall impression of using biotechnology with wheat and grains to produce food products such as bread, crackers, cookies, cereals and pasta?	27
All other things being equal, how likely would you be to buy bread, crackers, cookies, cereals or pasta made with flour from wheat that had been modified by biotechnology to use less land, water, and/or pesticides?	26
What is your overall impression of farmers using biotechnology to grow more crops that would help meet food demand? Would you say you are...?	16
The U.S. Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use substantially changes the foods nutritional content, like vitamins or fat, or its composition; or when a potential safety issue is identified. Otherwise, special labeling is not required. Would you say that you strongly support, somewhat support, neither support nor oppose, somewhat oppose or strongly oppose this FDA policy?	
How much have you read or heard about applying the science of biotechnology to animals? Would you say you have heard...?	
What is your overall impression of using biotechnology with animals that produce food products such as meat, milk, and eggs? Would you say you are...?	27
[If not favorable] Why are you not favorable toward using biotechnology with animals that produce food products? Check all that apply.	
Genomics is a form of animal biotechnology that uses knowledge about the genetic makeup of farm animals to aid in producing better offspring for improved meat, milk, and egg quality. What is your overall impression of animal genomics?	22
Genetic engineering is a form of animal biotechnology that allows for the transfer of beneficial traits from one animal to another in a precise way that allows for improved nutritional content or less environmental impact. What is your overall impression of genetic engineering in animals?	29

Now, please read the following statements regarding the potential benefits of animal biotechnology and indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all: animal biotechnology can increase farm efficiency; that is, it can increase the amount of food produced while decreasing the amount of resources needed, such as animal feed. 21

Please read the following statements regarding the potential benefits of animal biotechnology and indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all: animal biotechnology can improve the quality and safety of our food (for example, through improved animal health or improved nutritional quality of the food produced). 14

Please read the following statements regarding the potential benefits of animal biotechnology and indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all: animal biotechnology can reduce the impact of livestock, such as animal waste, on the environment. 18

Since the U.S. Food and Drug Administration (FDA) has determined that meat, milk, and eggs from animals enhanced through genetic engineering are safe, how likely are you to buy them? 31

How much have you read or heard about applying the science of nanotechnology in food applications? Would you say you have read or heard...?

What is your overall impression of using nanotechnology in food production or packaging for such purposes as extending freshness, decreasing the risk of foodborne illness, and improving nutrition? Would you say you are...? 8

How much have you read or heard about the concept of sustainability in food production?

Please rank the following aspects of sustainability in order of importance to you. Ensuring a sufficient food supply for the growing global population.

Please rank the following aspects of sustainability in order of importance to you. Land and water use and efficiency.

Please rank the following aspects of sustainability in order of importance to you. Maximum output with minimal use of natural resources.

Please rank the following aspects of sustainability in order of importance to you. Less waste.

Please rank the following aspects of sustainability in order of importance to you. Recyclable packaging.

Please rank the following aspects of sustainability in order of importance to you. Lower carbon footprint.

Please rank the following aspects of sustainability in order of importance to you. Fewer food miles.

Please rank the following five factors related to growing sustainable crops in order of importance to you. Growing more food on less land so valuable land like rain forests is NOT destroyed/used as growing space for increased food production.

Please rank the following five factors related to growing sustainable crops in order of importance to you. Reducing the amount of pesticides needed to produce food.

Please rank the following five factors related to growing sustainable crops in order of importance to you. Growing more food to help feed the growing global population.

Please rank the following five factors related to growing sustainable crops in order of importance to you. Plants that use water more efficiently, thereby conserving fresh water to help cope with predicted droughts and water shortages.

Please rank the following five factors related to growing sustainable crops in order of importance to you. Using conservation tillage farming methods, which reduce soil loss and green house gas emissions.

(IFIC 2008)	How likely would you be to purchase bread, crackers, cookies, cereal, or pasta products containing wheat that was grown using plant biotechnology, if they were produced using sustainable practices to feed more people using less resources (such as land and pesticides)?	19
	Thinking about your diet over the last few months, are there any foods or ingredients that you have avoided or eaten less of? [Biotech food]	0
	[If yes] What foods or ingredients have you avoided?	
	Can you think of any information that is not currently included on food labels that you would like to see on food labels? [Biotech food]	1
	[If yes] What?	
	How confident are you about the safety of the US food supply? Would you say?	13
	What, if anything, are you concerned about when it comes to food safety? [Biotech food]	
	As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called "biotechnology" and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology? Would you say you have read or heard...?	
	What is your overall impression of using biotechnology with plants	16

that produce food products? Would you say?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

[If yes] Which foods would those be?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

[If yes] What benefits do you expect?

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? 34

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? 22

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to reduce the saturated fat content in the food? 25

All things being equal, how likely would you be to buy a food product made with oils that had been modified by biotechnology to avoid trans fats? 25

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to provide more healthful fats, like Omega-3, in the food? 22

The U.S. Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you strongly support, somewhat support, neither support nor oppose, somewhat oppose or strongly oppose this policy of FDA?

During the past few months, have you taken any action or done anything because of any concerns you may have about foods produced using biotechnology? 7

And, how much have you read or heard about using biotechnology to produce medicines from special varieties of food crops such as corn and rice. Would you say you have heard?

What is your overall impression of using biotechnology to produce medicines from food crops such as corn and rice? Would you say...? 9

Now I would like to talk to you about animal biotechnology. First of all, how much have you read or heard about applying the science of biotechnology to animals? Would you say you have heard?

What is your overall impression of using biotechnology with animals that produce food products such as meat, milk, and eggs? Would you say...?	23
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can increase farm efficiency by increasing the amount of food produced or decreasing the amount of feed needed by the animals.	19
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can improve the quality and safety of food (for example, through improved animal health or improved nutritional quality of the food produced).	15
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can reduce the environmental impact of animal waste.	16
Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. Genomics is a form of animal biotechnology that uses knowledge about the genetic makeup of animals to aid in conventional breeding and selection. Would you say that your overall impression of animal genomics is...	17
Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. Genetic engineering is a form of animal biotechnology that allows us to move beneficial traits from one animal to another in a precise way. Would you say your overall impression of genetic engineering in animals is...	28
If the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from animals enhanced through genetic engineering were safe, how likely would you be to buy them? Would you say?	35
Cloning is a form of animal breeding that retains desirable traits by producing an animal that is an identical twin. Would you say your overall impression of animal cloning is?	45
In some cases, animals that have been produced through cloning are only used for breeding. Would you say your impression of this form of animal biotechnology is?	40
Since the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from cloned animals were safe, how likely would	52

you be to buy them? Would you say...?

Since the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from the offspring of cloned animals were safe, how likely would you be to buy them? Would you say? 51

How much have you read or heard about the concept of sustainable food production?

How important is it to you that the food products you purchased come from a food producer that is enrolled in a scientifically validated sustainability program? By sustainability, we mean to operate in a manner, which does not jeopardize the availability of resources for future generations.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Producing plants that require less fresh water for growth, thereby conserving the world's fresh water supply.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Increasing the production of food staples in the world, thereby reducing world hunger.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Reducing the amount of pesticides needed to produce foods.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Creating high-yield crops so valuable land like rain forests is NOT needed as growing space for increased food production.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Using no till farming methods, thereby reducing green house gas emissions.

(IFIC 2007) Thinking about your diet over the last few months, are there any foods or ingredients that you have avoided or eaten less of? [Biotech food] 0

[If yes] what foods or ingredients have you avoided?

Can you think of any information that is not currently included on food labels that you would like to see on food labels? [Biotech food] 1

[If yes] What types of information would that be?

How confident are you about the safety of the US food supply? Would you say...? 11

What, if anything, are you concerned about when it comes to food safety? [Biotech]

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area

is called "biotechnology" and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard...?

What is your overall impression of using biotechnology with plants that produce food products? Would you say? 18

As far as you know, are there any foods produced through biotechnology in the supermarket now?

[If yes] Which foods would those be?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

[If yes] What benefits do you expect?

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? 33

All things being equal, how likely would you be to buy a variety of produce, like tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and required fewer pesticide applications? 19

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to reduce the saturated fat content in the food? 20

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to provide more healthful fats, like Omega-3, in the food? 18

The U.S. Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you strongly support, somewhat support, neither support nor oppose, somewhat oppose or strongly oppose this policy of FDA?

During the past few months, have you taken any action or done anything because of any concerns you may have about foods produced using biotechnology? 5

[If yes] What actions have you taken?

And, how much have you read or heard about using biotechnology to produce medicines from special varieties of food crops such as corn and rice? Would you say you have heard...?

What is your overall impression of using biotechnology to produce medicines from food crops such as corn and rice? Would you say...? 6

Now I would like to talk to you about animal biotechnology. First of

all, how much have you read or heard about applying the science of biotechnology to animals? Would you say you have heard...?

[If you] What did you read or hear about animal biotechnology?

What is your overall impression of using biotechnology with animals that produce food products such as meat, milk, and eggs? Would you say...? 23

Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can increase farm efficiency by increasing the amount of food produced or decreasing the amount of feed needed by the animals. 20

Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can improve the quality and safety of food (for example, through improved animal or improved animal health or improved nutritional quality of the food produced). 12

Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can reduce the environmental impact of animal waste. 14

Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. First.... Genomics is a form of animal biotechnology that uses knowledge about the genetic makeup of animals to aid in conventional breeding and selection. Would you say your overall impression of animals genomics is...? 22

Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. First... Genetic engineering is a form of animal biotechnology that allows us to move beneficial traits from one animal to another in a precise way. Would you say your overall impression of genetic engineering in animals is...? 30

Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. First... Cloning is a form of animal biotechnology that retains desirable traits by producing an animal that is an identical twin. Would you say your overall impression of animal cloning is...? 50

Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, 42

please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. First... In some cases, animals that have been produced through cloning are only used for breeding. Would you say your impression of this form of animal biotechnology is...?

If the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from animals enhanced through genetic engineering were safe, how likely would you be to buy them? Would you say...? 39

And if the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from cloned animals were safe, how likely would you be to buy them? Would you say...? 53

And if the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from the offspring of cloned animals were safe, how likely would you be to buy them? Would you say...? 51
How much have you read or heard about the concept of sustainable food production?

How important is it to you that the food products you purchase come from a food producer that is enrolled in a scientifically validated sustainability program? By sustainability, we mean to operate in a manner, which does not jeopardize the availability of resources for future generations.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Producing plants that require less fresh water for growth, thereby conserving the world's fresh water supply.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Increasing the production of food staples in the world, thereby reducing world hunger.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Reducing the amount of pesticides needed to produce food.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Creating high-yield crops so valuable land like rain forests is NOT needed as growing space for increased food production.

Please rank the following five factors related to growing crops in a sustainable way in order of importance to you. Using no-till farming methods, thereby reducing green house gas emissions.

(IFIC 2006)

Thinking about your diet over the last few months, are there any foods or ingredients that you have avoided or eaten less of? [Biotech food] 0

[If yes] What foods or ingredients have you avoided?
Can you think of any information that is not currently included on food labels that you would like to see on food labels? [Biotech food] 1

[If yes] What?

How confident are you about the safety of the US food supply? Would you say? 9

What, if anything, are you concerned about when it comes to food safety? [Biotech food]

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called " biotechnology " and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology? Would you say you have read or heard...?

What is your overall impression of using biotechnology with plants that produce food products? Would you say? 17

As far as you know, are there any foods produced through biotechnology in the supermarket now?

[If yes] Which foods would those be?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

[If yes] What benefits do you expect?

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? 37

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? 26

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to reduce the saturated fat content in the food? 24

All things being equal, how likely would you be to buy a food product, made with oils that had been modified by biotechnology to provide more healthful fats, like Omega-3, in the food? 22

The U.S. Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you strongly support, somewhat support, neither support nor oppose, somewhat oppose or strongly oppose this policy of FDA?

[Of those that support or oppose] Why do you feel that way?

During the past few months, have you taken any action or done anything because of any concerns you may have about foods produced using biotechnology?	2
[If yes] What actions have you taken?	
And, how much have you read or heard about using biotechnology to produce medicines from special varieties of food crops such as corn and rice. Would you say you have heard?	
What is your overall impression of using biotechnology to produce medicines from food crops such as corn and rice? Would you say...?	6
Now I would like to talk to you about animal biotechnology. First of all, how much have you read or heard about applying the science of biotechnology to animals? Would you say you have heard?	
[If yes] What did you read or hear about animal biotechnology?	
What is your overall impression of using biotechnology with animals that produce food products such as meat, milk, and eggs? Would you say...?	24
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can increase farm efficiency by increasing the amount of food produced or decreasing the amount of feed needed by the animals.	21
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can improve the quality and safety of food (for example, through improved animal health or improved nutritional quality of the food produced.	15
Now, please read the following statements regarding the potential benefits of animal biotechnology. As you read each one, please indicate whether the information has a positive effect on your impression, a negative effect, or no effect at all. Animal biotechnology can reduce the environmental impact of animal waste.	13
Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. Genomics is a form of animal biotechnology that uses knowledge about the genetic makeup of animals to aid in conventional breeding and selection. Would you say that your overall impression of animal genomics is... ?	24
Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. Genetic engineering is a form of animal biotechnology that allows us to move beneficial traits	33

	from one animal to another in a precise way. Would you say your overall impression of genetic engineering in animals is...?	
	Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. Cloning is a form of animal biotechnology that retains desirable traits by producing an animal that is an identical twin. Would you say your overall impression of animal cloning is...?	57
	Animal biotechnology is a broad science, which is actually comprised of a few major areas. As you read the brief description of each area, please select the answer that corresponds with your overall impression of that specific aspect of animal biotechnology. In some cases, animals that have been produced through cloning are only used for breeding. Would you say your impression of this form of animal biotechnology is...?	46
	If the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from animals enhanced through genetic engineering were safe, how likely would you be to buy them? Would you say?	42
	And if the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from cloned animals were safe, how likely would you be to buy them? Would you say...?	59
	And if the U.S. Food and Drug Administration (FDA) determined that meat, milk, and eggs from the offspring of cloned animals were safe, how likely would you be to buy them? Would you say?	59
(IFIC 2001)	Thinking about your diet over the past few months, are there any foods or ingredients that you have avoided or eaten less of?	
	Thinking about your diet over the past few months, are there any foods or ingredients that you have avoided or eaten less of?	
	[If yes] What foods or ingredients did you avoid or eat less of? [Biotech food]	6
	[If yes] What foods or ingredients did you avoid or eat less of? [Biotech food]	6
	Can you think of any information that is not currently included on food labels that you would like to see on food labels?	
	If yes, what? [Genetically altered food]	2
	Can you think of any information that is not currently included on food labels that you would like to see on food labels?	
	If yes, what? [Genetically altered food]	1
	What, if anything are you concerned about when it comes to food safety? [Genetically altered/engineered food]	2
	What, if anything are you concerned about when it comes to food	2

safety? [Genetically altered/engineered food]

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called biotechnology and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology?

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called biotechnology and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology?

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called biotechnology and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology?

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As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called biotechnology and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology?

As you may know, some food products and medicines are being developed with the help of new scientific techniques. The general area is called biotechnology and includes tools such as genetic engineering. Biotechnology is also being used to improve crop plants. How much have you heard or read about biotechnology?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

If yes, which foods?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

If yes, which foods?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

If yes, which foods?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

If yes, which foods?

As far as you know, are there any foods produced through biotechnology in the supermarket now?

If yes, which foods?

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 43

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 37

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 43

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 43

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 38

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to taste better or fresher? Would you be very likely, somewhat likely, not too likely, or not at all likely to buy these items? 42

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely? 23

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely? 21

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer 27

pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely?

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely? 28

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely? 27

All things being equal, how likely would you be to buy a variety of produce, like a tomatoes or potatoes, if it had been modified by biotechnology to be protected from insect damage and require fewer pesticide applications? Would you be very likely, somewhat likely, not too likely, or not at all likely? 30

Biotechnology has also been used to enhance plants that yield food like cooking oils. If cooking oil with reduced saturated fat made from these new plants was available, what effect would the use of biotechnology have on your decision to buy this cooking oil. Would this have a positive effect, a negative effect, or no effect on your purchase decision? 10

Biotechnology has also been used to enhance plants that yield food like cooking oils. If cooking oil with reduced saturated fat made from these new plants was available, what effect would the use of biotechnology have on your decision to buy this cooking oil. Would this have a positive effect, a negative effect, or no effect on your purchase decision? 15

Biotechnology has also been used to enhance plants that yield food like cooking oils. If cooking oil with reduced saturated fat made from these new plants was available, what effect would the use of biotechnology have on your decision to buy this cooking oil. Would this have a positive effect, a negative effect, or no effect on your purchase decision? 18

Biotechnology has also been used to enhance plants that yield food like cooking oils. If cooking oil with reduced saturated fat made from these new plants was available, what effect would the use of biotechnology have on your decision to buy this cooking oil. Would this have a positive effect, a negative effect, or no effect on your purchase decision? 17

Biotechnology has also been used to enhance plants that yield food like cooking oils. If cooking oil with reduced saturated fat made from these new plants was available, what effect would the use of biotechnology have on your decision to buy this cooking oil. Would this have a positive effect, a negative effect, or no effect on your purchase decision? 14

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

Do you feel that biotechnology will provide benefits for you or your family within the next five years?

[If yes] What benefits do you expect?

The US Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you support or oppose this policy of FDA?

The US Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you support or oppose this policy of FDA?

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The US Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you support or oppose this policy of FDA?

The US Food and Drug Administration (FDA) requires special labeling when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you support or oppose this policy of FDA?

The US Food and Drug Administration (FDA) requires special labeling

	when a food is produced under certain conditions: when biotechnology's use introduces an allergen or when it substantially changes the food's nutritional content, like vitamins or fat, or its composition. Otherwise special labeling is not required. Would you say that you support or oppose this policy of FDA?	
	Over the past few months, have you taken any action or done anything because of any concerns you may have about foods produced using biotechnology?	5
	Over the past few months, have you taken any action or done anything because of any concerns you may have about foods produced using biotechnology?	5
	How much have you read or heard regarding a recall of StarLink corn products that were produced using biotechnology?	
	How much have you read or heard regarding a recall of StarLink corn products that were produced using biotechnology?	
(International Social Survey Programme 2000)	Modifying the genes of certain crops is how dangerous for the environment?	68
(Lake Research Partners 2010)	The Federal Food and Drug Administration may soon approve a new laboratory-engineered salmon under a process designed to approve veterinary drugs. Engineered salmon gain weight twice as fast as normal salmon but we don't know the effect on human health. The FDA has not conducted any health or environmental studies of its own and has instead relied on the research from the technology company. So do you think the FDA should APPROVE this genetically engineered salmon for human consumption or should it NOT approve this genetically engineered salmon?	78
	If the FDA approves this genetically engineered salmon it will be the first time any genetically engineered fish or animal has been approved and allowed into the American food supply. Research is already underway to put engineered pigs, chickens, and cattle into the food supply once the salmon is approved, even though the FDA has conducted no safety tests of its own. What do you think? Should the FDA ALLOW these genetically engineered meats and fish into the market before the FDA performs its own studies, or should it NOT allow it until the FDA performs its own studies?	91
(Miller 1998)	Do you think genetic engineering will improve our way of life in the next 20 years, have no effect, or make things worse?	10
	Do you think biotechnology will improve our way of life in the next 20 years, have no effect, or make things worse?	11
	Over the last few months, have you heard or read anything about issues involving modern biotechnology?	
	[If yes] What did you hear or read about modern biotechnology?	
	[If yes] How did you come to know about this information?	

If you wanted to know more about this topic, how would you get information?

Have you heard or read about the cloning of a sheep named Dolly in Scotland?

When you hear the term DNA, do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?

Now I am going to read you a list of applications, which may come out of modern biotechnology. For each one, please tell me whether you have heard of the application, then let me know whether you definitely agree, tend to agree, tend to disagree, or definitely disagree with the questions that follow. First, have you heard of using modern biotechnology in the production of food and drinks, for example, to make them higher in protein, keep longer, or taste better?

The use of modern biotechnology in the production of food and drinks is useful for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 26

The use of modern biotechnology in the production of food and drinks is risky for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 50

The use of modern biotechnology in the production of food and drinks is morally acceptable for society. Do you definitely agree, tend to agree, definitely disagree, or definitely disagree? 25

All in all, the use of modern biotechnology in the production of food and drinks should be encouraged. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 31

Next, have you heard of using biotechnology to insert genes from one plant into a crop plant to make it more resistant to insect pests?

Using biotechnology to insert genes from one plant to a crop plant is useful for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 17

Using biotechnology to insert genes from one plant to a crop plant is morally acceptable for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 20

Using biotechnology to insert genes from one plant to a crop plant is risky for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 39

All in all, using biotechnology to insert genes form one plant into a crop plant should be encouraged. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 24

Next, have you heard of using biotechnology to introduce human genes into bacteria to produce medicines and vaccines, for example, the production of insulin for people with diabetes?

Using biotechnology to introduce human genes into bacteria to produce medicines and vaccines is useful for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	9
Using biotechnology to introduce human genes into bacteria to produce medicines and vaccines is risky for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	41
Using biotechnology to introduce human genes into bacteria to produce medicines and vaccines is morally acceptable for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	16
All in all, the use of modern biotechnology to introduce human genes into bacteria to produce medicines and vaccines should be encouraged. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	14
Next, have you heard of using biotechnology to introduce human genes into animals to produce organs for human transplants, such as pigs for human hearts?	
Using biotechnology to introduce human genes into animals to produce organs for human transplants is useful for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	40
Using biotechnology to introduce genes into animals to produce organs for human transplants is risky for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	64
Using biotechnology to introduce genes into animals to produce organs for human transplants is morally acceptable for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	51
All in all, using biotechnology to introduce human genes into animals to produce organs for human transplants should be encouraged. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	48
Next, have you heard of using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease such as cystic fibrosis?	
Using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease is useful for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	19
Using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease is risky for society. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree?	42
Using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease is morally acceptable for society. Do you definitely agree, tend to agree, tend to disagree, or	27

definitely disagree?

All in all, using genetic testing to determine whether an unborn child has a genetic predisposition for a serious disease should be encouraged. Do you definitely agree, tend to agree, tend to disagree, or definitely disagree? 27

Now I am going to read you a list of groups. For each of these groups, if they made a public statement about the safety of biotechnology, would you have a lot, some, or no trust in the statement about biotechnology? First, the American Medical Association. Would you have a lot of trust, some trust, or no trust in a statement made by the American Medical Association about biotechnology?

The federal Food and Drug Administration. Would you have a lot of trust, some trust, or no trust in a statement made by the Food and Drug Administration about biotechnology?

Scientists from a university. Would you have a lot of trust, some trust, or no trust in a statement made by scientists from a university in your own state about biotechnology?

Food manufacturers. Would you have a lot of trust, some trust, or no trust in a statement made by food manufacturers about biotechnology?

The National Institutes of Health. Would you have a lot of trust, some trust, or no trust in a statement made by the National Institutes of health about biotechnology?

Reporters on a television news show like 60 minutes. Would you have a lot of trust, some trust, or no trust in a statement made by reporters on a television news show like 60 minutes about biotechnology?

The U.S. Department of Agriculture. Would you have a lot of trust, some trust, or no trust in a statement made by the Department of Agriculture in your own state about biotechnology?

An article in Time or Newsweek. Would you have a lot of trust, some trust, or no trust in a statement made by an article in Time or Newsweek?

An article in Consumer Reports magazine. Would you have a lot of trust, some trust, or no trust in a statement made by an article in Consumer Reports magazine?

Now I'm going to read to you some statements such as those you might find in a newspaper or magazine article. For each statement, please tell me if you generally agree or generally disagree. If you feel especially strongly about a statement, please tell me that you strongly agree or strongly disagree. OK? First, the interested and informed citizen can often have some influence on government policies toward science and technology if he or she is willing to make the effort. Do you strongly agree, agree, disagree, or strongly disagree?

Even if it brings no immediate benefits, scientific research, which advances the frontiers of knowledge, is necessary and should be

supported by the federal government. Do you strongly agree, agree, disagree, or strongly disagree?

Scientists should be allowed to do research that causes pain and injury to animals like dogs and chimpanzees if it produces new information about human health problems. Do you strongly agree, agree, disagree, or strongly disagree?

Current regulations are sufficient to protect people from any risks linked to modern biotechnology. Do you strongly agree, agree, disagree, or strongly disagree? 53

Biotechnology will personally benefit people like me in the next five years. Do you strongly agree, agree, disagree, or strongly disagree?

My family and I have already benefited from biotechnology. Do you strongly agree, agree, disagree, or strongly disagree?

The Bible is the actual word of God and is to be taken literally. Do you strongly agree, agree, disagree, or strongly disagree?

Plants and animals exist primarily to be used by humans. Do you strongly agree, agree, disagree, or strongly disagree?

The regulation of biotechnology should be left mainly to industry. Do you strongly agree, agree, disagree, or strongly disagree? 78

Modern biotechnology is so complex that public involvement in the policy process is a waste of time. Do you strongly agree, agree, disagree, or strongly disagree?

There is a personal God who hears the prayers of individual men and women. Do you strongly agree, agree, disagree, or strongly disagree?

It is not worth putting special labels on genetically modified foods. Do you strongly agree, agree, disagree, or strongly disagree? 82

Animals have rights that people should not violate. Do you strongly agree, agree, disagree or strongly disagree?

Now, please tell me whether you support or oppose the use of biotechnology in agriculture and food production? 17

Please tell me why you support the use of biotechnology in agriculture and food production?

Please tell me why you oppose the use of biotechnology in agriculture and food production?

Do you support or oppose the use of biotechnology to develop new medicines to treat human disease? 5

Please tell me why you support the use of biotechnology to develop new medicines to treat human disease.

Please tell me why you oppose the use of biotechnology to develop

new medicines to treat human disease.

There are differing views about whether people inherit particular characteristics, that is whether people are born with these characteristics, or whether they acquire them mainly from their upbringing, or the conditions in which they lived. I am going to read you a list of characteristics, and I would like you to tell me, for each one, whether you think it is mainly inherited or mainly the result of upbringing and living conditions. First, eye color. Is eye color mainly inherited or mainly the result of upbringing and living conditions?

Next, intelligence. Is intelligence mainly inherited or mainly the result of upbringing and living conditions?

A tendency to be happy. Is a tendency to be happy mainly inherited or mainly the result of upbringing and living conditions?

Athletic abilities. Are athletic abilities mainly inherited or mainly the result of upbringing and living conditions?

A person's attitude toward work. Is a person's attitude toward work mainly inherited or mainly the result of upbringing and living conditions?

Finally, musical abilities. Are musical abilities mainly inherited or mainly the result of upbringing and living conditions?

Now I am going to read you a list of things that might happen within the next 20 years as a result of modern biotechnology. For each one, please say whether you think it is likely or unlikely to happen within the next 20 years. First, substantially reducing environmental pollution. Is this likely or unlikely to happen within the next 20 years?

Next, creating dangerous new diseases. Is this likely or unlikely to happen within the next 20 years? 65

Substantially reducing world hunger. Is this likely or unlikely to happen within the next 20 years?

Reducing the range of fruits and vegetables we can get. Is this likely or unlikely to happen within the next 20 years? 41

Curing most genetic diseases. Is this likely or unlikely to happen within the next 20 years?

Getting more out of natural resources in Third World countries. Is this likely or unlikely to happen within the next 20 years?

Producing designer babies. Is this likely or unlikely to happen within the next 20 years?

Replacing most existing food products with new varieties. Is this likely or unlikely to happen within the next 20 years?

Now, let me return to a question about words and terms you may read or hear in the news. Some articles refer to the results of a scientific

study. When you read or hear the term scientific study do you have a clear understanding of what it means, a general sense of what it means, or little understanding of what it means?

In your own words, could you tell me what it means to study something scientifically?

Now, please think about this situation. Two scientists want to know if a certain drug is effective against high blood pressure. The first scientist wants to give the drug to a 1000 people with high blood pressure and see how many of them experience lower blood pressure levels. The second scientist wants to give the drug to 500 people with high blood pressure, and not give the drug to another 500 people with high blood pressure, and see how many in both groups experience lower blood pressure levels. Which is the better way to test this drug?

Why is it better to test the drug this way?

Now, I would like to ask you a few short quiz-type questions such as you might see on a television game show. For each statement that I read, please tell me if it is true or false. If you don't know or aren't sure, just tell me so and we will skip to the next question. Remember: true, false, or don't know. First, DNA regulates inherited characteristics in all plants, animals, and humans. Is that true or false?

All bacteria are harmful to humans. Is that true or false?

Antibiotics kill viruses as well as bacteria. Is that true or false?

Senility is inevitable as the brain ages and loses tissue. Is that true or false?

Given today's biotechnology, scientists can now create new genes that never existed in nature. Is that true or false?

More than half of human genes are identical to those with chimpanzees. Is that true or false?

Viruses can be contaminated by bacteria. Is that true or false?

Human beings, as we know them today, developed from earlier species of animals. Is that true or false?

The cloning of living things produces exactly identical offspring. Is that true or false?

Yeast for brewing beer consists of living organisms. Is that true or false?

Human beings can survive on almost any combination of foods, provided that the total diet includes enough calories. Is that true or false?

The human immune system has no defense against viruses. Is that true or false?

Ordinary tomatoes do not contain genes while genetically modified tomatoes do. Is that true or false?

It is possible to find out in the first few months of pregnancy whether or not an unborn child will have Downs Syndrome. Is that true or false?

By eating a genetically modified fruit, a persons genes could also become modified. Is that true or false?

It is impossible to transfer animal genes into plants. Is that true or false?

Intelligence in humans is related to the size of the brain. Is that true or false?

Genetically modified animals are always bigger than ordinary ones. Is that true or false?

Now, think about this situation. A doctor tells a couple that their genetic makeup means that they've got one in four chances of having a child with an inherited illness. Does this mean that if their first three children are healthy, the fourth will have the illness?

Does this mean that if their first child has the illness, the next three will not?

Does this mean that each of the couple's children will have the same risk of suffering from the illness?

Does this mean that if they have only three children, none will have the illness?

We've been discussing several issues to do with modern biotechnology. Some people think these issues are very important while others don't think so. On a scale from zero to ten where zero is not at all important and ten is extremely important, how important are these issues for you personally?

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Now, using the same scale, how well informed would you say you are about biotechnology, if zero means you are not at all informed about biotechnology and ten means you are very well informed about biotechnology.

Before today, had you ever talked about modern biotechnology with someone? No, frequently, occasionally, or only once or twice?

Now, let me change the subject. During the last year, have you written or spoken to any public official or legislator about any political issue or problem?

(National Public Radio 2000)

Thinking about major technological developments of the twentieth century, which one or two of the following do you think were the most significant?

For each of the following technologies, please tell me if you think it is

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	making life better or worse for Americans, or isn't it making much difference?	
(NPR and Thomas Reuters 2010)	On a scale of 1 to 5- where 1 is "Do Not Understand at All" and 5 is "Understand Completely"- how well do you understand genetically engineered foods?	
	What is your opinion regarding the safety of genetically engineered foods?	79
	Do you believe that foods should be labeled to indicate that they have been genetically engineered or contain ingredients that have been genetically engineered?	93
	Would you eat the following foods knowing that they have been genetically engineered? Fish.	65
	Would you eat the following foods knowing that they have been genetically engineered? Meat.	62
	Would you eat the following foods knowing that they have been genetically engineered? Vegetables, fruits, or grains.	40
	Prior to today, did you know that some of the foods available in stores today have been genetically engineered?	
(Pew Initiative on Food and Biotechnology 2004)	How much responsibility do you have for making your household's shopping decisions? Are you completely responsible, partly responsible, or not at all responsible for your household's shopping decisions?	
	How much have you seen, read or heard recently regarding the use of biotechnology in the production of food that is sold in grocery stores? Have you seen, read or heard a great deal, some, not too much, or nothing at all recently regarding the use of biotechnology in the production of food that is sold in grocery stores?	
	How much have you seen, read or heard recently regarding genetically modified food that is sold in grocery stores? Have you seen, read or heard a great deal, some, not too much, or nothing at all recently regarding genetically modified food that is sold in grocery stores?	
	What have you heard about genetically modified foods?	
	Do you favor or oppose the introduction of genetically modified foods into the US food supply?	47
	How likely would you be to eat genetically modified foods? Would you be very likely, somewhat likely, not too likely, or not at all likely to eat genetically modified foods?	52
	As far as you know, have you ever eaten genetically modified foods?	
	How much would you say you know about government regulation of genetically modified food? Would you say you know a great deal, some, not too much, or nothing at all about government regulation of	

genetically modified food?

Generally speaking, do you think there is [ROTATE] __too much 40
government regulation of genetically modified foods, __too little
regulation of genetically modified foods, or __the right amount of
regulation of genetically modified foods, or [ASK LAST] don't you
have an opinion on this?

Do you think genetically modified foods are basically safe, basically 27
unsafe, or don't you have an opinion on this?

Now, as you may know, more than half of products at the grocery store 25
are produced using some form of biotechnology or genetic
modification. Knowing this, do you think genetically modified foods
are basically safe, basically unsafe, or don't you have an opinion on
this? Do you believe that strongly or not so strongly?

Currently, the FDA does not require companies to prove that 50
conventional foods are safe before they can be sold on the market, and
companies can bring new conventionally produced foods to the market
without prior approval from the FDA. The FDA can act to take a food
off the market if there's a safety problem. Now I'm going to read you
some goals that people have set out for the regulation of genetically
modified foods. After each I'd like you to tell me whether you favor or
oppose that goal. If you are not sure how you feel about a goal, just
say so and we will go on. Streamlining the process so that new
advances in genetically modified food are brought to market as soon as
possible.

Now I'm going to read you some goals that people have set out for the 81
regulation of genetically modified foods. After each I'd like you to tell
me whether you favor or oppose that goal. If you are not sure how you
feel about a goal, just say so and we will go on. Requiring the FDA to
approve any genetically modified food as safe before it goes to market,
even if it causes substantial delays.

Now I'm going to read you some goals that people have set out for the 36
regulation of genetically modified foods. After each I'd like you to tell
me whether you favor or oppose that goal. If you are not sure how you
feel about a goal, just say so and we will go on. Prohibiting any
genetically modified food from being sold in the United States, even if
the FDA believes it is safe.

Now I'm going to read you some goals that people have set out for the 85
regulation of genetically modified foods. After each I'd like you to tell
me whether you favor or oppose that goal. If you are not sure how you
feel about a goal, just say so and we will go on. Ensuring that all
genetically modified foods are safe before they come to market.

Now I'm going to read you some goals that people have set out for the 85
regulation of genetically modified foods. After each I'd like you to tell
me whether you favor or oppose that goal. If you are not sure how you
feel about a goal, just say so and we will go on. Removing any
genetically modified food deemed to be unsafe after it has come to
market.

Now I'm going to read you some goals that people have set out for the regulation of genetically modified foods. After each I'd like you to tell me whether you favor or oppose that goal. If you are not sure how you feel about a goal, just say so and we will go on. Balancing the interests of consumers and food producers to provide the best and safest food.

Now I'm going to read you some goals that people have set out for the regulation of genetically modified foods. After each I'd like you to tell me whether you favor or oppose that goal. If you are not sure how you feel about a goal, just say so and we will go on. Labeling all food that is genetically modified. 92

Now I'm going to read you some goals that people have set out for the regulation of genetically modified foods. After each I'd like you to tell me whether you favor or oppose that goal. If you are not sure how you feel about a goal, just say so and we will go on. Labeling all processed food that contains genetically modified ingredients. 91

Now I'm going to read you some goals that people have set out for the regulation of genetically modified foods. After each I'd like you to tell me whether you favor or oppose that goal. If you are not sure how you feel about a goal, just say so and we will go on. Genetically modified foods should be subject to the same rules as new conventional foods. 12

Now I'm going to read you some goals that people have set out for the regulation of genetically modified foods. After each I'd like you to tell me whether you favor or oppose that goal. If you are not sure how you feel about a goal, just say so and we will go on. Genetically modified foods should be regulated more stringently than new conventional foods. 72

Do you favor or oppose scientific research into genetic modifications of animals?

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Plants.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Animals used for food sources, including cattle, fish and shrimp.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with

genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Animals used for other purposes, including cats, dogs and racehorses.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Insects.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Microbes, such as bacteria or algae.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. You may choose any number between 0 and 10. If you are not sure, please say so and we will move on. Humans.

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To reduce the need to use pesticides on crops. 22

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To reduce the cost of fish like salmon. 46

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to 14

genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce more affordable pharmaceutical drugs by using plants to produce pharmaceutical compounds.

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Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create new types of grass that don't need to be mowed as often. 33

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create fruits and vegetables that last longer on the store shelves. 44

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Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To provide organs for transplant to humans. 33

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To make it possible to transplant animal organs to humans. 52

- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To develop vegetable oil with heart healthy fats. 26
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create peanuts that won't cause allergic reactions. 26
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To increase the variety of available foods. 33
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To expand our understanding of science and nature. 18
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To develop better tasting fruits and vegetables. 38
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce less expensive food. 31
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce less expensive food to reduce hunger around the world. 20
- Now I'm going to read that same list of potential uses for genetic modifications. After each, please tell me whether you think that use would have a positive impact on you and your family, a negative impact on you and your family, or no impact at all on you and your family. If you don't know or aren't sure, please say so and we'll move on. To reduce the need to use pesticides on crops.

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Now I'm going to read that same list of potential uses for genetic modifications. After each, please tell me whether you think that use would have a positive impact on you and your family, a negative impact on you and your family, or no impact at all on you and your

	family. If you don't know or aren't sure, please say so and we'll move on. To produce less expensive food to reduce hunger around the world.	
(Pew Initiative on Food and Biotechnology 2003)	How much responsibility do you have for making your household's shopping decisions. Are you completely responsible, partly responsible, or not at all responsible for your household's shopping decisions?	
	How much have you seen, read or heard recently regarding the use of biotechnology in the production of food that is sold in grocery stores? Have you seen, read or heard a great deal, some, not too much, or nothing at all recently regarding the use of biotechnology in the production of food that is sold in grocery stores?	
	How much have you seen, read or heard recently regarding genetically modified food that is sold in grocery stores? Have you seen, read or heard a great deal, some, not too much, or nothing at all recently regarding genetically modified food that is sold in grocery stores?	
	What have you heard about genetically modified foods? Please be as specific as possible.	
	Do you favor or oppose the introduction of genetically modified foods into the US food supply?	48
	How likely would you be to eat genetically modified foods? Would you be very likely, somewhat likely, not too likely, or not at all likely to eat genetically modified foods?	50
	As far as you know, have you ever eaten genetically modified foods?	
	Recently, the United States launched a complaint against the European Union, because they were banning certain agricultural products that have been genetically modified. How much, if anything, have you happened to hear about this? Have you heard a great deal, some, not too much, or nothing at all about this?	
	Based on what you have heard, would you say you favor or oppose this complaint against the European Union's ban on certain genetically modified food, or aren't you sure?	
	How much would you say you know about government regulation of genetically modified food? Would you say you know a great deal, some, not too much, or nothing at all about government regulation of genetically modified food?	
	Generally speaking, do you think there is ROTATE __too much government regulation of genetically modified foods, __too little regulation of genetically modified foods, or __the right amount of regulation of genetically modified foods, or [ASK LAST] don't you have an opinion on this?	35
	Do you think genetically modified foods are basically safe, basically unsafe, or don't you have an opinion on this?	24

Now, as you may know, more than half of products at the grocery store are produced using some form of biotechnology or genetic modification. Knowing this, do you think genetically modified foods are basically safe, basically unsafe, or don't you have an opinion on this? Do you believe that strongly or not so strongly?

24

Which of the following statements best reflects your opinion about genetically modified foods: [ROTATE STATEMENTS] Genetically modified foods are essentially the same as other foods because people have been modifying foods through conventional breeding for hundreds of years, and genetic modification is just a new way of doing the same things OR Genetically modified foods are different from other foods because most of the changes allowed by genetic modification are impossible to do with conventional breeding OR [ASK LAST] Aren't you sure?

42

Currently, the FDA does not require companies to prove that conventional foods are safe before they can be sold on the market, and companies can bring new conventionally produced foods to the market without prior approval from the FDA. Now I'm going to read you some statements that people have said about the Food and Drug Administration's rules regarding genetically modified foods. After each I'd like you to tell me whether you agree or disagree with the statement. If you aren't sure how you feel about a statement, just say so and we will go on. Companies should be allowed to put a genetically modified food on the market without any special review by the Food and Drug Administration, if the company can show it is as safe as any other food.

61

Now I'm going to read you some statements that people have said about the Food and Drug Administration's rules regarding genetically modified foods. After each I'd like you to tell me whether you agree or disagree with the statement. If you aren't sure how you feel about a statement, just say so and we will go on. Companies should be encouraged, but not required, to let the Food and Drug Administration review data regarding the safety of a genetically modified food before that product goes on the market.

45

Now I'm going to read you some statements that people have said about the Food and Drug Administration's rules regarding genetically modified foods. After each I'd like you to tell me whether you agree or disagree with the statement. If you aren't sure how you feel about a statement, just say so and we will go on. Companies should be required to submit safety data to the Food and Drug Administration for review, and no genetically modified food product should be allowed on the market until the FDA determines it is safe.

89

Now I'm going to read you some statements that people have said about the Food and Drug Administration's rules regarding genetically modified foods. After each I'd like you to tell me whether you agree or disagree with the statement. If you aren't sure how you feel about a statement, just say so and we will go on. Genetically modified foods should not be allowed to be sold even if the Food and Drug Administration believes they are safe.

28

Currently, the Food and Drug Administration reviews data regarding

the safety of genetically modified foods that is voluntarily submitted by food companies. If the federal government changed its rules so that it became mandatory for the FDA to approve all genetically modified foods before it entered the market place, would you be [ROTATE] ___more willing to eat genetically modified foods, ___less willing to eat genetically modified foods, or [ASK LAST] would it not make a difference in how willing you would be to eat genetically modified foods?

Now, as you may know, more than half of products at the grocery store 17 are produced using some form of biotechnology or genetic modification. Knowing this, do you think genetically modified foods are basically safe, basically unsafe, or don't you have an opinion on this? Do you believe that strongly or not so strongly?

Do you favor or oppose scientific research into genetic modifications of animals?

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Plants.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Animals used for food sources, including cattle, fish and shrimp.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Animals used for other purposes, including cats, dogs and race horses.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Insects.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Microbes, such as bacteria or algae.

Now I'm going to list some life forms which can be genetically modified. After each, please tell me how comfortable you are with genetic modification of that specific life form. Use a scale of zero to ten where zero means that you are very uncomfortable with genetic modifications of that life form, and ten means that you are very comfortable with genetic modification of that life form. 5 is neutral, neither uncomfortable nor comfortable. If you are not sure, please say so and we will move on. Humans.

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To reduce the need to use pesticides on crops. 21

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To reduce the cost of fish, like salmon. 43

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce more affordable pharmaceutical drugs by using plants to produce pharmaceutical compounds. 14

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce more affordable pharmaceutical drugs by using animals to produce pharmaceutical compounds. 41

Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce more affordable industrial compounds in plants, including the material used to make plastic. 28

- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create goats whose milk can be used to produce industrial products like extremely strong silk, which can be used to make bulletproof vests. 33
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create new types of grass that don't need to be mowed as often. 33
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create fruits and vegetables that last longer on the store shelves. 41
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To produce beef with less fat. 43
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To provide organs for transplant to humans. 35
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To develop vegetable oil with heart healthy fats. 25
- Now I'm going to list some reasons to genetically modify plants or animals. For each item I read, please tell me if you think it is a good reason to genetically modify plants or animals, or a bad reason to genetically modify plants or animals. If you aren't sure how you feel about a specific item, just say so and we'll move on. To create peanuts that won't cause allergic reactions. 24
- Please tell me how important each of the following are in determining whether or not you favor genetic modifications of plants and animals. After each, please tell me whether it is very important, somewhat important, not too important, or not at all important in determining whether or not you favor genetic modifications of plants and animals. If you aren't sure about a specific item, please say so and we'll move on. Your religious beliefs.

Please tell me how important each of the following are in determining whether or not you favor genetic modifications of plants and animals. After each, please tell me whether it is very important, somewhat important, not too important, or not at all important in determining whether or not you favor genetic modifications of plants and animals. If you aren't sure about a specific item, please say so and we'll move on. The science involved.

Please tell me how important each of the following are in determining whether or not you favor genetic modifications of plants and animals. After each, please tell me whether it is very important, somewhat important, not too important, or not at all important in determining whether or not you favor genetic modifications of plants and animals. If you aren't sure about a specific item, please say so and we'll move on. Your ethical beliefs.

Please tell me how important each of the following are in determining whether or not you favor genetic modifications of plants and animals. After each, please tell me whether it is very important, somewhat important, not too important, or not at all important in determining whether or not you favor genetic modifications of plants and animals. If you aren't sure about a specific item, please say so and we'll move on. The impact it might have on you and your family.

Please tell me how important each of the following are in determining whether or not you favor genetic modifications of plants and animals. After each, please tell me whether it is very important, somewhat important, not too important, or not at all important in determining whether or not you favor genetic modifications of plants and animals. If you aren't sure about a specific item, please say so and we'll move on. The trust you have in the people providing information.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Religious leaders.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Scientists and academics.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Government

regulators.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. The Food and Drug Administration, or FDA.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Biotechnology companies.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Consumer groups.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Environmental groups.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Food manufacturers.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Farmers.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or

organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. The news media.

Now I'm going to read you a list of groups and organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each group or organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Friends and family.

(Pew Initiative on Food and Biotechnology 2001)

How much responsibility do you have for making your household's shopping decisions. Are you completely responsible, partly responsible, or not at all responsible for your household's shopping decisions?

Overall, do you have a very favorable, somewhat favorable, somewhat unfavorable, or very unfavorable impression of genetically modified foods? 44

Overall, do you have a very favorable, somewhat favorable, somewhat unfavorable, or very unfavorable impression of biotechnology used in food production? 30

Overall, do you have a very favorable, somewhat favorable, somewhat unfavorable, or very unfavorable impression of irradiated foods? 25

Overall, do you have a very favorable, somewhat favorable, somewhat unfavorable, or very unfavorable impression of organic foods? 15

I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Biotechnology being used in the production of food. 62

I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Genetically modified foods. 61

I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Chemicals and fertilizers being used in the production of food. 78

I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Listeria. 40

I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Irradiation.	50
I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Food poisoning.	84
I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Salmonella.	84
I'm going to list some things people tell us they are concerned about when it comes to food safety. After each, please tell me whether it is one of the things that worries you most about food safety, whether it worries you a great deal, some, not too much, or not at all. If you are not sure, please say so and we'll go on. Food freshness.	89
How much have you seen, read or heard recently regarding the use of biotechnology in the production of food that is sold in grocery stores? Have you read, seen or heard a great deal, some, not too much, or nothing at all recently regarding the use of biotechnology in the production of food that is sold in grocery stores?	
How much have you seen, read or heard recently regarding genetically modified food that is sold in grocery stores? Have you heard a great deal, some, not too much, or nothing at all recently regarding genetically modified food that is sold in grocery stores?	
Do you favor or oppose the introduction of genetically modified foods into the US food supply?	58
How likely would you be to eat genetically modified foods? Would you be very likely, somewhat likely, not too likely, or not at all likely to eat genetically modified foods?	54
As far as you know, have you ever eaten genetically modified foods?	
When you go to the grocery store how important is it to you to know whether a product contains genetically modified agricultural products? Is it very important, somewhat important, not too important, or not at all important for you to know whether a product contains genetically modified agricultural products?	75
To the best of your knowledge, how much of the food in a typical American grocery store is genetically modified -- that is, food modified through biotechnology or contains genetically modified ingredients?	

Do you think genetically modified foods are basically safe, basically unsafe, or don't you have an opinion on this? 24

Now, as you may know, more than half of products at the grocery store are produced using some form of biotechnology or genetic modification. Knowing this, do you think genetically modified foods are basically safe, basically unsafe, or don't you have an opinion on this? 22

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. The Food and Drug Administration, or FDA.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. The Environmental Protection Agency, or EPA.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Grocery stores.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Farmers.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Environmental groups.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at

all? If you have never heard of the organization, or don't know, please say so and we'll move on. Food Safety groups.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Food manufactures.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Consumer groups.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Scientists and academics.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Local community leaders.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Research centers.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at all? If you have never heard of the organization, or don't know, please say so and we'll move on. Friends and family.

Now I'm going to read you a list of organizations from which you can get information about genetically modified foods. After each, please tell me how much you trust what each organization says about genetically modified foods. Do you trust what they have to say about genetically modified foods a great deal, some, not too much, or not at

all? If you have never heard of the organization, or don't know, please say so and we'll move on. Elected Officials.

Do you favor or oppose scientific research into genetic modifications of food?

Have you heard any stories in the news recently about genetically modified foods?

Recently, a number of food companies recalled taco shells and other corn products from grocery stores because they were found to contain a type of genetically modified corn that had not been cleared for human consumption. How much if anything have you happened to hear about this? Have you heard a great deal, some, not too much, or nothing at all?

How concerned are you about this food recall [StarLink]? Are you very concerned, somewhat concerned, not too concerned, or not at all concerned? 74

Have you changed your food purchasing habits as a result of this recall [StarLink]? 22

How much, if anything, have you heard in the news recently about genetically modified rice that might help reduce cases of children's blindness in the developing world? Have you happened to hear a great deal, some, not too much, or nothing at all?

(Slovic 1993)

For the next items, please indicate your opinion on the health risks only for the American public as a whole. For each item, please tell me whether you think there is almost no health risk, slight health risk, moderate health risk, or high health risk for the American public as a whole. [Use of genetically engineered bacteria in agriculture] 70

(Smith, Marsden, Hout, and Kim 2011)

Ordinary tomatoes do not contain genes, while genetically modified tomatoes do. True or False?

Here is another public issue: genetically modified foods. Genetically modified foods come from plants or animals whose characteristics have been changed by the alteration, addition, or deletion of DNA in their genetic material using advanced laboratory techniques. Some say that genetically modified foods are unsafe and pose risks for human health. Others say that they are safe and necessary to reduce world hunger. How well do the following groups understand the risks posed by genetically modified foods? Medical researchers.

Here is another public issue: genetically modified foods. Genetically modified foods come from plants or animals whose characteristics have been changed by the alteration, addition, or deletion of DNA in their genetic material using advanced laboratory techniques. Some say that genetically modified foods are unsafe and pose risks for human health. Others say that they are safe and necessary to reduce world hunger. How well do the following groups understand the risks posed by genetically modified foods? Elected Officials.

Here is another public issue: genetically modified foods. Genetically modified foods come from plants or animals whose characteristics

have been changed by the alteration, addition, or deletion of DNA in their genetic material using advanced laboratory techniques. Some say that genetically modified foods are unsafe and pose risks for human health. Others say that they are safe and necessary to reduce world hunger. How well do the following groups understand the risks posed by genetically modified foods? Business leaders.

To what extent do medical researchers agree on the risks and benefits of genetically modified foods?

Some say that the government should restrict the sale of genetically modified foods. Others say there is no need for such restrictions. How much influence should each of the following groups have in deciding whether to restrict the sale of genetically modified foods? Medical Researchers.

Some say that the government should restrict the sale of genetically modified foods. Others say there is no need for such restrictions. How much influence should each of the following groups have in deciding whether to restrict the sale of genetically modified foods? Elected officials.

Some say that the government should restrict the sale of genetically modified foods. Others say there is no need for such restrictions. How much influence should each of the following groups have in deciding whether to restrict the sale of genetically modified foods? Business leaders.

When making policy recommendations about genetically modified foods, to what extent do you think the following groups would support what is best for the country as a whole or what serves their own narrow interests? Medical Researchers. 13

When making policy recommendations about genetically modified foods, to what extent do you think the following groups would support what is best for the country as a whole or what serves their own narrow interests? Elected Officials. 48

When making policy recommendations about genetically modified foods, to what extent do you think the following groups would support what is best for the country as a whole or what serves their own narrow interests? Business leaders. 63

Which statement best describes your own view about eating foods that have been genetically modified? [I don't care whether the food I eat has been genetically modified. I am willing to eat genetically modified foods, but would prefer unmodified foods if they are available. I will not eat food that I know has been genetically modified. 82

The cloning of living things produces genetically identical copies. True or False?

Here is a list of some different environmental problems. Which problem, if any, do you think is the most important for America as a whole? [Genetically modified foods] 3

	Which problem, if any, affects you and your family the most? [Genetically modified foods]	0
	If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information? The newspapers, magazines, the internet, books or other printed materials, TV, radio, government agencies, family, friends, colleagues, or some other source?	
	If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information? The newspapers, magazines, the internet, books or other printed materials, TV, radio, government agencies, family, friends, colleagues, or some other source?	
	If you wanted to learn about scientific issues such as global warming or biotechnology, where would you get information? The newspapers, magazines, the internet, books or other printed materials, TV, radio, government agencies, family, friends, colleagues, or some other source?	
(Taylor 2000)	How much have you seen, read, or heard about new types of plants and crops, which have been genetically engineered- a lot, some, not much, or nothing at all?	
	How much have you seen, read, or heard about new genetically modified foods- a lot, some, not much, or nothing at all?	
	How likely do you think it is that the following will happen because of the use of new types of plants and crops developed by genetic engineering- very, somewhat, not very, or not at all likely? Food based on these new crops will be poisonous or cause disease in people who eat them.	45
	How likely do you think it is that the following will happen because of the use of new types of plants and crops developed by genetic engineering- very, somewhat, not very, or not at all likely? Agricultural production will increase.	
	How likely do you think it is that the following will happen because of the use of new types of plants and crops developed by genetic engineering- very, somewhat, not very, or not at all likely? They will upset the balance of nature and damage the environment.	56
	How likely do you think it is that the following will happen because of the use of new types of plants and crops developed by genetic engineering- very, somewhat, not very, or not at all likely? They will make food less expensive than it would be otherwise.	
	Do you think the government should require the labeling of all packaged and other food products stating that they include corn, soy or other products which have come from genetically modified crops, or is that not important?	86
	Overall do you think the benefits of developing and growing these new plants and crops outweigh the risks of doing this, or do you think the	48

risks outweigh the benefits?

(Taylor 1993)

In the movie, 'Jurassic Park, scientists build a theme park containing real dinosaurs that were cloned from ancient biological cells that were fossilized. How likely do you think it would be for real scientists to take ancient genetic material and clone copies of animals, plants and even dinosaurs -- very likely somewhat likely, not very likely or not likely at all?

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 potential benefits?

57

How likely do you think it is that animals, plants or bacteria which are produced by genetic engineering will pose a serious threat to human life or the environment-- very likely, somewhat likely, not very likely, or not likely at all?

60

***If taken as an indicator of concern**

Appendix E. Codebook for Dataset

<i>Information</i>	<i>Code</i>	<i>Description</i>
Question Identification	1-569	Each question was given an identification code ranging from one through 569
Source Identification	1	ABC
	2	CBS
	3	Gallup Poll
	4	Harris Poll
	5	Harris Interactive and the Chicago Council on Foreign Relations
	6	IFIC
	7	ISSP
	8	ICPSR
	9	Lake Research Partners
	10	NPR
	11	Pew Initiative on Food and Biotechnology
	12	Thomas Reuters and NPR
Year Study Conducted	1993-2010	The year the study was conducted, if the study spanned across multiple years, the last year was recorded
Question Type	1	Seven-point Likert Scale
	2	Six-Point Likert-Type Scale
	3	Five-point Likert-Type Scale
	4	Four-Point Likert-Type Scale
	5	Trichotomous
	6	Dichotomous
	7	Open-Ended
	8	Ranked
	9	Multiple Choice
	10	Scale
Response Type	1	Degree of Confidence
	2	Safe or Not
	3	Yes or No
	4	Likelihood of Phenomena
	5	Should or Should Not
	6	Amount of Information Obtained
	7	Degree of Favorability
	8	Support or Oppose
	9	Positive or Negative Reaction to Statement
	10	Degree of Importance
	11	Degree of Danger
	12	Greater Risk or Greater Benefit
	13	Level of Understanding
	14	Level of Agreement
	15	Level of Trust
	16	Support or Oppose
	17	Inheritance or Environmental
	18	Understand or Not
	19	True or False
	20	Frequency of Event
	21	Right or Wrong

	22	Degree of Influence
	23	Level of Responsibility
	24	Same as Conventional or Not
	25	Degree of Concern, Confidence or Worry
	26	Favor or Oppose
	27	Good or Bad
	99	Missing: Open-ended or Multiple Choice
Collection Method	1	Telephone
	2	Web
	3	In-Person
	4	Mixed
	5	Written
Scope	0	Localized
	1	National
Linguistic Facet	BIO	Biotechnology
	GM	Genetic Modification
	GE	Genetic Engineering
	GA	Genetic Alteration
Theoretical Facet	BEL	Belief
	KNOW	Objective Knowledge
	ATT	Attitude or Affect
	VC	Conative Behavior
	AC	Actual Behavior
Spatial Facet	LOC	Local
	NS	Nation State
	GLO	Global
	NA	Not Specified
Temporal Facet	PAST	Past
	PRES	Present
	FUT	Future
Substantive Facet	GMF	Genetically Modified Food
	GMC	Genetically Modified Crops
	ANIM	Genetically Modified Animals
	MED	Medical Use
	HUM	Human Health Issue
	ENV	Environmental Health Issue
	REG	Regulation
	LAB	Labeling
	ECON	Economics
	CLON	Cloning
	PEST	Pesticide Use
	HUNG	Human Hunger Issue

Appendix F-1. Description of Excel Function and List of Key Words by Dimension

To increase the reliability in coding each question, I wrote an Excel function that would code each question according to parameters I set. Using the IF, SUM and COUNTIF formulas, the function dummy coded each dimension for every indicator. The coding was discriminated based on key words that I developed for each category. The function takes the following form:

=IF(SUM(COUNTIF(Cell Position, {Key word 1, key word 2... key word X}))>0,1,0)

Basically, this function dummy codes every question for every dimension according to the key words I specified. In the above function, “cell position” indicates the location of the question in the Excel sheet. The function is interpreted as: if the sum of the number of key words appearing in the specified question exceeds zero then assign the cell one, otherwise assign the cell zero. Appendix Table 1. specifies the key words for each dimension by facet. Notice that the key words for each dimension are not exclusive.

Table F1. Key Words for Dimensions by Facet

<i>Facet</i>	<i>Dimension</i>	<i>Key Words</i>
Linguistic	Biotechnology	Biotech, Bioengineered, Biotechnology
	Genetic Modification	GM, Modification, Modified, Modify
	Genetic Engineering	GE, Engineered, Engineering
	Genetic Alteration	GA, Alteration, Altered
Theoretical	Belief	As Far As, How Likely, How Much, Opinion, Tell Me
	Knowledge	Informed, Meaning, Percentage, Understand
	Attitude	Good/Bad, Impression, Risk
	Conative Behavior	Effect On, Would You
	Actual Behavior	Do You, Have You, How Did You, Taken Action
Spatial	Local	Impact, Personally, Your Family, Your Market
	National	American, Federal, National, United States, 60 Minutes
	Global	Global, EU, Scotland, World
Temporal	Past	Avoided, Before, Few Months, Have You, Prior, Recall, What Did, What Were
	Present	Agree, Are You, Do You, How Concerned, Impression, Opinion, Rate, You Have, You Think, Worries You
	Future	How Likely, If You Saw, Is This Likely, Will Improve, Would You
Substantive	Food	Eat, Food
	Crops	Agriculture, Corn, Crop, Fruit, Plant, Produce, Starlink, Tomatoes
	Animal Use	Animal, Beef, Egg, Fish, Livestock, Meat, Milk, Poultry, Salmon, Sheep
	Medical Use	Antibiotics, Curing, Medicare, Medicine, Transplant
	Human Health	Allergic, Allergen, Consumption, Disease, Eat, Fat, Illness, Safe, Threat, Warning
	Environmental Health	Environment, Fresh Water, Green House, Nature, Resources
	Regulation	Ban, FDA, Food Recall, Government, Label, Prohibit, USDA, Regulate, Rules
	Labeling	Label
	Economics	Afford, Buy, Consumer, Cost, Expensive, Product, Purchase, Market, Spend, Sold

Cloning	Dolly, Clone, Cloning
Pesticide Use	Bug, Chemical, Herbicide, Insecticide, Pest
Human Hunger	Hunger, Production
Other	Better Taste, Fast Growth, Genetic Test, Irradiated, Listeria, Nutritional, Organic, Research, Sustainability

VITA

Jenna A. Lamphere was born to Gerald and Judene Lamphere in Lapeer, Michigan. After graduating from North Branch High School in Michigan, she attended Arkansas Tech University in Russellville, Arkansas. She completed her Bachelors degree in Sociology and Psychology in 2007. In 2010, Jenna moved to Knoxville to study environmental sociology.

Currently, Jenna is working as a research assistant, focusing on growing Knoxville area's green economy, while investigating policy efforts nationwide that have advanced green economic development. Previously, Jenna has assisted with research on meta-ethnography on new immigrant destinations, alternative agricultural techniques, and hydraulic fracturing. She has served as a moderator for the Sociology Graduate Student Association (SGSA), and she has been a presenter for International Association for Society and Natural Resources, Southern Sociological Society, the Society for the Study of Social Problems, and several of SGSA's Film Series events.

Jenna completed her master's degree in environmental sociology in December of 2012. She will continue to do research as she works towards a Ph.D. in sociology at the University of Tennessee.