



FROM

Nutrigenomic Science

TO

Personalized Nutrition

THE MARKET IN 2010



Institute for the Future | Nutrigenomics

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From Nutrigenomic Science to Personalized Nutrition: The Market in 2010

New Consumer, New Genetics Program

March 2003

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About the Institute for the Future

Located in the heart of Silicon Valley, the Institute for the Future (ITF) is a not-for-profit research organization with over 30 years of experience in long-term data-based forecasting. ITF identifies *future trends* and *key discontinuities* that will transform the marketplace. We provide key foresights and guide our members in drawing insights as input to their strategy, as well as possible action steps. Through the exploration of possible futures, we help companies, government agencies, and private foundations make better decisions in today's uncertain world.

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Introduction

This report of the New Consumer, New Genetics Program, *From Nutrigenomic Science to Personalized Nutrition: The Market in 2010*, explores the likely impacts of the emerging science of nutrigenomics on the consumption habits of Americans in the next decade. The goal is to identify the forces that will determine the influence of nutrigenomic science on the market for personalized nutrition products and services in 2010.

Advances in nutrigenomics promise a new understanding of the connections between nutrients and long-term health. But the impact in the marketplace depends on whether consumers learn about the connections between specific nutrients and their own genetic makeup and change their habits in light of this information.

With this in mind, we had three goals for our research this last year: to determine how the complex scientific information discovered by nutrigenomics research will be disseminated to the public; to identify the drivers and barriers to the dissemination of that information; and to forecast the likely penetration rate of this information into the daily life of consumers in the next decade (see Figure I-1 on page 2).

THE PERSONALIZED NUTRITION MARKET IN 2010

Our research indicates that a substantial share of the U.S. population is ready to absorb and use high-quality information about personalized nutrition to change their shopping and eating habits. Analysis of the data shows that about one-third of all American adults are likely to make at least some decisions based on knowledge of personalized nutrition by 2010. This will create an opportunity for a substantial transformation of the food and nutrition industry in the United States and elsewhere—especially for producers and packagers of food, retailers, pharmacies, managers of magazines and health reports, and health insurance companies.

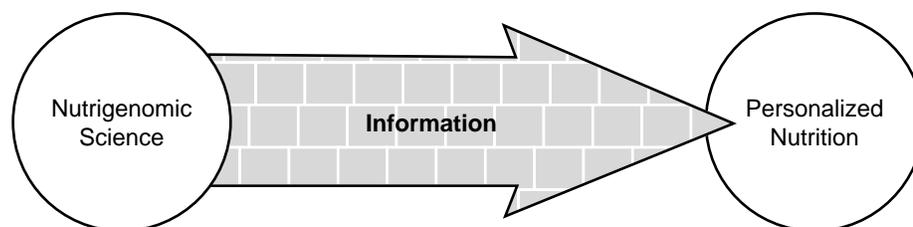
WHAT ARE NUTRIGENOMICS AND PERSONALIZED NUTRITION?

The two concepts at the core of our study are the emerging science of nutrigenomics and the practical applications of this science in the form of personalized nutrition products and services.

- *Nutrigenomics* is the scientific study of the way specific genes respond to given nutrients—in other words, the relationship of what we eat with the way our genes function. The goal is to promote human health through optimal nutrition.
- *Personalized nutrition* is the application by individuals of their knowledge of nutrigenomics to their everyday decisions about nutrition. The goal is to maximize their own and their family’s long-term health based on their knowledge of nutrition and their unique genetic makeup. Consumers will learn about their genetics in at least two important ways: either directly, by means of genetic testing, or indirectly, based on family history or personal experience (Figure I-2).

How the relatively new science of nutrigenomics will lead to a broader acceptance of personalized nutrition will depend on two key influences: the flow of information from the study of nutrigenomics to the general public,

Figure I-1
From Nutrigenomic Science to Personalized Nutrition



Source: Institute for the Future

and the broader acceptance in medicine and the society at large of the critical role of prevention in maintaining long-term health.

THE LAYOUT OF THE REPORT

Nutrigenomics research will increase the understanding of the effects of particular nutrients on specific genes. The efficacy of the science will be determined by the discovery of shared genetic characteristics among sub-groups of the population—common population polymorphisms—that occur among fairly sizable population groups. The groups with these characteristics will benefit from changes in nutrition in predictable and consistent ways.

This report identifies the characteristics of those types of individuals most likely to embrace personalized nutrition, examines the forces likely to influence their number, and forecasts how many people will be most open to learning about the preventive benefits of personalized nutrition and act on them in the marketplace.

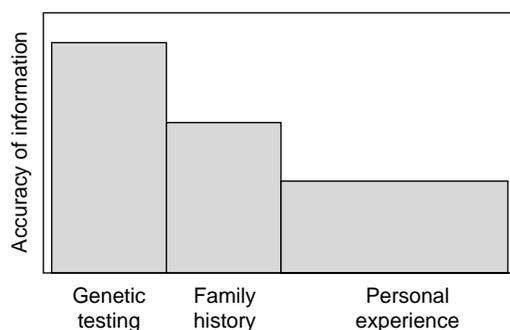
This report has six chapters:

- *Sophisticated Consumers Welcome Information.* Many consumers are becoming more active in using information for per-

sonal needs. This characteristic opens them to the information that will flow from nutrigenomics research.

- *The Bioethics of Nutrigenomics and Personalized Nutrition.* As nutrigenomics raises possibilities of important changes for individuals, consumers, businesses, and society at large are sure to raise a host of bioethical issues concerning the uses and misuses of genetic information in particular and the validity of the whole enterprise in general. Such issues are likely to affect the perceptions of the benefits and risks of personalized nutrition.
- *Regulation: Grappling with a Revolution.* The future role of the government in regulating personalized nutrition products and services, ensuring the safety of food and other nutrients, and monitoring the labeling of food and nutrition products will affect the spread of information about personalized nutrition, as well as its market growth.
- *The Consumer Nutrition Index.* The Institute for the Future's Consumer Nutrition Index (CNI), as derived from our latest survey, provides a good picture of today's consumer interest in learning more about nutrition and adapting their behaviors accordingly. Those most interested in doing so will be the target market for personalized nutrition in the next decade.
- *The Forecast: One-Third Will Turn to Personalized Nutrition.* Based on our research, we forecast the types of people most likely to turn to some form of personalized nutrition by 2010 and what percentage of the population they are likely to be.
- *The Market for Personalized Nutrition.* We explore the key business implications of the forecast.

Figure I-2
Information Sources for Personalized Nutrition



Source: Institute for the Future

Chapter 1

Consumers Welcome Information

Consumers will play the key role in the emergence of a market for personalized nutrition products and services. By definition, personalized nutrition is aimed at the individual, or at least at smaller and smaller subsets of the population. For personalized nutrition to take hold in the marketplace, individual consumers will have to actively choose it one by one. Mass appeals won't work. For any forecast of market acceptance, then, we must understand what share of consumers is likely to change their behaviors—without the presence of any adverse symptoms—based on information about the way their genetic profiles respond to different foods or supplements.

The basis for such decisions is the willingness of consumers to integrate information from a variety of scientific sources and make changes to their lifestyles. The first step in understanding how likely consumers are to make such choices is to find out how today's consumers use all kinds of information in a variety of settings. Many consumers use information more intensively these days. These are the ones that will be most open to the discoveries of nutrigenomics.

MEASURING THE GROWTH OF SOPHISTICATED CONSUMERS

In our research, we have examined sophisticated consumers' use of information and the ways they like to communicate. (Sophisticated consumers are those with more education, greater affluence, and more experience with information technologies than more traditional consumers.) We have tracked information and communication patterns across a wide range of industries, such as health care, retail, telecommunications, utilities, and financial services. In all of these areas, these more sophisticated consumers have pushed for easier access to information, a more focused message, and more control over the information. In doing so, they have become a force to be reckoned with in these industries, utterly transforming supply chains and communication practices.

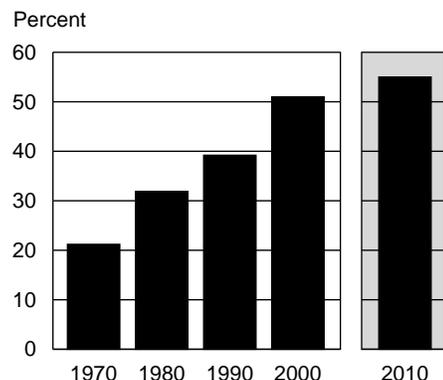
Not all consumers use information in the same way, but at least half of today's adult population can be described as active information users. In fact, while patterns in the use of

information vary, large numbers of sophisticated users use information intensively for daily activities.

The demographic characteristics of the active information user are educational attainment, household income, information-intensive occupations, and the steady use of new information technologies. All four indicators show an increasing share of the population with these characteristics and thus a long-term rise in the share of people using information more intensively.

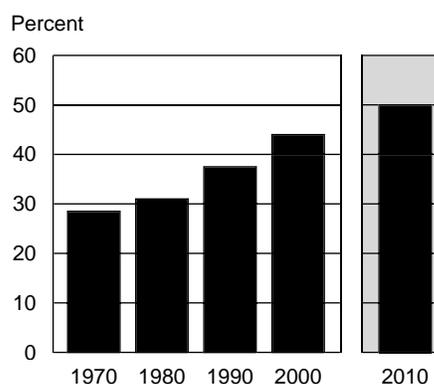
The share of the population that has gone to college in the United States, for example, has been rising steadily and rapidly in the past 30 years. The average growth in the number of people over 25 with some college has been rising at an annual rate of 4.6% in these three decades, well above the 1.6% growth in the number of those 25 years of age and older. Indeed, the college-trained population has reached more than 51% of the total adult population (see Figure 1-1). The share should continue to rise at a rapid pace for at least the

Figure 1-1
Rise in College Level Attainment
(Percent of all people 25 and over who have gone to college)



Source: Institute for the Future; U.S. Census Bureau.

Figure 1-2
Share of High-Income Households Is Rising
(Percent of U.S. households with \$50,000+ income, in constant 2001 dollars)



Source: Institute for the Future; U.S. Census Bureau.

next decade, since over 60% of today's 20- to 24-year-olds have been to college compared to 25% of those 65 years of age and older.

Likewise, the share of households with incomes over \$50,000 (in constant 2001 dollars) has risen from about 28% in 1970 to 44% in 2000 (see Figure 1-2). This share, too, should continue to grow since the baby boomers—the first generation to have at least 50% of its members attend some college and 50% to have information-intensive jobs—will be in their peak earning years until the turn of the decade.

The share of people who work in information-intensive jobs—as managers, professionals, technicians, and business sales agents, to name a few—shows the same rapid growth trend, having jumped from 30% in 1970 to 46% in 2000 (see Figure 1-3). People in these kinds of jobs spend the majority of their work days processing information, sharing that information with others, and developing ideas about how to use that information to do their jobs. Over time, these workers realize that

such tools and skills are also useful at home. Essentially, it is these kinds of information-based behaviors that make sophisticated consumers different from other consumers.

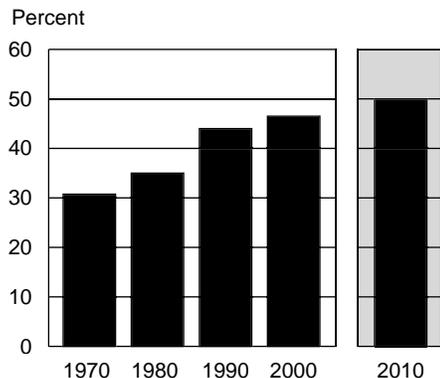
Finally, the share of the population who have ready access to PCs at home or who report that they go online regularly is also growing rapidly (see Figure 1-4). Computers and Internet access are two of the most important information-gathering tools in the sophisticated consumer's arsenal.

ACTIVE, SOPHISTICATED CONSUMERS ARE INFORMATION INTENSIVE

As consumers move up the scale of education, income, information work, and access to information and communications technologies, they tend to search for and use more information in their buying decisions and they tend to use it in new and different ways.

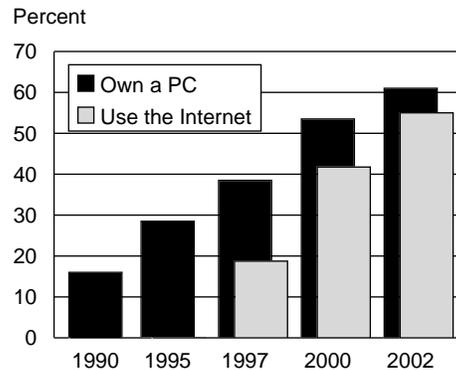
In the following figures, we have used education as a proxy for active and sophisticated consumers. We find a high correlation among the four sociodemographic characteristics that define sophisticated consumers—education,

Figure 1-3
The Number of People in Information-Intensive Jobs Is Growing
(Percent of workers in jobs that are information intensive)



Source: Institute for the Future; U.S. Census Bureau.

Figure 1-4
PC Penetration and Internet Use Are Rising
(Percent of households that own a PC and use the Internet regularly)



Source: Institute for the Future, Household Surveys; U.S. Census Bureau.

income, occupation, and access to new information sources. Education, however, may be the characteristic that best captures the key hypothesis that information empowers consumers. The data reported is very consistent with previous years. It shows increases in information activity primarily among the middle level of our spectrum—high school graduates, those with some college, and college graduates.

Interested in More Sources

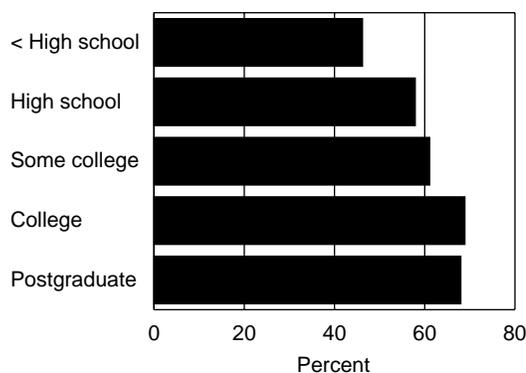
In our surveys, we have discovered that sophisticated consumers are likely to use a wider array of information channels before making important purchases. Using education as a proxy for sophisticated consumers, we find that those with more education are more likely to have used several sources before making a major household purchase (see Figure 1–5).

Three key factors underlie the fact that sophisticated consumers use more information. First, sophisticated consumers are relatively comfortable with the process of gathering and comparing information, given their advanced education. Second, they realize the limitations of any single information source—they want more information because they feel better about products and services that earn high marks from a variety of sources. And third, sophisticated consumers are price-conscious—despite their higher incomes, they don’t want to spend a lot of money without reason, and they are willing to shop for the best deal.

Use Information when Making a Life Change

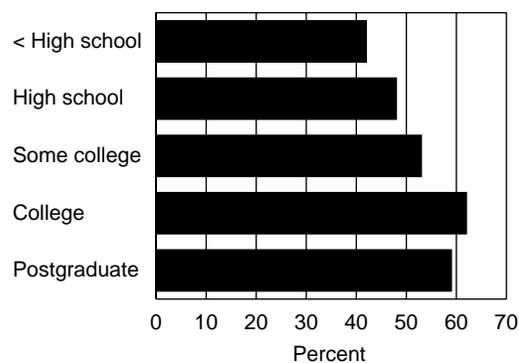
Sophisticated consumers process more information when making changes in their lives. When they make health care decisions, for example, sophisticated consumers are much more likely

Figure 1–5
Sophisticated Consumers Use More Information Sources
(Percent that used 4+ information sources before making their last major household purchase)



Source: Institute for the Future, U.S. Household Survey 2002.

Figure 1–6
Sophisticated Consumers Look Widely for Treatment Options
(Percent that consulted sources other than their doctor, for information about alternative treatment options)



Source: Institute for the Future, U.S. Household Survey 2002.

to look for medical treatment options outside a doctor’s office (see Figure 1–6).

Even when making small changes in behavior—like trying a new brand of food—sophisticated consumers rely on more information than traditional consumers. The share of consumers who “almost always” check the nutrition label of a food product before they try a new one rises dramatically with education (see Figure 1–7).

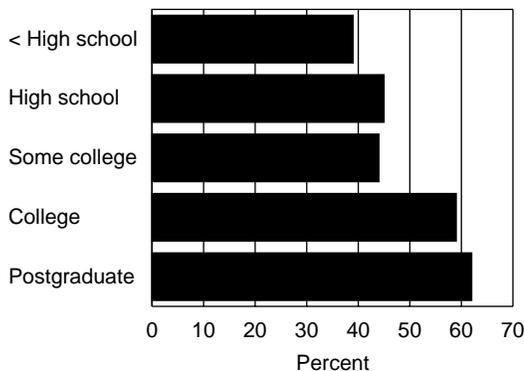
Like Self-Initiated and Interactive Information

Commercial information comes in many different forms. Many of these are presented to the consumer as they participate in other activities—mass media ads as they watch TV or listen to the radio, print ads as they read newspapers or magazines, sale signs as they shop for groceries or clothes, billboards as they commute to work, event sponsorship notices when they go to a concert or ballgame.

Perhaps because this glut of unsolicited information is easy to tune out, sophisticated consumers place a much higher value on commercial information for which they initiate the process by doing such things as Web searches or asking a company to send them information. Indeed, such information is two to three times more likely to be considered “the most useful information” in their final decision when making a major household or financial services purchase (see Table 1–1). The value of this information lies in its relevance—as the consumer requested it himself, it is far more likely to meet his specific needs and interests, and more likely to be trusted.

Sophisticated consumers are also much more likely to welcome information exchanges with businesses. Although such exchanges are down from their peak in 2000, the most sophisticated consumers are still almost twice as likely to give permission to

*Figure 1–7
Even When Making Small Changes,
Sophisticated Consumers Use More Information
(Percent of population who “almost always”
check the nutrition label before buying a new
food brand, by education)*



Source: Institute for the Future, U.S. Household Survey 2002.

*Table 1–1
Self-Initiated Information Is Most Valuable to
Sophisticated Consumers
(Percent that report self-initiated information*
was most useful before making ... purchase
decision)*

	Major Household Item	Financial Services
< High school	9	16
High school	14	18
Some college	24	38
College	33	51
Postgraduate	42	51

* Self-initiated information includes Internet information or information requested from companies.

Source: Institute for the Future, U.S. Household Survey 2002.

companies to send them regular updates about products or services (see Figure 1–8).

IMPLICATIONS FOR NUTRIGENOMICS

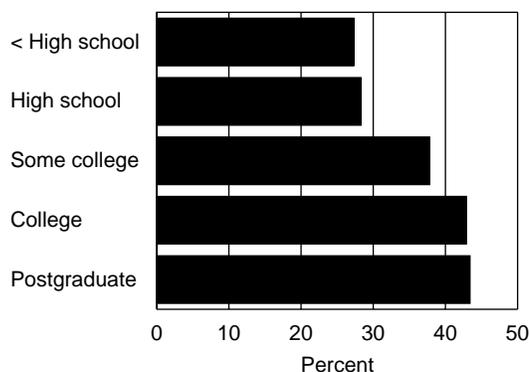
Nutrigenomics and personalized nutrition will provide information about the relationship between nutrition and particular genes that will be of vital interest to consumers. But to understand nutrigenomics, consumers will have to be their own active agents. In contrast to acute health care issues, where people go for treatment when they have obvious symptoms, nutrigenomics will be more preventive in nature. No single institution or stakeholder will drive the dissemination of information about nutrigenomics. Consumers will have to figure out the effects of nutrigenomics on their own.

The consumers most likely to do this are those we call the active, sophisticated consumers—those already skilled in how to

search for and process complex information and already familiar with the channels most likely to spread information about nutrigenomics and personalized nutrition. Indeed, our research indicates that a number of active consumers will find information about personalized nutrition valuable. These engaged consumers will determine for themselves what behavioral changes will help them “do” personalized nutrition for optimal health.

Before personalized nutrition can enter the marketplace, however, two things must be worked out—one, the bioethical issues stirred up by the science of nutrigenomics; and, two, how the government will regulate both the information from nutrigenomics research and the personalized nutrition products and services based on that research. These are covered in the next two chapters.

Figure 1–8
Sophisticated Consumers Are Willing to Share Personal Information with Businesses
(Percent that report they have given permission to companies to send them regular updates about products or services, by education group)



Source: Institute for the Future, U.S. Household Survey 2002.

Chapter 2

The Bioethics of Nutrigenomics and Personalized Nutrition

If consumers are to choose options for personalized nutrition based on the findings of the nutrigenomic sciences, first they must have access to these findings. In other words, they must be able to get information about nutrigenomics and what it means for their personal health, and they must be able to trust that information. The next step is to make this information work for them. For this, many will need access to information about their own genetic profile, as well as a detailed knowledge of nutrition products and services.

Whether consumers have access to trustworthy information, secure genetic testing, and safe personalized nutrition products and services will be influenced by results of the bioethical debate. When is scientific information ready for people to act on it? Who is responsible for interpreting science? Will genetic data be adequately protected? Each of these fundamental issues has the potential to influence the spread of personalized nutrition.

WHAT IS BIOETHICS?

Ethics is about what's right and wrong, about basic moral issues and obligations. Bioethics is the applied study of moral issues in medical care and treatment. It explores what should or should not be done as judged by its impact on human beings.

As science advances and technology offers new and unforeseen possibilities and problems, questions arise about the most basic consequences of what we are discovering and creating. To begin to answer these questions, we need to explore the risk–benefit tradeoffs with all the stakeholders involved—scientists, policymakers, religious leaders, and consumers. What are the benefits of scientific breakthroughs? What are the risks and potential side effects of using a new technology?

When questions about the safety of a new technology have been raised in the past, the focus has been on understanding and explaining the science without always giving proper weight to the wider impact on society and the environment of that technology. The controversy over the effects of genetically modified agricultural products and food on the environment and on the food chain is one example. By considering all perspectives at the earliest stages of a new scientific development, we can try to anticipate all the issues that will arise for the public.

A SPECTRUM OF PERSPECTIVES

Most ethical debates raise the question of whether an action is morally acceptable or not. One's ethical approach can be grounded in any of a number of influencing factors such as religion, culture, or personal history.

In fact, the range of ethical perspectives in response to an issue falls along a spectrum. At one end of the spectrum are those who believe

in an absolute authority that can define the right—whether it is God, the bible, the constitution, law, or science. At the other end of the spectrum are those who believe that each action is different and that the situation always determines what is right or wrong (so-called “situational ethics”). Most of us find ourselves somewhere in the middle, using varying amounts of trust in authority and our own appreciation of the uniqueness of each situation. In nutrigenomics, for example, we may have confidence in the credibility of peer-reviewed science, but feel that only personal experience will help us decide whether to give nutritional supplements to our own children. This is where the notion of ethical debate arises. Where there is no uncertainty, there is no debate.

The actions of a particular individual are usually determined by combinations of appeals to personal judgments and belief in authority, but are often grounded on a core ethical belief. For example, a doctor who refuses to perform an abortion justifies this decision on the grounds of her own moral rules, such as the rule against killing another human being, which are in turn supported by principles, such as the sanctity of life, which ultimately are justified by ethical theories.

Both the interpretation of the situation and comprehensive description of the case from all perspectives are key to a fair ethical debate. Broad scientific, metaphysical, or religious beliefs often underlie our interpretation of a particular situation in which we must act. In addition, we may invoke these convictions to vindicate certain theories and action-guides. Moral debate about a particular course of action may stem not only from disagreement about the relevant moral action-guides but also from the interpretation of factual information.

NO EASY ANSWERS FOR THE ETHICS OF NUTRIGENOMICS

Ethical issues in nutrigenomics are particularly complicated because the science and its applications sit squarely between nutrition science on the one hand and medicine on the other. Since they don't fall clearly in one camp, the ethical issues of nutrigenomics cannot be wholly guided by the well-established moral precepts of either discipline. The focus of food ethics is on the safety of production and the end products, not their efficacy, whereas the focus of drug ethics is not only on the safety of production but on the efficacy of results.

Ethical Issues in the Food Industry

Experimenting with food to create better nutrition and health goes well back into pre-historic times. This long, long history of food use has established a wide acceptance of what is beneficial and helpful about food. In fact, the Hippocratic oath of ancient Greece stated that the key rule in the application of food and nutrition is “to do no harm.”

As a result, the basic principle of food production and nutrition regulation today is to ensure safety and clarity about ingredients. The key ethical debates in the last few decades about food and nutrition have been about ensuring the accurate labeling of food products, stopping false claims of special benefits for some foods, and identifying the use of hormones or genetic modification of agricultural products and foods where applicable. In other words, the emphasis with regard to food and nutrition has been in regulating information and safety rather than mandating functions or efficacy.

Ethical Issues in Medicine

The roots of medical ethics also can be traced to ancient Greece and the Hippocratic oath of “do no harm.” Codes of ethics written by groups such as the American Medical

Association have used this principle to guide physician behavior for centuries. Beyond “do no harm,” such codes have the goal of ensuring that patients understand their situation and give informed consent, that patient privacy is protected, that some level of access to health care is provided for all, that patients are protected against discrimination, that the proper treatment of human subjects in clinical research is ensured, and that guidelines on the standard of care for particular disease states are continuously updated.

Ethical Guidelines for Nutrigenomics

As we write this report, ethicists at the University of Toronto and the University of Guelph are constructing a comprehensive set of ethical guidelines for nutrigenomics that will address the science as well as its application in products and services. The guidelines could be used to educate and prepare key stakeholders and the public for the expansion of nutrigenomics. The audience for the guidelines will include consumers and the public, legislators, regulatory authorities, public health officials, insurance firms, food producers and packagers, industry associations, business school leaders, consultants to the nutrigenomics industry, and entrepreneurs. Since the link between ethical issues and the legal world is strong, these bioethical guidelines could provide an initial template for the regulation of nutrigenomics (which we discuss in more detail in the next chapter).

With this report and our collaboration with ethicists, we want to help our readers think through potential bioethical issues as a prelude for the public debate that is likely to come. This will lay the foundation for strategic thinking about how to approach the marketplace when the regulation of nutrigenomics and personalized nutrition services comes about.

BIOETHICAL ISSUES

The bioethical issues raised by nutrigenomics fall into six categories:

- The scientific validity of nutrigenomics.
- The privacy of personal information and protection from genetic discrimination.
- Consumer control and the notion of informed consent.
- The role of clinicians in genetic testing and personalized nutrition.
- Intellectual property and access to information, products, and services.
- Moral issues and business ethics.

Ethical issues usually arise when applying the findings of nutrigenomics to people and their health. Individual consumers will likely make these choices case by case. Regulators will help define the larger set of practices appropriate to these circumstances.

1. The Scientific Validity of Nutrigenomics

Scientific advances are very exciting and make for great news stories. As a relatively new science where truth and hype are not yet clearly distinguished and evidence of long-term beneficial effects is in short supply, nutrigenomics is suffering the same fate as other nascent scientific fields such as gene therapy, which holds great promise of highly targeted treatments without a true appreciation of long-term effects.

Nutrigenomics is being hyped by a popular science press that doesn't present a comprehensive discussion of how the science works, nor does it distinguish clearly what practical applications the science has for individuals.

In fact, scientists are just beginning to look at the complexity of gene interactions, and it will probably be some time before they are clearly mapped. So far there has been little empirical work done to determine what happens over time to nutrient-gene interactions that take place within a whole spectrum of gene arrays. The ethical issue is how to make judgments of scientific validity when longer term systemic consequences are unknown. At what point in the process of scientific inquiry can personal actions be recommended? While the pharmaceutical market has very clear standards for the empirical testing of the efficacy of disease-preventing outcomes, the field of nutrigenomics does not.

Although the field of nutrigenomics is already advancing knowledge, particularly in the realm of nutrition science, the nature of scientific inquiry is to move ahead slowly step by step with hypotheses and the widespread and open sharing of results. The very openness of scientific inquiry may become part of the problem in this case. A worst-case scenario would be a patient getting hold of preliminary information, having a

personal genetic test done, and starting to use large quantities of a nutrient that has adverse impacts on his body's metabolism.

► **ISSUE**

Is it right or wrong for the field of nutrigenomics to move ahead with recommendations for behavior without empirical studies of longer term efficacy?

The broad communication and individual assessment of risk are related to scientific validity. Even once a nutrition technology has been proven scientifically valid, science writers, physicians, nutritionists, food magazines, food packagers, and consumers still need to balance competing claims and make decisions that weigh the benefits and risks and draw implications for consumers.

What's more, scientific validity in a controlled setting will not completely answer the risk question for individuals, for whom the gene–nutrient interactions take place in a complex setting of many such reactions. Risk assessment requires a multifactorial approach, while an individual consumer's understanding of risk is much simpler and more personal than scientists' and clinicians'. Clinicians, genetic testing companies, and personalized nutrition service companies will often mediate information and advice that is disseminated to consumers. Genetic testing that leads to concrete nutritional recommendations only looks at a subset of genes and a small part of the individual's genetic picture and the resulting advice and recommendations for products and services must be considered within these parameters.

Strategic recommendations of the bioethical considerations of the scientific validity of nutrigenomics include:

- > **Understand the business risks of the bioethical issues.** New fields require the brave to forge the way without always knowing if there's solid ground ahead. There are significant risks to leading the way in an untested field, especially one whose bioethical ramifications have yet to be decided. When making the leap, understand your potential market and the ability of your business to serve it well, but realize that some of the risk isn't business risk per se but moral risk.
- > **Articulate the benefits and risks of nutrigenomics in a balanced way.** To inform the bioethical debate, promote high-quality studies from unbiased researchers, regulators, and government sources. Be self-critical and candid about the answers nutrigenomics cannot provide. Leverage the answers it can provide.
- > **Be clear about risk communication.** It is incredibly important to be careful about giving advice to consumers of personalized nutrition services. Many of those concerned about their health are looking for someone to fix all their problems in one fell swoop, to give them a clean bill of health. Since nutrigenomic science targets prevention and health promotion rather than the curing of disease, it is important to stress the probabilistic relationship between genes and the environment.
- > **Remember the opportunity—don't lose the excitement.** There are opportunities to help people experiment with foods and supplements to improve their health in ways they never have been able to before, with possibilities for real changes down the road. To make it that far, do everything you can to bring the bioethical debates to resolution.

2. Privacy and Genetic Discrimination

Genetic testing presents a unique threat to privacy because it involves the collection of genetic material—the very essence of our physical makeup—and the sensitive information that may be derived from that material. Many ultimately fear a kind of sci-fi totalitarian nightmare, in which employers, insurance companies, state authorities, the criminal justice system, and so forth discriminate against individuals with less desirable genetic characteristics.

Indeed, the scientific community, let alone the public, is just beginning to understand the awesome power of individual genetic information, what it might mean for future societal costs and savings, what it might mean for the generations to come, how it can be used (and abused). Clearly, there are huge benefits in knowing what an individual's genetic makeup portends for his or her health. But there is also a generalized public dread of the potential abuse of that information. Who will control that information? Do the benefits outweigh the risks of having that information out there?

The concern about genetic privacy derives from a fundamental lack of public knowledge about current legal privacy protections in diagnostics and medical care. This disconnect between public fear and the privacy protections already in place must be overcome for individuals to accept DNA collection and the individualized information and services that can be derived from it.

► ISSUE

Should personal genetic testing be recommended if we cannot absolutely guarantee personal control of that information?

Strategic recommendations of the concerns about privacy and genetic testing include:

- > **Handle personal information with care.** Privacy protections in medical care are being examined closely as a greater proportion of personal medical information is converted to digital form or collected electronically. As a result, a great deal of electronic medical information is subject to stringent handling regulations. Is such information really well protected? And, perhaps more important, does the public at large believe this?
- > **Limit DNA storage.** The easiest way to address the concerns about DNA storage is to destroy the DNA material immediately after the test is conducted. Sciona, a U.K.-based biotechnology company that specializes in genetic diagnostics and their relationship to well-being has already adopted this measure. For Sciona, there is no need to store the material and this rules out criticism of mismanagement.
- > **Scrub aggregations of data.** Analyzing aggregated genetic data from large numbers of individuals allows for the detection of patterns and potential observations about communities of individuals that would be very beneficial for improving population health and providing products and services. The only way to do this while protecting personal privacy is to “scrub” the data of all personal identifiers. The degree to which data must be scrubbed to be free of identifying markers is still being debated. A conservative approach will likely be the best way to avoid criticism.
- > **Earn consumer trust.** Organizations that do genetic testing must prove themselves more trustworthy than incumbent stakeholders because they are the new players on the block.

3. Consumer Control and the Notion of Informed Consent

Not only do consumers want control over any personal information that might result from procedures like genetic testing, they also want control of the experience of personalized nutrition altogether. In other words, they don't want to be told what to do, but want to make informed decisions on their own.

What's more, bioethical codes require physicians and researchers to obtain informed consent from patients or research subjects before significant treatment or research procedures can be conducted. This has been extended in many situations to include individuals' rights to control not only what happens to their bodies but also their personal information. Beyond promoting personal autonomy, informed consent functions to protect patients and subjects, to avoid fraud and duress, to encourage self-scrutiny by the medical profession, to promote rational decisions, and to involve the public in these kinds of ethical issues.

This is where it gets a little tricky in the realm of nutrigenomics. Since the field is so new, and, ultimately, so complex, is any consumer capable of truly offering informed consent? Will that ever be the case?

This ethical issue uniquely challenges promoters of personalized nutrition. Informed consent requires that an individual be given adequate information to choose a course of action. But the complexity of genetic information and the difficulty of interpreting that information at the individual level, let alone considering the influence of all environmental factors, make truly informed consent quite hard to achieve.

As genetic testing services are made available to consumers, counseling will be essential to aid in the interpretation of the impact of nutrition across a broad range of genes. But an assessment of probabilities and risks will always have to be

undertaken. In a preventive model based on nutrition that is considered safe, the consumer will always have the final say. After all, personal autonomy also means that individuals cannot be arbitrarily stopped from experimenting and trying things that may be useful to them, including nutritional variations and genetic testing.

This leads to another ethical issue, however. There are growing gaps in society based on the ability of individuals to handle complex information—the gap between those with less than a high school diploma and those with a postgraduate degree is huge. Those who have access to large amounts of information tend to use more of it in their daily decisions and tend to use it more effectively; those without access tend to do without information even for important decisions. If left completely up to individual control, a potential major health benefit such as personalized nutrition may end up going just to those who are comfortable with complex information.

As a result, there seems to be some obligation within the health system or by government regulation to ensure that purveyors of critical information about possible preventive actions provide as much information as possible in a variety of formats.

This issue will be hotly debated, as no clear model for risk communication exists in the public sector. We have public health mandates such as seat belt laws and laws about drinking and driving, but we have not successfully reached people on many nutrition issues to date.

► ISSUE

If there are real gains to be made from personalized nutrition, is there a public role in spreading the word as opposed to leaving such choices to the individual consumer?

Strategic recommendations with regard to the bioethical considerations of consumer control and informed consent include:

- > **Respect the consumer.** As individuals get more information about themselves and their health, serving them while respecting their desire for control and self-determination will be the key to winning their trust. Ultimately, the government and health system won't be able to get in the way of valid experimentation and the believers who spread that word.
- > **Give information to those who want it and provide counseling and other information services.** Information is the currency of personalized nutrition. The context for information dissemination about personal health risk will be full of mixed messages and offer information of uneven quality. Becoming a trusted source for high-quality information and determining when and how to most appropriately provide that information in targeted and timely ways will enable you to give consumers options for making decisions based on truly informed consent and exerting control over their experience with nutrigenomics.

4. The Role of Clinicians in Genetic Testing and Personalized Nutrition

It's unclear whether the primary model for personalized nutrition will be physician mediated or go directly to the consumer. An important question is this: What will be the clinicians' role in the use of genetic testing for the purposes of personalized nutrition?

We must keep two things in mind here. One, today's physician training puts prevention and wellness at the periphery of the normal mode of practice, which is focused on finding and treating disease. Two, physician behavior regarding patients is guided by a professional code of ethics. The role of the physician in this network of moral relationships is as a trustworthy source of guidance and advice. Given the current uncertainty of the science of nutrigenomics, can doctors be expected to become involved in decisions about personalized nutrition?

In the context of personalized nutrition, this issue is complicated by the fact that though individuals turn to their doctor for treatment and prevention advice, the physician's focus is more on treatment and curing of symptomatic disease and less on prevention and wellness. Personalized nutrition is aimed at wellness and changing nutritional behavior, which has been the domain of dietitians and nutritionists who compete with commercial weight-loss services and products for consumer attention. Though some physicians currently make referrals for genetic testing and counseling as well as nutritional advice, the connections are weak and a genetic counselor or dietitian is rarely a key player in a medical practice.

As direct-to-consumer diagnostic genetic testing for predisposition to disease as well as genomic profiling for other reasons, such as personalized nutrition, is made available, physicians will be hard pressed to become educated enough to respond to consumer demand for advice. If physicians are under- or uneducated about genetic testing and unable to provide relevant information and advice to patients, for example, there is a risk of erosion of trust in the physician role in the preventive model by the public. There is also a potential risk of harm if the consumer doesn't get appropriate counseling in response to a test. This same concern was raised with the development of home-based testing for HIV, and as a result, a number of home-based HIV test services provide counseling with the results of the test (something that is still controversial and has had mixed results).

► **ISSUE**

Should clinicians act as the intermediary between patients and personalized nutrition options?

Strategic recommendations regarding clinician responsibility and direct-to-consumer genetic testing include:

- > **Be clear about the difference between treating disease and promoting prevention.** In fostering nutrigenomic science and personalized nutrition services, it will be important to establish how the wellness model of disease prevention

is distinct from the medical model for the treatment of symptomatic disease. Help physicians and other clinicians understand how to navigate between vital information about a disease and “nice to know” information about wellness and disease prevention so that they can pass on information to their patients in a morally responsible way.

- > **Clearly establish health care providers' roles (if any).** Whether targeting physicians or nutritionists, create partners of the health care providers by understanding the risks and benefits of their involvement from their perspective and by helping them define their roles in such a way as to ameliorate their risk.
- > **Professional training and education will be the key to helping providers.** Providers of personalized nutrition products and services can sponsor physician education regarding disease prevention, nutrigenomics, and nutritionist integration at the point of care. Look for collaborative opportunities with other health educators and promoters in the fields of public health, nutrition, and health education.
- > **Put the genetic test in an educational context.** When offering direct-to-consumer genetic tests, provide an educational framework along with them to help the consumer deal with and respond to the results.

5. Intellectual Property and Public Access

The ethical issues regarding intellectual property (IP) and access to patented products in the realm of genomics are multifaceted and complex. It's the same for nutrigenomics, if not worse.

Two key issues are the extent to which scientific discoveries in genomics should be patented, owned, and commercialized, and the concern about disparity in access should this be the case.

As biotech and pharmaceutical companies have explored business opportunities for using genetic technologies, some have sought to patent specific research procedures, sequencing information, and other research products, such as synthetically created life forms. The question of what is patentable continues to be hotly debated by scientists, ethicists, regulators, and entrepreneurs. This debate will extend to include products of gene-protein interaction research, such as nutrigenomics. The patent laws are even fuzzier in the realm of nutrigenomics, though, since most nutrients are found in nature and thus are present in naturally occurring foods, which by law cannot be patented. What might be more susceptible to patents are the testing procedures and special supplements of targeted nutrients.

IP laws may create a real gap in the development of the personalized nutrition market. Pharmaceutical research leads to patented drugs that can have large and long-term markets protected from competition by law. The potentially huge rate of return on this kind of protected market justifies very large research budgets and draws scientists into working in areas that are patentable (and therefore lucrative). That may exclude them from doing much of the work in nutrigenomics, which is based on nutrients found in food—which are very difficult if not impossible to patent and thus carry fewer financial rewards. IP laws, then, help

form a rational business model that encourages the development of targeted drugs to solve health problems and discourages R&D activity and business models that are based on products that cannot be patented.

► ISSUE

IP laws and reward structures discourage researchers and firms from working on many products that could be useful in terms of personalized nutrition.

Strategic recommendations of the bioethical considerations of intellectual property include:

- > **Be careful ... a little bad PR goes a long way.** When deciding whether to patent a product, take into consideration the potential public relations implications of a negative public reaction.
- > **Provide information.** Becoming a trusted purveyor of information may be more important than owning a patent. If information is the currency of personalized nutrition, then providing information will be key to any personalized nutrition business model.
- > **Emphasize processes and services as they may become more important than products.** Companies might have more success positioning themselves as someone to be trusted as the provider of a packaged offering that includes testing, counseling, and special preparations.
- > **Level the playing field, maybe?** Is there more harm than good in maintaining current laws that don't allow for patents on most food products? Should entrepreneurs expect the same level of patent protection to secure intellectual property rights for new discoveries in this area, even though food products in general are not patentable? This is an area worth exploring in a responsible manner.

6. How to Deal with Moral Issues and Business Ethics

Business ethics refers to the way a company behaves about issues of right or wrong. The reputation and behavior of a business are the basis for public trust or lack thereof. The public perception of a company often determines its ability to sell products and services successfully. Companies that are most concerned about their public image will set up an internal system to monitor, define, and respond to ethical issues.

Businesses that promote and use a technology make investments in the technology and cannot help but be biased toward the success of that technology. Their objectivity with regard to the risk–benefit tradeoff of the technology might be compromised by their interest in it being successfully adopted.

In the case of personalized nutrition, and other industries that depend on the use of genetic material and technology, the business relationship with the public has already been tainted by a negative public opinion regarding genetically modified (GM) organisms, especially in Europe. Politically active groups such as GeneWatch have very powerful communications networks and organizing skills, which can be tapped to draw intense public scrutiny on businesses that are

commercializing gene-based technologies. These groups are fearful of both foreseeable and unforeseeable results of gene-based technology. They question the risk–benefit tradeoff.

► ISSUE

How can businesses play a leadership role in creating a new and important preventative model without exposing themselves to risk?

Strategic recommendations include a number of ways an organization can integrate bioethics and business ethics to meet these concerns head on:

- > **Form an external advisory board** that consists of scientists, ethicists, and consumer advocates. Such a board can challenge and provide early feedback regarding potential ethical implications of your activities.
- > **Hire an external ethics consultant** who, as an unbiased third party, scrutinizes and critiques business procedures and practices with regard to ethics.
- > **Create an internal ethics consultancy** with the same function for scrutinizing the ethical implications of business procedures and practices.

ARE WE HEADED TOWARD REGULATORY INTERVENTION?

Until many of these bioethical issues are dealt with, the science of nutrigenomics will remain just another interesting lab exercise. Because the industry itself won't be able to find all the answers, the role of government regulation is likely to become critical in dealing with some of these issues, as we discuss in the next chapter.

Chapter 3

Regulation: Grappling with a Revolution

One way to address bioethical considerations is by means of government regulation. But how do you regulate the emerging areas of nutrigenomics and personalized nutrition products? Like food products, since they are concerned with nutrition? Or like drugs, since they will be based on very specific notions of prevention of disease?

These are two very different models, with different implications for the marketplace. There are good arguments on both sides, and it's likely that future regulation will take the form of some combination of the two.

The primary goal of the regulation of food and drugs in the United States is to protect public safety. This goal has been interpreted quite differently for drugs on the one hand and food on the other, resulting in vastly different regulatory mechanisms. The genomic revolution is taking place on the middle ground between the two, and is likely to significantly change how people look at food and nutrition as tools for ensuring health.

Regulation—of both the science of nutrigenomics and the way information derived from that science is disseminated—will have a profound effect on the impact of this scientific revolution. The key questions are these: Are current regulatory policies adequate to deal with the range of issues likely to arise? And what might future regulatory mechanisms look like?

THE CONTEXT OF REGULATION

In the United States, the Food and Drug Administration (FDA) is responsible, as the name implies, for regulating both food and drugs. The FDA's goal has always been to protect public health and oversee the preparation of products that provide the "reasonable certainty of no harm."

Today's Regulatory Environment

The FDA was established early in the 20th century to prevent abuses and public deceptions in both the food and drug industries. From the first, the agency required that the information describing the contents of products (both food and drugs) be clear and easily understood. It also conducted checks to determine whether what was stated as content actually appeared in the product. In a major shift in policy during the 1930s, pharmaceutical companies were required to prove the safety of a new drug before it was put on the market, and by the 1950s they were required to prove the efficacy of their claims. Meanwhile, common foods have long been considered safe as long as content and preparation procedures were strictly followed.

In the 1970s, the FDA established special rules for supplements. To determine what type of regulation applies to a given product, the FDA puts great weight on its intended use, as follows:

- *Drugs.* Drugs are intended to treat a disease or a symptom of disease and to prevent the spread of infectious disease. Because of the strength and potency of many drugs, their clearly delineated uses and potential side effects, drug regulation is strict. New drugs must pass tests that prove their safety and efficacy in the treatment of a disease.
- *Food.* Food is generally intended to be used for nutrition or simply the social pleasure of dining. The safety of commonly used foods has been long accepted by tradition. When the FDA began to regulate the production of food, it was to ensure the freshness and safety of the food concerned, not its efficacy. Gradually, the labeling of food became the focal point of regulation. The FDA mandated that labels on all prepared food had to include a true description of what the package contained. Currently, labeling regulation requires that any such information on the package be useful. The key to effective food regulation is pre- and post-market surveillance and testing; the goal of regulation is to ensure the safety of the food supply and public confidence in that safety. Nutrigenomics, which provides information about food ingredients that could be important for preventive health, introduces a whole new set of issues because it allows claims to be made about preventing certain conditions in particular subgroups of the population. However, presenting this kind of information on food labels does not fit neatly into current FDA rules, especially when foods can be adapted to meet important genetic differences among potential customers.
- *Dietary supplements.* Dietary supplements fit somewhere in between drugs and food. They are intended to supplement traditional foods by providing enhanced amounts of ingredients that naturally occur in food, such as vitamin C, say, or antioxidants. Because they consist of so-called "natural" ingredients, they don't need pre-market approval. In fact, when the FDA wanted to impose additional regulations on dietary supplements in the 1970s, it ran into a major lobbying effort by the supplement

industry with the strong support of activist consumers whose outspoken position was “leave us alone.” Those who believe in supplements feel very strongly about their effectiveness and want to ensure their availability. The result of legislation in 1976 (the Proxmire Bill which prohibited the FDA from regulating vitamins and minerals as prescription drugs), 1994 (the Dietary Supplement Health and Education Act), and 1997 (the Food and Drug Modernization Act) was to limit the FDA’s ability to restrict the content, availability, and labeling of dietary supplements and to allow manufacturers to make limited health claims. In a similar case of consumer activism, when the U.S. Department of Agriculture (USDA) tried to use a broad definition of “organic” that would have included genetically-engineered foods, irradiated foods, and crops grown in sewer sludge, there was a huge number of comments (275,000 in a four-month period in 1998) that led to the withdrawal of official guidelines. The government is setting labeling and other guidelines for the nutrition content of foods and will no doubt soon have to deal with active and engaged citizens with similarly strong opinions on these matters as well.

In the regulation of drugs, there is a greater trade-off of risks and benefits that must meet a much stricter standard than that for food; in putting drugs on the market “the benefits must outweigh the risks of harm.” But nutrigenomics and personalized nutrition present a unique problem for the regulator. Personalized nutrition offers a path to better health for the active consumer through preventive care and nutrition. But the path is intensively information dependent, which is pushing the boundaries of what the current regulations on labeling and health claims can reasonably cover.

If health claims on labels are restricted, the burden of linking the product to its beneficial effects must be done at a place and in a way that is removed from the product; if a broader interpretation of labeling requirements is allowed, then the nutrigenomic information on the label can get dreadfully complex if it is to cover a wide range of benefits for different genetic groups. A key issue is whether the government wants to take a more proactive role in being the clearinghouse for appropriate claims and information, whereas in the past it has emphasized safety concerns. In any case, the current regulations on food and nutrition don’t address the bioethical issues that are likely to be raised by the spread of nutrigenomics and related sciences.

Information as Key to Personalized Nutrition

How we communicate about food content will be critical to the spread of nutrigenomic information to those interested in personalized nutrition. Personalized nutrition demands that we change the way we think about, present, and regulate health information about food. Advances in nutrition science and nutrigenomics will create a flow of information about the long-term beneficial impacts of certain food ingredients for specific groups of people. This type of information could be made available in a range of places—on product labels, next to the products, in stores, in wellness newsletters, in magazine articles, in the recommendations accompanying the results received from a testing company, in conversations with doctors. To be effective, the information must coincide with a person’s knowledge or guesses about their own genetic composition. Each information exchange might be of a different kind, might be presented by different players, and might attract a different audience. It’s going to be hard for

consumers to understand what they might get from each source and to distinguish which source is the best for which circumstances.

It is important to note that only a portion of the population will consist of active and engaged consumers willing to gather and process the information necessary to understand personalized nutrition and translate that information into behavioral change. It is likely to be difficult for the FDA to require or mandate information at the federal level that will benefit only a segment of the population.

In fact, the importance of information in providing benefits to individual consumers raises the question of whether regulation of personalized nutrition should take the form of food regulation or information regulation. Indeed, information about these products will have to be worded so as not to claim to treat disease if such products are to avoid falling in the category of “drugs” and become subject to the FDA’s stringent tests for efficacy. As preventive medicine, broader health promotion, and wellness get more blurred in people’s minds, we have to create new rules about how to talk about food content in the future. So far there is not a clear notion about how to engage more consumers to go beyond disease prevention to health promotion without sounding like we are talking about drugs.

As part of a prevention strategy, many more people will look to get adequate amounts of particular nutrients that may appear in small amounts in certain foods. This will lead them to seek enhancements through supplements or products fortified with more of these nutrients. (For example, women today who are predisposed to osteoporosis are increasing their calcium intake by taking calcium supplements or drinking calcium-fortified orange juice.) What the government is sure to concern itself with is the potential for abuse. Too much of one nutrient may have adverse affects on other parts of

the body. Regulations may have to focus on the tolerable upper limit of such supplements. So far active and engaged consumers can deal with simple products that are “high in this” or “low in that,” but as knowledge grows, consumers may end up putting very complex sets of nutrients together that may interact with each other in unexpected ways.

NEAR-TERM CHANGES

We are at the beginning of a scientific revolution in personalized nutrition that will be very hard to fit into today’s regulatory framework. What consumers are going to need—a trusted source of information that allows a wide range of opinions about the benefits of such products to their personal health in particular—is not supported within the current regulatory system. Indeed, a large disconnect exists between regulations that are made to protect everyone at once and scientific research—into both food and drugs—that is in the process of discovering variations that may be valuable to a single person.

What’s more, those currently in positions of power, such as pharmaceutical companies, as well as the regulators themselves, have some interest in maintaining the status quo. For regulators, the processes and procedures are known, with businesses paying a share of the cost; for pharmaceutical companies, current regulations form a major hurdle that discourages new entrants, and the rewards of approval under the current system can be huge.

But the same vested interest in the system is not as powerful in the food or supplement areas. While there certainly is a common shared interest in safe foods, the restrictions on labeling may be more of a hindrance than a help to the more active consumer. And at least some companies may find that being more active in labeling and information sharing may be in their best interests and result in greater

consumer support. In nutritional supplements, in fact, an activist consumer upwelling has already forced a substantial easing of regulations. We may see more of the same for food.

While it is not the duty of the regulator to interpret data for each individual, steps taken by the regulator can help or harm the process of sharing new and potentially valuable information. The variety of information media, the complexity of nutrigenomic science, and the difficulty of personal interpretation all muddle the transfer of nutritional information to the consumer. Each product may have different types of claims that can be made about it—and often those claims are focused on some very small and exclusive groups likely to benefit. The FDA has some influence over how information can be formulated and used for certain food products and supplements but is not in a position to make individual recommendations.

An intermediary that can be an honest broker of the latest scientific information—monitoring, indexing, summarizing, tailoring, reminding—can provide a huge service to the consumer, can make the regulator’s job easier, and can increase the reach of the manufacturer by disseminating the most useful information. But the varied needs of the consumer for information, the complexity of that information, and how it is used and interpreted by the consumer will inevitably cause problems for whoever tries to play this role because of the great danger of partial information and misinterpretations. Who will be liable for negative consequences? These are the questions that need to be hashed out.

LONGER TERM SHIFTS

It is not just the FDA that is under pressure to change. In fact, there is a groundswell of change in regulatory policy of any kind. Driven by a more activist and engaged consumer, the emergence of a whole range of new

information and communications technology options, and a somewhat higher tolerance for risk in a wide variety of areas—telecommunications, media, information delivery, financial services, career management—regulation policy in general is slowly shifting toward a more open and market-oriented framework.

We see some evidence of such changes in the new antitrust policies that define the basic rules for competition by looking not just at the size of the entities involved in proposed mergers, for example, but also at the potential benefits to consumers. These changes are especially evident in areas that deal with the consumer and information—telecommunications, the media, information delivery systems, and financial options to name four prominent ones—where the benefit of a more open system leads to more and better choices for consumers.

The general rule in many of these areas is to allow more information to flow to consumers to enable consumers to make better choices for themselves. In exchange for that autonomy, consumers are willing to take more of the risk onto themselves. In the long run, consumers are likely to realize the possibilities of personalized nutrition and to make some of the same demands they are making in other areas—let us have more information about the science and products and let us take more responsibility for how we use that information.

HOW REGULATORS MIGHT RESPOND

In response to the general changes in the attitude toward regulation, look for regulators to gradually change the way information is managed in food and health care as well. Regulation of food will shift from restricting the information found on labels to encouraging the dissemination of information that could be helpful to the consumer. Regulation of drugs will remain focused on new chemical entities. Successful companies in the food and nutri-

tion area will be those that can provide active, engaged consumers with the best information about options available by a number of channels and in many forms. Regulators will come to act more like the Securities and Exchange Commission, which actually mandates flows of information about companies and details of their current operations that must be available to anyone who wants it.

While this shift toward better information provision will take time, look for a number of concrete regulatory changes to begin to appear soon.

- *Education.* The first step in the revolution will likely be better public education about nutrition and health. Right now, the FDA has little expertise in genomics, which has significant implications for health applications and nutrition. There is a real challenge in educating the regulators—but there is a chance of a real creative push by means of education and training. The Nutrition Labeling and Education Act (1990) discussed the need for encouraging public education. As a result, there is a real potential for the government through the USDA, the FDA, and the Department of Health and Human Services to raise the profile of personalized nutrition. So far what has been done has been at the general level of a healthy diet, though even that has run into controversy around universal applicability. But the first stage of a regulatory change may be to help build an informed and aware public. Information must begin to reflect the increasing nuances and richer set of responses inherent in personalized nutrition.
- *Learn about efficacy.* Government and business should both invest in improving and increasing the number of longer term efficacy studies of the new personalized nutrition products. Since prevention can only be measured over extended periods, there would have to be a public role in this. But by funding longer term studies through universities and research centers, the government and food and nutrition companies together could help to begin building a database that measures the impact of changes in nutrition on small groups with shared genetic characteristics. This would provide support for developing labels and other consumer information that could reflect the outcome of these longer term tests—by saying that a particular type of nutrient was effective for a certain percentage of people with a particular set of genetic characteristics, for example.
- *New view of safety.* Regulators may have to become involved in new areas—the bioactivity, toxicity, and allergenicity of food products and dietary supplements, which until now lobbyists have successfully kept out of their purview. Safety issues would not be generalized to all users of food but issued as warnings that individuals would be responsible for monitoring.
- *Focus on safety.* With a wider market for information encouraged, the FDA would go back to its traditional focus on safety. The FDA could ensure that regulatory efforts on food and supplements would be put under enforcement that would better protect the consumer, allowing all kinds of information to flow when safety is proven.

IMPLICATIONS FOR BUSINESS

The regulatory framework for the spread of the results of nutrigenomics research and personalized nutrition products has yet to be set in place. This gives businesses with an interest in these areas ample time to work with regulators to create something that makes sense for everyone involved. They might consider some of the following:

- *Push for professional education and training.* Education, training, and systems of regulation need to be re-thought and re-built to encourage consumers to look into their own genetic characteristics and take responsibility for action. Consumers will need a rich set of accessible information to engage effectively. New ways of disseminating scientific information with the participation of research scientists, government regulators, academics, public health leaders, nutritionists, and companies with an interest in science and nutrition-based products will form the base of this public knowledge. Companies will have a part to play in helping to spread information: sponsoring longer term epidemiological studies, publishing academic work in easy to read formats, providing background material to magazine and health writers, holding forums, and sharing as much as possible of their own findings with the public will be key ways of getting this information out.
- *Don't let the government take the easy course.* Keep in mind that the needs of the population are divided: A certain number want to explore the benefits of nutrients; others just want to enjoy food and will have little interest in personalized nutrition. Regulators and the government must deal with these two very different constituencies. It will be easy for the government to find the lowest common denominator and seek the haven of a focus on safety and ignore advances in personalized nutrition. Businesses could push the government to take a role in improving access to useful and clear information that will be important for public understanding and trust of the more complex science.
- *Respond to testing.* Watch for an explosion in genetic testing to take place in the next five years. Consumers will seek genetic testing for many reasons, to assess their predisposition to disease and to decide on personalized nutrition among them. The key to taking this science beyond being merely a fad for experimenters is the ability of personalized nutrition to make some clear statements about how food and nutrition can prevent disease and promote health. The key driver for the testing market, though, will be companies that offer nutrition options once a test confirms the existence of a particular gene. Companies should begin working with regulators now to make certain there are no legal barriers to doing so.
- *A prevention model.* Personalized nutrition gives the health care system another opportunity to shift popular approaches to health care toward a prevention model. There are a number of precedents for the wide acceptance of preventive options—vaccines, exercise, general diet changes, mandatory use of seat belts, and water fluoridation. Personalized nutrition will be a part of a growing acceptance by the informed public of what is necessary for a healthy lifestyle. Unique to this kind of prevention is the personalized nature of it—not everyone will receive the same message. Food and nutrition leaders need to convince the public that an investment in

time and effort to find out more about themselves will enable them to take effective action on their own. They must convince the regulators to help make good information widely available, to allow companies the ability to make products based on that information, and to give consumers latitude in responding to that information and using the products and services that best fit their needs.

- *Be careful of complexity.* On the other hand, giving consumers information that is so complex they can't use it may be counterproductive. Even if people learn more about their genetic makeup, nutritional responses will be somewhat limited. One of the key issues is the complex interaction of genes themselves. As nutrigenomics begins to unearth these relationships, it will make it more difficult for individuals to track the possibility of complex multifactorial interactions on their own. The goal of helpful intermediaries will be to identify those genetic tendencies that portend potential adverse medical outcomes that can be managed by nutritional interventions. The goal is to manage health and not disease. Companies must work with regulators to set up the parameters of the marketplace so that they can create products and services that can be truly helpful, and so that consumers have both the protection they need and the freedom to make their own choices. A fine line indeed.
 - *Find a motivation.* Getting people to change is hard; the gap between learning about something and changing behavior is huge.
- There will be opportunities for motivation as the science moves ahead—genetic testing will give concrete indicators of the need to change; individuals will become more sophisticated about keeping their own family histories; there will be more larger-scale tests with targeted groups. Each of these will give motivations to specific activist consumers. Work with regulators so that the law won't stand in the way of reasonable accommodations to consumer autonomy in these areas.
- *Don't give up the food experience.* Keep a focus on the social and aesthetic side of food and don't try to medicalize it. Food and food preparation have strong cultural meanings that are in danger of being devalued by technological intervention. The great advantage of personalized nutrition is that it offers an opportunity to take the foods we use every day and show their value for a personal health. Work with regulators to make sure personalized nutrition products don't get categorized with drugs by default.
 - *Be aware of international needs.* In a globalized world, we really need to develop common guidelines around the world for the regulation of food and drugs, and in particular, how information and labels should manage the new possibilities of personalized nutrition across borders. If this isn't done well, the huge misunderstandings that plague genetically modified foods today could be repeated, leading to public confusion, restrictions on trade, and the slowing of innovation.

Chapter 4

The Consumer Nutrition Index

The intensity of the bioethical debate and the likelihood of regulations changing in response to advances in nutrigenomics research depend on two things: the intensity of consumer interest in personalized nutrition, and the actual number of consumers likely to take up personalized nutrition as a way of maintaining their health. In this chapter, we use IFTF's consumer survey to estimate the likely intensity of interest, and in Chapter 5 we forecast how many consumers are likely to embrace some form of personalized nutrition in 2010.

THE CONSUMER NUTRITION INDEX

To figure out the intensity of consumer interest in personalized nutrition, we ranked consumers using our 2002 Consumer Nutrition Index (CNI). The 2002 version is an update of the 2001 CNI described in the IFTF report, *The Future of Nutrition: Consumers Engage with Science* (IFTF SR-731).

The CNI is based on two behaviors—information use and proactive changes in dietary activities. Specifically, we have used the answers to four questions in the IFTF 2002 Household Survey (a nationally representative survey of 1,500 consumers in the United States) to create an index that gauges current consumer behaviors. We believe that consumers who exhibit certain behaviors now are the ones most likely to respond to advances in nutrigenomics and ultimately embrace personalized nutrition.

Questions About Information Gathering

People gather information in a variety of ways. They go to many different sources when they have a question about health or nutritional needs—their doctors, family and friends, online newsletters, stores, labels on food products, nutritionists, magazine articles, even the latest issues of *Science News* or the *New England Journal of Medicine*. The first question in the index focuses on the range of sources used by the respondents when they searched for nutrition information during the preceding year. A second question focuses on how the respondents used government-mandated nutritional labels when considering new products in the supermarket.

Questions About Dietary Activities and Nutrition

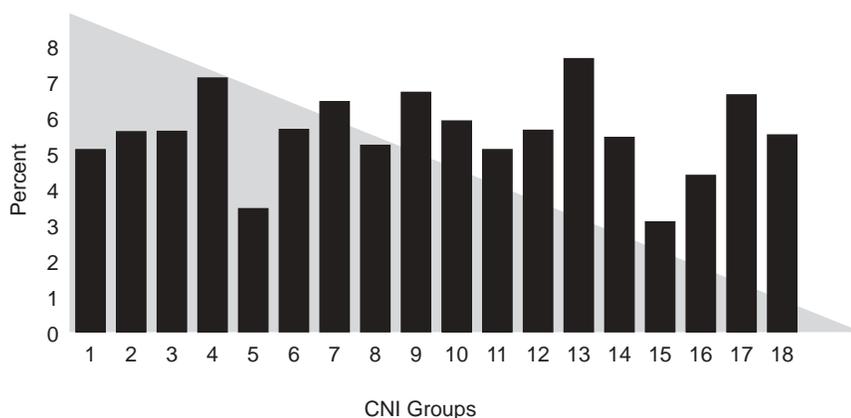
People are constantly changing their food and nutrition consumption. We wanted to get an idea of how many consumers are changing

their current behaviors to improve nutrition. Again, we examined two concrete behaviors: changes in diets to improve health, and the frequency of use of nutritional supplements.

SORTING CONSUMERS ALONG THE INDEX

Our goal for the CNI is to relate behavioral change, namely behaviors related to nutrition and to use of nutritional information. Since we want to look at the entire population, we have created a distribution that covers all possible behavior combinations—from intensive information use and significant dietary changes to no information use and no dietary changes. The spectrum of behaviors is best represented by a triangle that represents a gradual declining intensity of information and diet change behavior (see Figure 4–1). The population itself is broken down into 18 subgroups. Each of the 18 groups makes up a small share of the population that averages about 5.5%, but ranges from 3% to almost 8%. Appendix A

Figure 4–1
The Consumer Nutrition Index Illustrated
(Percent of population in each CNI population group)



Source: Institute for the Future, U.S. Household Survey 2002.

provides the breakdown and definitions of each population group.

SOME INTERESTING GROUPS

Analysis of the CNI identifies several groups along the spectrum that tell us a lot about the potential market for personalized nutrition products and services. We'll start by looking at behavioral and demographic profiles of representative groups along the spectrum. Each of these groups is particularly pertinent to our analysis of the market. We'll look first at the two extremes of the spectrum, at groups where the vast majority is likely to try personalized nutrition and groups where the vast majority is not likely to show much interest. Then we will look at some of those groups that are close to the middle of the spectrum—these are the groups most likely to be most uncertain about how they respond to the idea of personalized nutrition. It is important to note that these groups *were not selected by demographic char-*

acteristics, but by patterns of information use and nutrition behavior. However, while each group has a diverse set of participants, we found that certain demographic characteristics are over-represented in each group compared to what would be expected in a random sample.

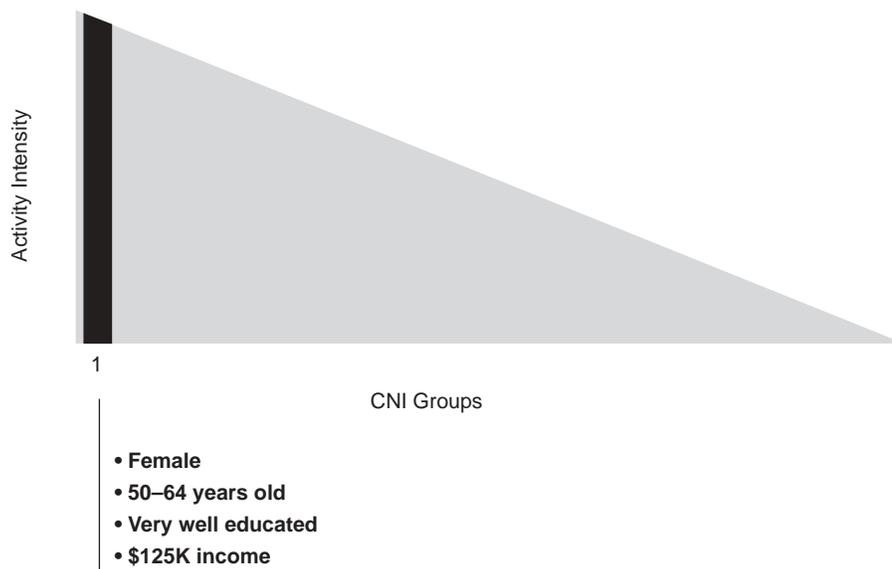
Group 1.

The Experimenters

The first group, the Experimenters, is made up of those who gather the most nutritional information, frequently change their diets for health reasons, and use nutritional supplements most often (see Figure 4–2). This group is on the far left of the distribution and represents those who read everything on nutrition they can get their hands on and are constantly experimenting with behavioral changes.

While a variety of people make up this (and every) group, Experimenters are much more likely to be older women (between the ages of 50 and 64), with high levels of educa-

Figure 4–2
The First Group—The Experimenters



Source: Institute for the Future, U.S. Household Survey 2002.

tion and income. They are much more likely to have had a serious illness or to have been diagnosed with a chronic illness. Higher income may give them the necessary time and resources to spend on health and nutrition, and higher education levels provide them with the ability to filter and interpret information. They are prime candidates to jump on the personalized nutrition bandwagon. They might not stick to a single change in behavior, however, but undertake constant adjustments and experiments. They will be easy to attract but hard to keep focused.

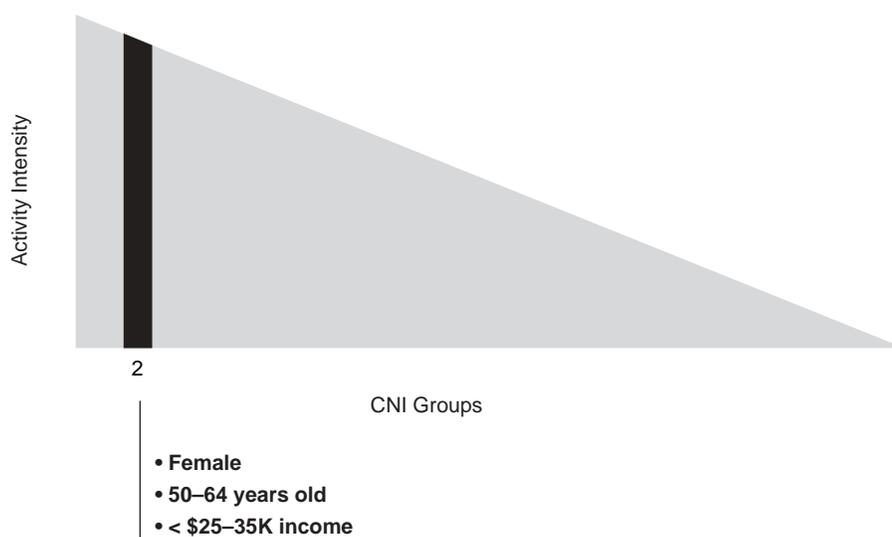
Group 2. The Older Female Proactives

The second group, the Older Female Proactives, is made up of heavy information users who make frequent changes in behavior but not as often as the Experimenters (see Figure 4-3). As the group's name indicates, people in this group are much more likely to be female,

to be between 50 and 64, and to come from moderate-income households. A very high proportion of this group relies heavily on information in which they initiate the query (for example, asking companies questions directly or searching the Internet). They are slightly less likely than average to have had a serious illness or have been diagnosed with a chronic illness. It's interesting to note that both of the groups on the far left of the distribution tend to be female and of an age whereby they have had a lot of experience in the marketplace (and likely the workplace as well) and are increasingly concerned about health issues for themselves and their families.

Older Female Proactives are likely to be very interested in personalized nutrition and might be more willing to stick with a nutrition program if the information they receive continues to support it. This is a prime group to follow closely and monitor over time.

Figure 4-3
The Second Group—The Older Female Proactives



Source: Institute for the Future, U.S. Household Survey 2002.

**Groups 15.
The Young Don't-Bother-Me's and
Group 18.
The I-Don't-Care's**

Then there are the groups that we don't expect will provide very many candidates at all for personalized nutrition.

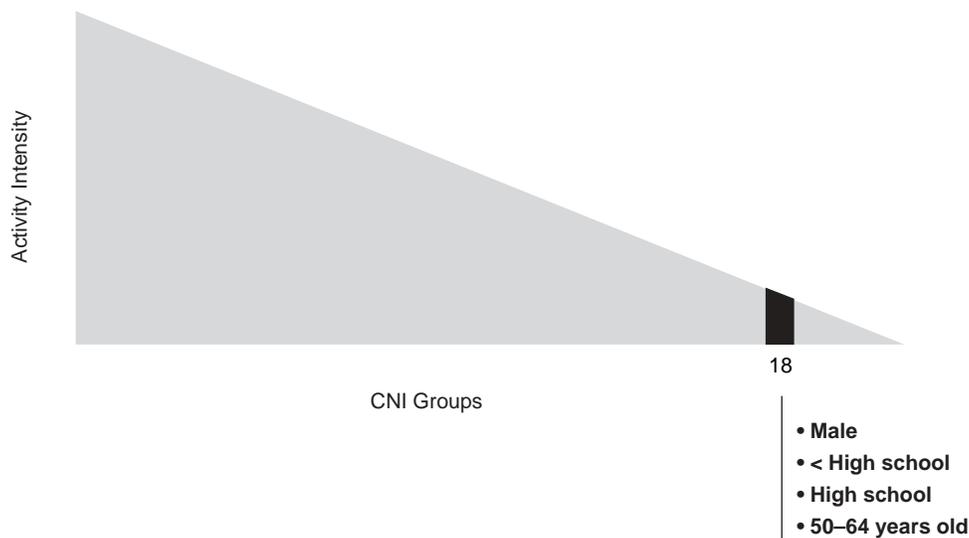
At the very end of the right side of the spectrum are the I-Don't-Care's. The I-Don't-Care's spend little time and effort on nutrition and health (see Figure 4-4). They don't gather information on nutrition, they don't look at labels, they haven't changed their diets for health reasons, and they don't take nutritional supplements.

This group tends to have the opposite characteristics to those on the far left of the spectrum—specifically, members tend to be male with lower education levels. Yet, like the groups at the far left, they are of an age (50 to 64 years old) where they are settled in their ways and know what they like. They are the

group that is least likely to have had a serious illness or to have been diagnosed with a chronic illness. They are also the least likely to be interested in personalized nutrition.

The Young Don't-Bother-Me's are only slightly more responsive than the I-Don't-Care's (see Figure 4-5 on page 36). Members of this group gather small amounts of nutrition information and have weak behavior changes, and like the I-Don't-Care's tend to be male. But there are some sharp demographic contrasts between them and the very last group—they tend to be young rather than old, and they tend to have moderate levels of education rather than low levels. Like many younger males in general, members of this group are pretty healthy and aren't concerned about health—yet. There's some hope that sometime in the future, as they age and learn more about it, they will be more interested in personalized nutrition.

Figure 4-4
The Last Group—The I-Don't-Care's



Source: Institute for the Future, U.S. Household Survey 2002.

**Groups 8 and 9.
The Moderates**

In the middle of the spectrum are two groups collectively named the Moderates (see Figure 4–6). They represent those who gather moderate amounts of information and demonstrate relatively high levels of behavioral change. More than other groups, they cluster around the mean in most demographic characteristics including income, education, and age. As with the groups on the left side of the spectrum, however, they tend to be female.

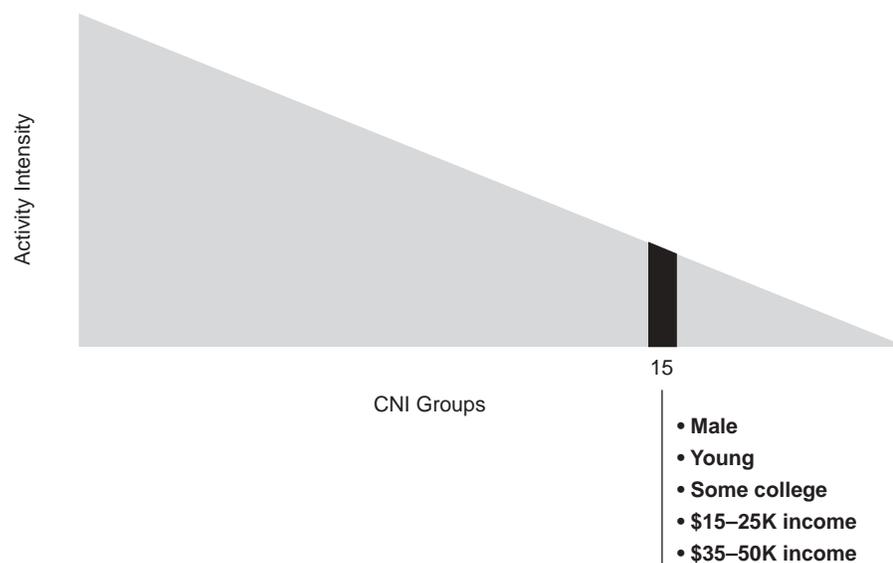
The Moderates represent an important bellwether for change in the future. A small portion of them are likely to pick up enough information to act. They might be open to stories of success and adaptations with big promises that are easily accomplished. These are the people that are likely to determine the successful penetration of personalized nutrition to the mass market.

**Group 5.
The Well-Educated Old, and
Group 6.
The Younger Male Proactives**

These two groups are worth noting because they are heavy information users but show some ambiguity about adapting nutrition behavior. They will be sensitive to the flow of information from personalized nutrition and will be the groups that may well respond if the information they receive is convincing and well-supported.

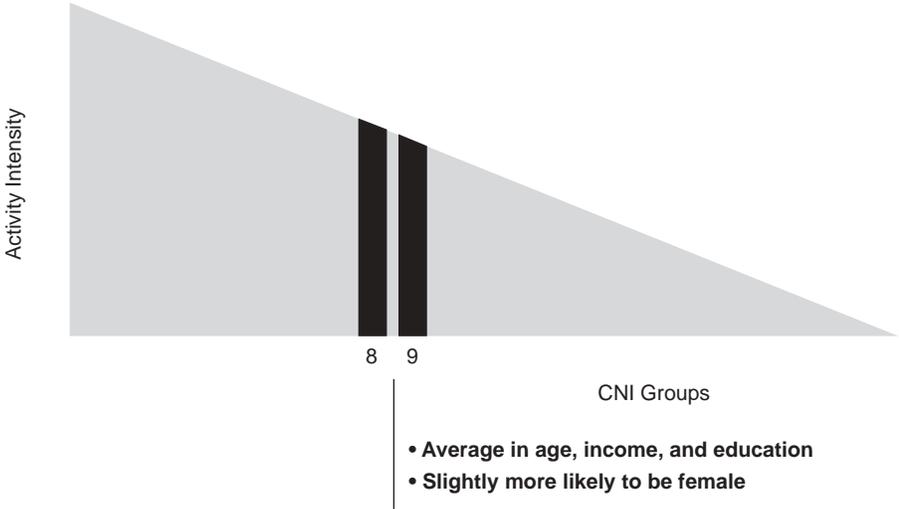
The Well-Educated Old is made up of people who use lots of information but have a bifurcated pattern of behavioral response— heavy use of supplements, but no diet changes (see Figure 4–7). This is a group that tends to be female, over 65 years of age, and well educated. Maybe with their experience in life they have already set on what they think is an appropriate diet and don't feel they need to

Figure 4–5
Group 15—The Young Don't-Bother-Me's



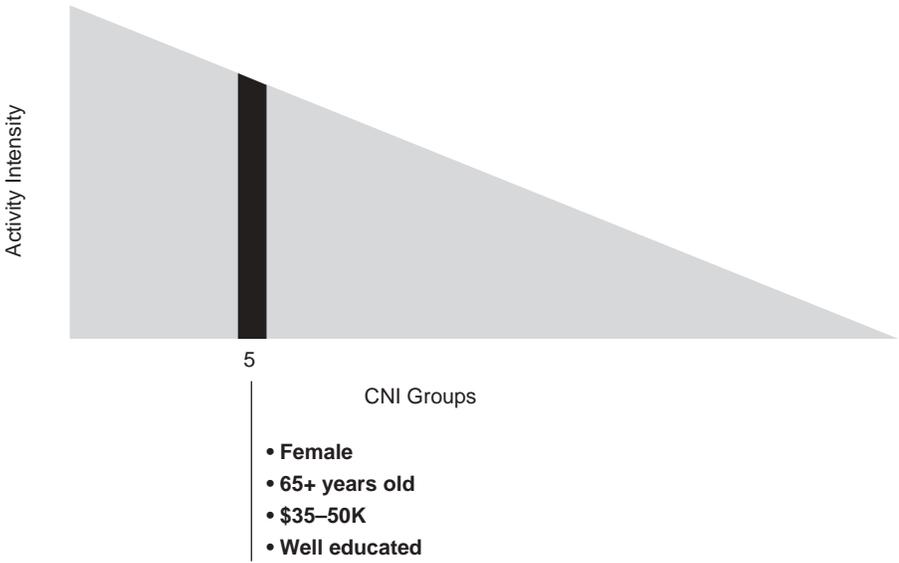
Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4-6
The Middle Groups—The Moderates



Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4-7
Group 5—The Well-Educated Old



Source: Institute for the Future, U.S. Household Survey 2002.

change, but still continue to gather and process information. But they are a group for which the penetration of personalized nutrition information will make a mark and may be increasingly successful as time goes on because of their information-seeking behaviors.

The Younger Male Proactives also display heavy information use but only moderate behavior change (see Figure 4–8). It’s the only group on the left side of the spectrum in which males are over-represented. And it is the only substantial group of heavy information users who do not have a strong behavioral component. Yet it has many other characteristics of the heavy information user: high education, youth, and relatively high income. Members of this group also show the highest likelihood of searching out alternatives to the doctor for treatment and to use proactive information sources. Because they are proac-

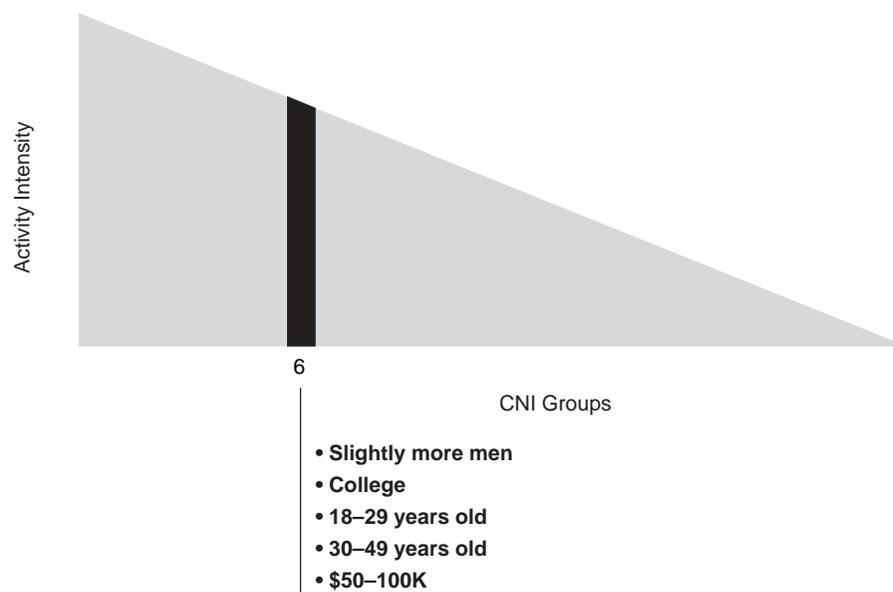
tive, members of this group are good candidates for adaptation as they reach the ages of rising health concerns—over 50 years old.

Two Outlier Sub-Groups

Our general hypothesis is that good information leads to behavior change. We assume that this will be the case as new information from nutrigenomics appears over the next decade and beyond, and that the more information consumers have about nutrigenomics, the more the market for personalized nutrition will expand. Indeed, we have formulated our CNI distribution so that it moves from heavy users of information and strong behavior change on one extreme to no use of information and no behavior change on the other.

Still, there are the odd players who break the links between information and behavior. Some heavy users of nutritional information make no changes in dietary behavior, and

Figure 4–8
Group 6—The Younger Male Proactives



Source: Institute for the Future, U.S. Household Survey 2002.

some respondents that make constant changes in behavior claim to have little or no interest in information. But, as our hypothesis implies, the numbers of people who fall into these categories are very small (about 1% of the population) and not large enough to form a group of their own. These outlier subgroups have distinctive demographic characteristics—they tend to be male and of an age when people get more set in their ways (50 to 64 years old). But there is one interesting educational difference between the two—those who gather lots of information but don't change behavior at all tend to be well-educated; those who change without any information tend to have less than a high school education.

What's the explanation for this? We don't know for sure, but we have a theory. The first group might be satisfied with their current diets and might simply be open to the excitement of learning the revolutionary information that can flow from nutrigenomics. The second group may have no interest in information but might passively adapt to changes initiated by someone else, say, their spouses. It will take

some work to get these groups into the personalized nutrition fold, but it's not outside the realm of possibility.

CHARACTERISTICS OF THOSE MOST LIKELY TO EMBRACE PERSONALIZED NUTRITION

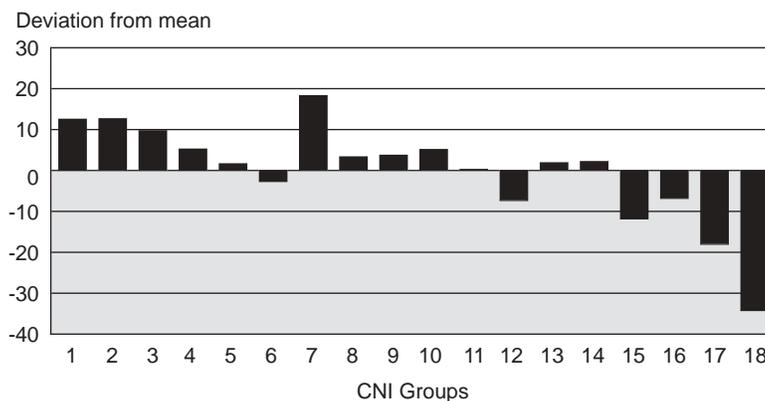
Upon careful examination, we have found some interesting patterns among the people on the more active and engaged (the left) side of the CNI distribution. They are much more likely to be female, college educated, and older, but not very old (between 50 and 64 years of age). They tend to purchase organic food, search for information proactively, and look for alternative opinions in other areas of life as well, such as medical treatment.

They Are Likely to be Women

We have noted all along that women seem to be more active in learning about nutrition and changing their behavior. Nearly every group on the left side of the distribution has more women than would be expected in a random distribution (see Figure 4–9).

Why? Because women usually manage the household's health domain. Though gender

Figure 4–9
Women Are a Key Market
(Percentage point deviation from group mean)



Source: Institute for the Future, U.S. Household Survey 2002.

expectations are changing all the time, women are still more often the family caretakers and those most likely to institute health changes on behalf of the family. They are still most likely to shop for groceries and cook. Women are also more likely to diet than men. All of these mean that women are over-represented among those who gather nutrition information and change diets regularly.

They Are Likely to be Educated

Education also makes a difference. Most of the first 11 groups on the left side of our spectrum have an overabundance of well-educated people (see Figure 4–10). This makes sense because heavy information use and education are closely correlated, and we have biased our index toward information gathering. Still there does seem to be a strong correlation between higher education and diet change as well—which could well reflect an important causal

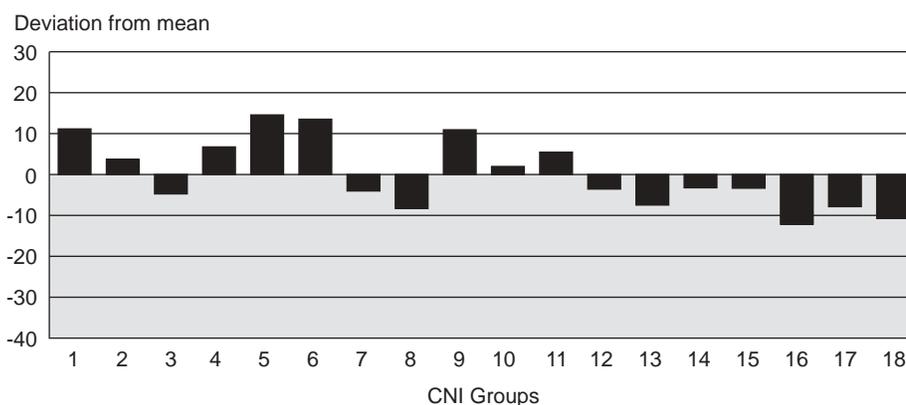
connection between the dissemination of nutrition information and change in diet.

They Are Likely to be of a Certain Age

Younger people are less interested in nutrition and behavior change. Most of the first seven groups are dominated by one or more of the older age groups, who tend to be much more interested in health matters (see Figures 4–11 and 4–12). Yet it is also true that some of the groups least likely to change are older as well—possibly reflecting the fact that some older people are quite content with their current behaviors.

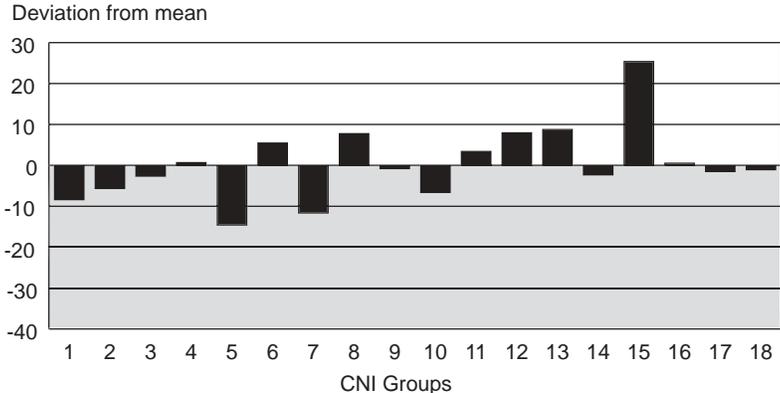
One explanation for young people’s lack of interest in nutrition and health issues is that the young are generally healthier and psychologically often feel immortal. In contrast, aging increases the likelihood of chronic illness and use of the health care system. It seems that the “younger olds”—those between 50 and 64—

Figure 4–10
College Education Makes a Difference
(Percentage point deviation from group mean)



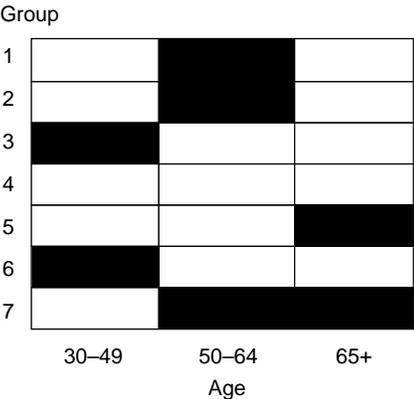
Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4–11
 Younger People Not Much Interested ...
 (Percentage point deviation from group mean for those 18-29 years old)



Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4–12
 ... While the Older Folks Dominate Those Groups Concerned with Nutrition
 (Predominant age group in each CN I group)



Note: There is no dominant age group in CN I group 4.

Source: Institute for the Future, U.S. Household Survey 2002.

may be the target market for personalized nutrition. This is just the age that many of the maturing baby boomers will reach in the coming decade.

They Are Likely to be Organic Shoppers

The CNI closely follows the same distribution as that of organic shoppers (Figure 4–13). In the minds of many consumers, organic food products are preferred for health reasons, so it is not surprising to see that people who change diets for health reasons or use supplements regularly also shop for organic products.

They Are Likely to be Proactive Information Gatherers

Heavy users of information also tend to be proactive searchers. That is, they are more likely to find most useful the kind of information for which they initiate the search, such as requesting information from a company or searching for information on the Web. Thus, there is a significant correlation between proactive information seekers and our spectrum (Figure 4–14).

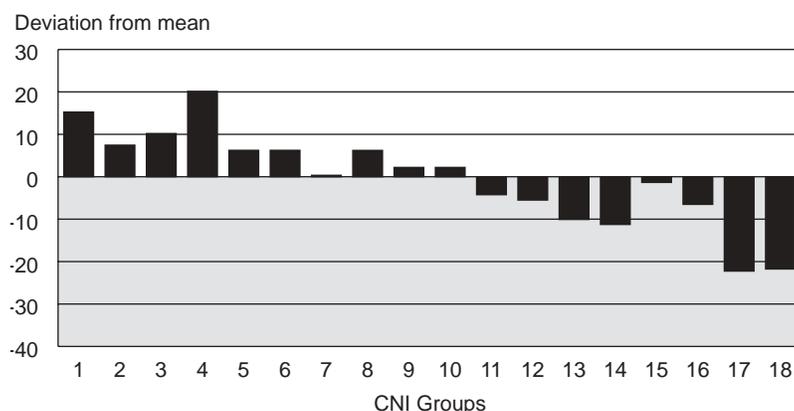
They Are Likely to Seek Alternative Medical Advice

People who search for nutrition information and experiment with their nutritional behavior are also likely to search for information in other facets of their lives. Thus, we find that the people on the far left of our CNI distribution are much more likely to seek out opinions about medical treatment options from sources other than their doctor (Figure 4–15).

THE CNI AS A FORECAST TOOL

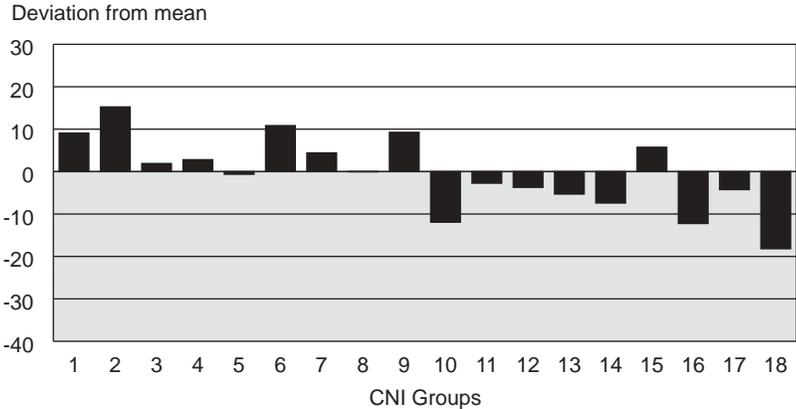
The CNI gives us good profiles of patterns of information use today. The dissemination of new information is the key to the growth and development of personalized nutrition. The index identifies those groups that are most likely to respond as nutrigenomics produces more focused information in the future. In the next chapter, we develop a forecast for the potential size of the personalized nutrition market in the future.

Figure 4–13
Diet Changers Are Organic Shoppers as Well
(Percentage point deviation from group mean)



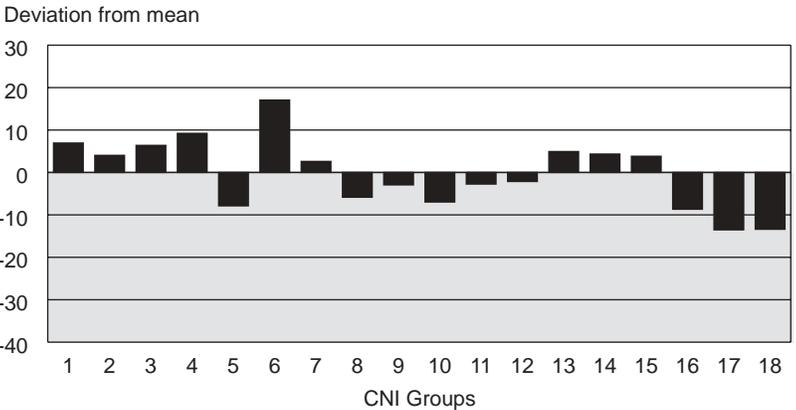
Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4–14
Proactive Searchers Are Interested in Nutrition Information/Behavior
 (Percentage point deviation from group mean)



Source: Institute for the Future, U.S. Household Survey 2002.

Figure 4–15
Those Most Interested in Nutrition Information/Behavior Look for Alternate Medical Advice
 (Percentage point deviation from group mean)



Source: Institute for the Future, U.S. Household Survey 2002.

Chapter 5

The Forecast: One-Third Will Turn to Personalized Nutrition

The Consumer Nutrition Index suggests that a significant number of people will gather and process information discovered by the science of nutrigenomics and make behavioral adjustments in their nutrition intake based on what they learn. Those who do this based on data from, or even estimates of, their genetic profile are participating in “personalized nutrition.” But what percentage of the population is likely to do so? We think about one-third.

DEFINING THE TERMS

First, some definitions.

Personalized nutrition takes place when individuals make their everyday decisions about nutrition to maximize their own or their family’s health in light of their unique genetic makeup.

Personalized nutrition combines information gathering with action in the marketplace. Those who partake of personalized nutrition will know enough about themselves (either by genetic testing or personal or family history) to make decisions about nutrition and food shopping based on their genetic makeup. Personalized nutrition will cover a range of potential activities from gathering information to selecting food and nutrition products. Possible scenarios include a person who undergoes genetic testing and gets a tailored professional recommendation on specific nutritional needs, or a person who recognizes from family history a susceptibility to certain types of cancer and learns from newspaper or magazine articles that certain nutrients may be useful in reducing the chance of developing those cancers.

Our definition of personalized nutrition includes but does not require genetic testing, and includes but does not require the ingestion of specially prepared food or nutritional supplements. In all cases, though, personalized nutrition involves some behavioral change in response to an individual's genetic endowment.

Since nutrigenomics is a new science, there are as yet few concrete findings about nutrition that can be tailored to specific genetic subgroups in the general population. Without a current population that is already changing behavior based on this kind of information, it is hard to build a base measure from which to put together a forecast, just as it is hard to build a base measure of what share of people are interested in learning about nutrigenomics and changing their behavior. Instead we use current data about individuals who gather general information on nutrition and adapt their diets to speculate about how many people might respond to specific information about nutrigenomics as it becomes available.

We also want to give some substance to the term behavior adaptation. By "behavior adaptation," we mean making a substantive choice to change nutrition intake on a regular basis as opposed to trying something once or twice. Our proxy for those likely to accept some form of personalized nutrition consists of those people from our index that "make a change in diet for health purposes" or "take nutritional supplements on a regular basis."

Thus, for our forecast of the share of the population likely to embrace personalized nutrition, we will *estimate the number of people who will change their behavior for purposes of preventive health based on information they gather and apply from nutrigenomic research and their knowledge of their own personal genetic profile.*

There are a couple of important caveats in what we are trying to do. Note that identifying

people who will gather information and make changes does not imply that they make the correct decisions, or that they learn more about themselves, or that they buy special or different food; only that they will base some concrete behavioral decisions on information generated by nutrigenomics.

There is a further practical problem in making this forecast. Traditionally, health care changes by individuals are driven by institutional means—doctors make recommendations, insurance companies reimburse certain types of actions, big pharmaceutical companies advertise the benefits of medications. But for prevention based on nutritional change, though there are a fair number of commercial dietary counseling and weight management organizations, there is no major player that has accepted responsibility for disseminating the results of nutrigenomic research and helping individuals translate that science into lifestyle choices. Thus, the pathways of behavior adaptation are likely to depend much more on the flow of information to individual consumers and on individual choices than many other decisions involving health.

There exists a much higher range of uncertainty, as well, since the debate about the benefits and dangers of certain foods is often confusing. Even well-regarded interpreters of current science like *The New York Times* are inconsistent in what constitutes a healthy diet.

Here we look at the drivers that are likely to contribute to the dissemination of personalized nutrition, our key assumptions, and then the forecast itself.

THE DRIVERS

At the heart of any forecast about consumer activity are three important drivers—changes in the underlying demographics, changes in the context of decision making, and consumer responses.

Demographic Shifts

A tremendous demographic shift will take place in the next decade. The baby boom generation—people born between 1946 and 1964—is aging. The statement sounds simple on the surface, but has profound impacts on the potential growth of personalized nutrition. The baby boomers are a huge generation compared to any that came before and even any that came after (see Figure 5–1). Specifically, this cohort is 50% larger than the one that came before it and almost 15% larger than the one that came after.

The baby boom generation is special in other ways as well. It is the first generation that went to college en masse. The rate of those going to college rose from about 35% during the 1940s to over 58% as the baby boomers came of age in the late 1960s. In turn, the share of those moving into knowledge-based jobs rose from 30% of all workers in 1970 to about 45% by the mid-1990s when all the boomers were integrated into the workplace.

The aging of the boomers is extremely important. By 2010, about three-quarters of the baby boomers will be between the ages of 50 and 64, an age that is correlated in our survey with rising concern about nutrition and health. Those groups that are more likely to be represented among the groups on the left side of our Consumer Nutrition Index—people who are between 50 and 64 years old, educated, and heavy, proactive information users—will increase dramatically in size. This group will most likely make up a good portion of the new market for personalized nutrition.

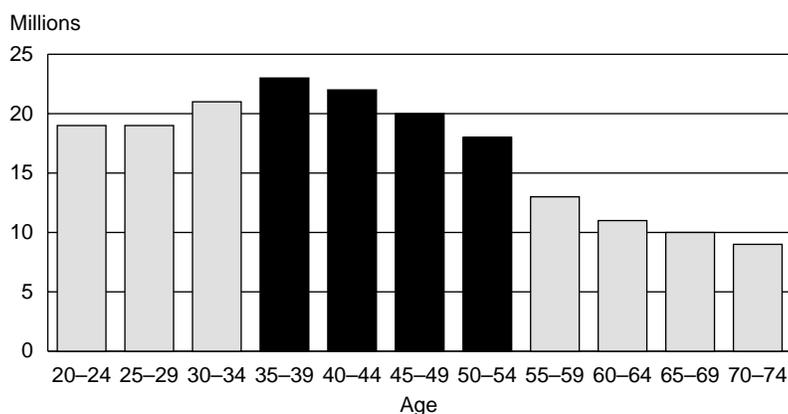
Contextual Shifts

A number of contextual factors will influence the growth of personalized nutrition.

Advances in Nutrigenomic Science

Researchers in the field agree that nutrigenomics will offer us increasing information about how nutrient–gene interactions can engender health-promoting metabolic shifts in individuals. Many of the studies will be rele-

Figure 5–1
The Boomer Generation Is Large and Important
(Size of age cohorts in the United States, 2000)



Source: U.S. Census Bureau

vant to large groups of people who share a common gene or genes that indicate certain nutrients are necessary for optimal health.

A Plethora of Information Sources

Scientific papers about nutrigenomic advances will begin to show up in a variety of formats. Initially, they will appear in medical journals and reference books. But the ideas will be repeated, summarized, reprocessed, and interpreted in a wide range of information sources that reach wider audiences: Internet-based bulletin boards and newsletters focused on health; magazine articles in specialized publications about food, nutrition, wellness, and health; media sources where professional articles are reviewed and commented on such as *The New York Times* Science section, the *Wall Street Journal* section on personal health, *Science Weekly*, *Ladies' Home Journal*, *Prevention*, *Fitness*, and *Good Health* magazines, to name a few; other kinds of Web sites; and commercial market spaces such as specialized information sources in health food stores, product placements, and signage; and labeling on products themselves. As the information spreads throughout the marketplace, and the notion of personalized nutrition becomes more commonplace, the demand for such services will grow.

The Confusion of Scientific Advancement

A characteristic of rapid change in science is the continual challenging of the current hypothesis and standards and explorations of potential new pathways. In this way, the information from nutrigenomic research will be incomplete at any given time. Sometimes the information will even seem to conflict. Nutritional recommendations for a specific gene associated with cancer may be contra-

indicated to one for heart disease, for example. It will take a while to work these things out.

No Clear Leadership Role in Information Control

It will not be easy for consumers to find one clear and reliable source of information about the findings of nutrigenomics and to settle disputes between competing claims. When consumers face acute medical or chronic care issues, they often use the health care system as an intermediary, taking advice from physicians, checking the standards of reimbursement set by insurance firms, and consulting a range of friends and family who have faced similar issues.

Personalized nutrition, by definition, does not have the same institutional or even informal support network in place. Nutrigenomics will generate new information without a lot of the convincing testing being completed. Personalized nutrition will be personalized to the extent that for each individual there won't be systemic information built up around his particular issues. What's more, no major industry player will have a clear profit motive in providing consumers with personalized information or with enough information on products so that an individual can make a decision.

Learning About Oneself

As genetic technologies proliferate in the next decade, people will become increasingly sensitive to their own genetic type. The starting point is likely to be a gradual sharing of data about family members—parents, uncles, aunts, brothers, sisters and children—who share genetic characteristics. Gradually, a range of genetic tests will become available as the costs decrease over time, and these will provide more specific genetic information. Consumer awareness of the benefits of personalized nutrition will only grow.

The Government's Role

The federal government will continue to play a big role in the management of nutrition and health information. Currently, the government is fairly restrictive about what can be claimed on a label. While government bodies are not likely to be proactive in changing regulations, with some pressure, they are likely to establish new standards that will open up the extent of information that can be placed on labels and in stores. This will help consumers make personal choices in a market of proliferating information.

Consumer Responses

Consumers will respond to these demographic and contextual shifts in a variety of ways. Expect to see some or all of the following.

A Catalyst for Controversy

Nutrigenomics and personalized nutrition will raise a variety of bioethical issues promulgated by disparate sources—concerns about genetic testing, privacy, interpretations of science, lifting of restrictions on consumer choice, the nature of the health professions, and the role of professional associations and accreditation. These types of issues are of visceral concern to people—and large numbers of people will be influenced by claims and counterclaims as they arise.

For example, nutrigenomics will involve genetic testing for some, which will raise critical, highly contentious issues concerning the security, confidentiality, and privacy of personal health information. As new products are developed that are specifically tailored to an individual's needs or the needs of subgroups of a population who share genetic characteristics, issues about the efficacy and safety of supplements or of genetically modified foods may arise. Enhancing foods with certain proteins or vitamins may raise issues with those concerned about food purity and safety.

Further, there are environmental issues about what new modified or enriched foods might mean to agriculture and food production.

Experimentation Will Be High

As the science of nutrigenomics moves forward, personalized nutrition will be just that—personalized. Each consumer will have a wide array of choices of how to “do” personalized nutrition. Go for genetic testing or stick with family history? Use only natural foods, or experiment with enhanced foods or supplements or, eventually, genetically modified foods? Work to prevent specific conditions, or aim for general good health? No one will find a single answer for themselves right away, let alone for everyone interested in personalized nutrition.

What's more, today's answer may not be the same as tomorrow's. Look for people to experiment and change; for friends and family to go down different paths toward personalized nutrition. This will be a problem for establishing a successful prevention strategy because, by definition, it is the long-term use of a strategy, not constant shifting among many strategies, that is likely to make personalized nutrition work.

The Emergence of Trusted Agents

With the wide variety of choices available for pursuing personalized nutrition, consumers will likely turn to others for advice. These others may include friends and family members, but also so-called experts—trusted agents. The problem will be that trusted agents will be hard to find. No simple decision-making tool (like the food pyramid) that has consensus is likely to exist. The proliferation of options and products will overwhelm the drive to consensus. In this maelstrom of information and criss-crossing of pathways, those companies or agents who monitor and aggregate research findings, or who can develop a nutrient “plan”

for those who have learned something about their genetic composition—without letting an obvious self-interest get in the way—will have an opportunity to become that trusted agent.

Consumer Empowerment Won't Make It Right

While everyone can agree that consumer empowerment is a good thing in general, in a field based on an emerging science, where even scientists don't know the long-term effects of various decisions, it doesn't make sense to put everything in the hands of the consumer. Consumers will make mistakes, put the wrong products together or apply the right remedy to the wrong problem, sometimes to disastrous effect. This will surely generate publicity and controversy, and call for stricter government regulation. We think the government ought to resist sweeping regulation of particular aspects of personalized nutrition, however, and help consumers seeking personalized nutrition solutions by providing access to the best information about the market in general. Because of the personalized nature of this market, the tolerance for individual mistakes will have to be high.

BASIC ASSUMPTIONS: HOW THE INFORMATION WILL SPREAD

The Consumer Nutrition Index represents the distribution of the entire population based on their propensity for gathering and processing nutritional information and making choices about what to eat based on that. At some point, the sources that heavy information users now turn to will report increasing amounts of information about nutrigenomics. In other words, information about personalized nutrition will become available for those interested in learning about it.

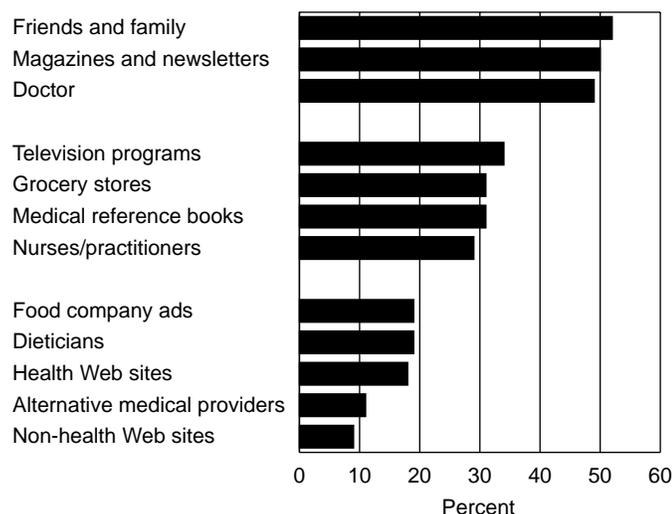
The process of information dissemination will begin with the spread of research information among experts—from medical journals to commentators and science writers. But real impacts on large numbers of consumers will only come when agents and intermediaries—doctors, nutritionists, pharmacists, grocery store managers, and labeling and advertising people—begin to participate in the job of disseminating, teaching, and recommending actions based on the science. Today, consumers turn to a huge variety of sources for nutrition information (see Figure 5–2).

We have a good sense now of what channels of information are being used by each of our 18 groups across the spectrum. Those on the left side of the spectrum use more information of every kind, but a few channels in particular seem to be more important to those consumers most susceptible to the lessons of personalized nutrition (see Table 5–1):

- Across the spectrum, family and friends are most heavily relied on for nutrition information.
- Doctors' advice and magazine and newspaper articles are used most heavily on the left end of the spectrum when seeking nutrition information.
- Grocery stores, a bit surprisingly, are an important source of nutrition information for many people as well.

It is important to note, though, that information flows in very different ways to each of our different groups—no single source of information will drive the personalized nutrition market.

Figure 5–2
Consumers Gather Nutrition Information from a Variety of Sources
 (Percent of consumers that reported consulting ... for nutrition information in the last 12 months)



Source: Institute for the Future, U.S. Household Survey 2002.

Table 5–1
Nutrition Information Flows to Selected CNI Groups
 (Percent of each group that consulted ... for nutrition information in the last 12 months)

	Friends & Family	Doctor	Reference Books	Magazines & Newsletters	TV Programs	Grocery stores
Group 1. Experimenters	72	89	75	88	67	62
Group 2. Older Female Proactives	69	64	50	81	41	44
Group 5. Well-Educated Old	68	79	50	85	51	50
Group 6. Younger Male Proactives	78	83	62	70	57	42
Group 8. Moderates (young)	62	41	21	47	33	30
Group 9. Moderates (educated)	50	58	30	44	28	25
Group 15. Young Don't-Bother-Me's	55	28	7	0	15	17
Group 18. Older I-Don't-Cares	1	2	1	2	4	4

Source: Institute for the Future, U.S. Household Survey 2002.

THE FORECAST

The key to forecasting the future market for personalized nutrition is understanding the process by which information will flow from scientists to consumers. The people most likely to change their nutrition behaviors are those who currently rely on information to make decisions.

By definition, those on the left side of the CNI utilize more information and more sources, and the sources they use will eventually be rich in information about nutrigenomics. The second step is to identify those who are willing to change behavior in light of more information. Again, we base this on our CNI distribution, which ranked people by those who both gathered information and changed their nutritional behavior.

We think that personalized nutrition will not be an easy sell, even among those who are currently very active in changing their diets for health purposes. The extra step of finding out about their genetic composition, either by genetic testing or a systematic look at family history will, for many, be too much and hold little promise of immediate results. Further, some of these information-rich consumers will also be active in debating the counter-issues likely to arise (for example, the bioethical concerns about nutrigenomics) and the role of trusted agents (for example, what the government is likely to do about labeling and health claims in their regulatory approaches). Still, the concept of personalized nutrition is likely to penetrate some groups more than others. Table 5–2 shows our assumptions about the share of each group likely to take personalized nutrition seriously.

In making our forecast, we've tried hard not to exaggerate the potential market but to come up with a reasonable and realistic projection of what to expect in the next ten years. To this end, we have looked at each of the

CNI groups and put together what we think are reasonable assumptions about how the members of each group will respond as new information starts to flow through various channels. We have taken a conservative approach in making those assumptions so that we capture those who both gather information and change behavior based on that information. In other words, we make our assumptions based on what people are already doing today and are likely to continue to do in the future. The impact of each of our assumptions on each of the groups is outlined in the Table B–1 in Appendix B.

We know that 65% of adults made some change in diet for health purposes over the last 12 months, that 53% say they take supplements daily, and that 48% say they look at nutrition labels when buying a new brand. We have made estimates in Table 5–2 of what share of each of the 18 groups are likely to explore the new personalized nutrition market. When we make a weighted average of the share of the population in each of these groups and then adjust the population sample by the demographic shifts that will take place in the composition of each of the groups through 2010, we come up with a forecast that about one-third (34%) of the adult population will be involved in personalized nutrition in 2010—that is, this group will be making dietary decisions based on their unique genetic makeup. The 34% is the sum of the share in each of our 18 groups (see Figure 5–3 on page 54).

What the forecast means, then, is that about one-third of shoppers for food and nutrition products will be aware of the advances in science that describe the benefits of personalized nutrition, will be able to make some estimates about their own genetic disposition (either formally or informally), and will experiment with diet or nutrition changes on a regular basis in response. It does not say that these shoppers

Table 5–2
The Personalized Nutrition Market in 2010
(Percent of CNI group that are likely candidates to act on nutrigenomic information)

CNI Group	Percent	Key Assumptions
Group 1. Experimenters	85	Will read anything and try anything; will certainly experiment with new nutrition ideas but might not stick with any one of them in their constant search for the new.
Group 2. Older Female Proactives	70	Also very strong experimenters; at the age when interest in prevention and nutrition is at its highest. Likely to stick to a system that makes sense.
Group 3. Involved young families	70	Proven record of absorbing information and acting to establish healthy patterns in a young family.
Group 4. Involved of all ages	60	Favor the use of supplements to target specific needs.
Group 5. Well-Educated Old	50	Already use supplements; are likely to appreciate better information that will help them target supplements more directly to their unique health issues.
Group 6. Younger Male Proactives	50	Are very active in gathering information, but somewhat slower to act on it. Likely to be a sizeable share of those who don't actually change behavior for longer term benefits.
Group 7. Moderate information use strong actions	50	Are more active in behavior change than in information gathering. Look for about half to react as important information about personal applications filters down; may start slowly but over time will get the message from friends and family and the health care system.
Group 8. Moderate information use/ moderate to strong action; young	30	Many will learn of the science of nutrigenomics; about a third are likely to experiment as they get older.
Group 9. Moderate information information use/moderate to strong action; young	30	About a third of this well-informed group will become experimenters, over time.
Group 10. Moderate information use/ take supplements	20	Are interested in information, but their use of supplements is moderate, and they are likely to be somewhat slow to respond to new information that requires special investigation.
Group 11. Moderate information use/ moderate diet changes	20	A group that is interested in information but slow to respond to it. About a fifth of them are likely to be interested.
Group 12. Moderate information use/few diet changes	15	Are likely to pick up information about nutrigenomics but are also likely to have low response rates to something that has no immediate promise of transformation.
Group 13. Low information use/ many diet changes	10	Experiment a lot with behavior but don't stop to process much information. Few of them are likely to look deeply into their own genetic status.
Group 14. Low information use/ a few diet changes	5	Will not catch much news about personal nutrition and are not likely to change much of what they do even if they did.
Group 15. Young Don't-Bother-Me's	5	Not very interested in information; they take only sporadic action even when they have it.
Group 16. Older, low education, not very interested	3	Gather some information, but seldom act on it.
Group 17. Elderly, low education, no interest	0	Don't use information on nutrition and are not likely to be candidates for sophisticated personalized nutrition.
Group 18. Older I-Don't-Care's	0	One of the healthiest groups—fewer have chronic or serious illnesses. They don't gather information now and are unlikely to have much motivation to start with personalized nutrition.

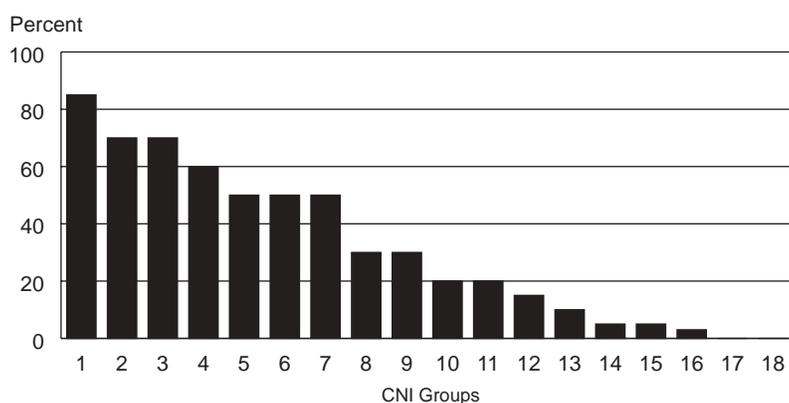
Source: Institute for the Future

will have the right information, make the right choices, or sustain a nutrition change over an extended period. But it does say that there is a large group that is listening and interested in the claims of personalized nutrition.

One-third is a baseline. But we feel the market upside is substantial if the right flow of information and institutionalized support

becomes available. Trusted agents, the health care industry, and involved companies can make a difference if they take effective action. While we have sharpened some of the elements of our CNI in this year's research, this is roughly the same conclusion we came to a year ago using the blunter measure we had at that time.

Figure 5-3
One-Third of Consumers Will Be Involved in Personalized Nutrition in 2010
(Percent of each CNI group likely to be engaged in the personalized nutrition market in 2010)



Source: Institute for the Future

Chapter 6

The Market for Personalized Nutrition

Our research offers clear implications for businesses looking to leverage the growing interest in personalized nutrition in the next decade. Such businesses include food producers, food packagers, grocery stores and pharmacies, health testing companies, health organizations, insurance companies, nutrition advisors, and food and health information providers like magazines and newsletters.

KEY CONCLUSIONS

Personalized nutrition and the nutrigenomic sciences that provide the foundation for it are poised to enter the consumer marketplace, with the following implications for a range of stakeholders:

Consumers Will Be Interested

Today, 87% of all adults report that they gather information about the nutritional value of food. With 65% making small diet changes for health reasons, 53% taking supplements daily, and 48% saying they rely on nutrition labels to make decisions on new foods, there is no question that today's consumers are ready to absorb and utilize high-quality information about personalized nutrition.

The Direct Market Will Be Sizeable ...

Our conservative forecast indicates that at least one-third of consumers will be making at least some small changes in their nutrient intake in response to information about personalized nutrition by 2010. Though this will be an important segment of the total market, it could be substantially larger if information becomes more accessible and if certain institutionalized sources of information like physicians, health plans, and food labels are more aggressive in disseminating information about personalized nutrition and government regulation makes that possible.

The one-third of the population interested in personalized nutrition won't represent the entire shopping expenditure of one-third of the people. Rather, it will indicate the number of people who will be aware of personalized nutrition information while shopping, and who will use it to drive some of their decisions. Maybe one-third of the shopping decisions of that one-third will directly involve diet or nutrition choices in which personalized nutrition will be a direct component of the buying decision. Thus, of the total of \$800 billion spent on food purchases in 2010, about 10% will be driven by direct personalized nutrition decisions. ("I will buy this vegetable because it has the right level of this vitamin that I need.") Still, that would be about \$80 billion in today's food market. What's more, an increasing share of the \$40 billion supplement market will be driven by personalized nutrition decisions as well. ("This supplement has the nutrients I know are beneficial for my particular genetic group.")

... But the Indirect Market May Be More Important

Keep in mind, though, that decisions regarding the purchase of particular nutrients that will make one healthier based on genetic makeup are only a small part of the potential

market impact. Personalized nutrition will be a growing factor in the whole range of decisions about the foods we eat every day, decisions that will be continuously refined by new nutrigenomics research.

While we make decisions about what to eat or take as a supplement every day, what we have learned from nutrigenomics will be integrated with all other considerations—a balanced diet, taste, favorite foods, and interesting and fun foods. All of these factors will affect choices about particular products—breakfast cereals, breads, wines, meats, vegetables, packaged foods, desserts, and so on. The insights of nutrigenomics will be one of a number of factors integrated into daily decisions. What this means is that, just as with today's concern about cholesterol and polyunsaturated fats, just about everyone in the food business will have to take public awareness of personalized nutrition into account when producing and marketing their products.

Preventive Health Care Will Grow in Importance

Nutrigenomic science, the information generated by it, and personalized nutrition products and services will contribute to the increasing consumer interest in preventive medicine. The health care system and some key stakeholders—such as health insurers and closed-panel and capitated HMOs—will continue to shift toward prevention as an increasingly important part of their overall strategy for cost-effective health care. Studies have shown that simple newsletters or bulletins about food and nutrition sent from doctors or insurers can have a significant impact on behavior. Private nutrition services that focus on helping the consumer with prevention will appear. Although most of these will be paid for out of pocket, some of the costs of these services may be subsidized by health insurers or employers.

DECISION POINTS

To leverage the birth and spread of this new market segment, players in the food and nutrition industries will have some key choices to make. These six observations are a way to start thinking about these decisions strategically.

Find a Motivation

Getting people to change is hard; the gap between learning about something and changing behavior is huge. There will be opportunities for motivation as the science moves ahead—genetic testing will give concrete indicators of the need to change; individuals will become more sophisticated about keeping their own family histories; there will be more larger scale tests with targeted groups. Each of these will give motivations to specific activist consumers. Recognize that not everyone will be motivated, but that a substantial part of the population may be. Focus on reaching them with good information about how to use personalized nutrition to lead healthier lives.

Who Will Be the Information Leader?

The market for personalized nutrition will be driven by the information individual consumers receive about it. There's a role for value-added and trusted agents who can disseminate this information effectively. The problem is that while many players will see opportunities in providing information, a dominant role for a single player isn't likely to emerge any time soon. The benefits of passing along information on personalized nutrition don't directly align with the particular goals of any of the players that may be inclined to pick up the mantle:

- Newspapers and magazines will find growing reader interest, but this interest will probably not be a dominant one for any except specialized food and nutrition magazines.

- Some of the largest health plans may find virtue in prevention strategies based on nutrigenomics, but most will not see the value in instilling behaviors that only pay off years in the future, when many current health plan members will no longer be members. (The average turnover rate is approximately two years.) However, Medicare and Medicaid officials, who are interested in longer term payoffs, may want to strenuously promote the health benefits of nutrigenomics to the general public—especially younger people—so that by the time they reach their Medicare years, they have been maximizing their dietary choices for years, and are healthier as a result.
- Physicians can help patients with advice, though nutrition is not generally part of their critical expertise, and the time it takes to offer any kind of individualized advice is high.
- Pharmacies and grocery stores do not have the extra budget money to hire a large number of nutritionists for open-ended conversations with customers.
- The government is concerned about regulating false claims, and not checking the efficacy of new ones.
- Grocery stores make money with products on their shelves and consumers walking past those products, not with loads of information and consumers stopping to browse in crowded aisles.

Still, any player willing to spend time on publicizing the benefits of food and nutrition in an objective way would win the attention of an interested group of active and engaged consumers. They could also find growing demand for food products, nutritional supplements, and advisory services. All of the providers of these kinds of goods and services have an

interest in helping vital information flow from nutrigenomics researchers to personalized nutrition users. There are good opportunities for partnerships that could sponsor, prepare, and publish this kind of information.

Potential Partnerships

New partnerships are likely to be formed in the realm of prevention strategies and personalized nutrition. Look at the markets where industry players can collaborate to present information to the growing number of consumers who will be interested in personalized nutrition. Figure 6–1 presents some of the more interesting possibilities in which both partners might benefit.

Information Regulation Will Be Important

The government could play a key role supporting the market for personalized nutrition if it makes a transition from guaranteeing safety and restricting claims to encouraging the spread of information from research studies, as well as the potential benefits that might flow from nutrigenomics. Various government agencies dealing with food and public health, such as the National Institutes for Health and the FDA, may carve out new roles as funders of research studies that link nutrigenomics with personalized nutrition. They could create new channels of information dissemination, or foster and encourage food producers and stores to commercialize the growing interest in prevention. This may involve rethinking the role of labels and claims. The least the government should do is help the market with a

dissemination of basic research on which private companies can build their more de-tailed and personalized information. Whatever happens, the government is likely to play the role of facilitator rather than leader of information dissemination.

Be Aware of Potential Controversy

Controversy will inevitably arise about some issues related to nutrigenomics and personalized nutrition—genetic testing, privacy protection, false claims, misuse, the right amount of nutritional inputs, respect for individuals, rules of liability, and so on. Any company making claims for personalized nutrition or providing specialized information will have to be aware of the whole range of factors that could go wrong, and how they will be perceived by the society at large when they do. Don't be caught off guard. Have plans in place for dealing with these inevitable moments.

Keep Food Fun and Entertaining

Food and food preparation have strong cultural meanings that are in danger of being devalued by technological intervention. For most people, however, food will continue to be a social and fun experience. It is the great advantage of the food industry that it can add the preventive health benefits of personalized nutrition to something that is both social and fun rather than making it a chore in the way that taking medicine can be. Keep it that way. Focus on the social and aesthetic side of food while providing options for a healthy lifestyle and don't try to medicalize it.

Figure 6-1
Potential Partnerships in Prevention and Personalized Nutrition

	<p>Think of the opportunity in a new type of store that provides individuals with more detailed information by means of labels, brochures, interactive displays, kiosks, and nutrition counselors for helping individuals making personal choices on a variety of foods.</p>
	<p>Think of the opportunity for bringing together the range of insurers, employers, and government bodies that pay much of the costs for both private and public health insurance to build prevention strategies that may play out over decades.</p>
	<p>Think of the opportunity for health groups to be associated with a low-cost provider of nutrition information such as more active community pharmacies or interactive counseling Web sites perhaps set up as part of adult education programs by local school districts. Regular discussions with families about diets could integrate well care more effectively into the daily lifestyle of the patient population. Like the transformation of dental care a couple of decades ago, the move from acute care to prevention could represent a fundamental paradigm shift in the system at large, which would eventually translate into new ways of making money.</p>
	<p>Think of the opportunity for nutrigenomic scientists to distribute results to magazines, newspapers, and newsletters, and for marketers to be able to utilize these results to make much more targeted and tailored materials for distribution to those for whom it is most relevant.</p>
	<p>These might be the places with the greatest synergies for information dissemination. It is here that nutritionists and nutrition advice are most likely to be found and that consumers will have the broadest range of choices of foods, supplements, and drugs to meet their personal needs and tastes. A nutritionist should be on duty at every major grocery store or pharmacy.</p>

Source: Institute for the Future

Appendix A

The Consumer Nutrition Index

The Consumer Nutrition Index (CNI) is based on a distribution of the adult U.S. population into segments that link the gathering of information about nutrition to changes in dietary behavior. The basis of the current version of the CNI is the Institute for the Future's national random telephone survey of 1,500 householders conducted in the summer of 2002 by Princeton Survey Research Associates.

The CNI is built on the responses to four survey questions, two about information gathering and two about dietary behaviors:

INFORMATION GATHERING

- How many different sources of information did you go to over the last 12 months to find out about the nutritional value of foods?
- When you think about buying a new brand of food do you look at the nutritional label?

DIETARY BEHAVIORS

- In the past 12 months, have you made any changes in the kinds of food you eat in order to be healthier?
- How often do you take nutritional supplements?

We weighted each of the questions equally and then built a spectrum that begins with the heaviest users of information who make the most frequent changes in diets or are the heaviest users of nutritional supplements on one side running through to those who didn't use information at all and made no dietary changes or do not use nutritional supplements.

We divided the population into 18 distinct groups, with each group accounting for approximately 5.5% of the total population (the actual share in each of the 18 groups varies from 3.5% to 7.1%). In determining the sequence of

the groups whenever there was ambiguity in ranking—for example, where moderate information use is combined with low behavior adaptation and came relatively close to low information use combined with moderate behavior adaptation—we always gave priority to information use as the primary driver.

Table A-1 describes the information and behavioral components of each of our 18 discrete categories in general. Table A-2, on page 64, provides a more detailed description of the dietary behavior categories.

Table A-1
Criteria for the Distribution Along the CNI

CNI Group	Information Searcher*					Dietary Behaviors*				
	Very Heavy	Heavy	Moderate	Low	Not	Very Strong	Strong	Moderate	Low	None
1	x					x				
2		x				x				
3		x					x			
4		x					x			
5		x						x		
6**		x						x		
6**		x							x	
7			x			x				
8			x				x			x
9			x				x			
10			x					x		
11			x					x		
12***			x						x	
12***		x								x
12***			x							x
13**				x				x		
13**				x				x		
14**				x				x		
14**				x				x		
15**				x					x	
15**				x					x	
16				x						x
17***					x	x	x	x		
17***					x		x			
17***					x			x		
17***					x			x		
17***					x				x	
18					x					x

* To determine the Information Searcher category for each respondent, points were assigned for the number of sources consulted about nutritional information and for whether nutrition labels were referred to before making a new food purchase. Total points were then assigned to five categories ranging from Very Heavy to Not an Information Searcher. To determine the Dietary Behaviors category for each respondent, points were assigned for the frequency of diet changes and use of dietary supplements. Total points were then assigned to five categories ranging from Very Strong to None.

** The definition of these CNI groups includes an "or" statement. For example, Group 6 comprises those who are heavy information searchers, have made 1–2 small diet changes, and use supplements weekly or never OR those who are heavy information searchers, have made no diet changes, and use supplements weekly.

*** These CNI groups (12 and 17) include two or more distinct groups of people that have been combined into one. Because so few people fit these definitions, several small, related groups were combined to create a group with a share of the population sufficient for comparison.

Source: Institute for the Future, U.S. Household Survey 2002.

Table A-2
The Details: Criteria for the Distribution Along the CNI

CNI Group	Information Searcher*					Dietary Behaviors					
	Very Heavy (>3 points)	Heavy (3 points)	Moderate (2-2.9 points)	Low (1-1.9 points)	Not (0 points)	Diet changes in last year			Supplement Use		
						3 or more	1-2	0	Daily	Weekly/ When Sick	Never
1	x					x			x		
2		x				x			x		
3		x				x				x	x
4		x					x		x		
5		x						x	x		
6**		x					x			x	x
6**		x						x		x	
7			x		x	x			x		
8			x			x				x	x
9			x				x		x		
10			x					x	x		
11			x				x			x	x
12***			x					x		x	
12***		x						x			x
12***			x					x			x
13**				x		x					
13**				x					x		
14**				x			x			x	
14**				x				x	x		
15**				x			x				x
15**				x				x		x	
16				x				x			x
17***					x	x			x	x	x
17***					x		x		x		
17***					x			x	x		
17***					x		x			x	x
17***					x			x		x	
18					x			x			x

* To determine the Information Searcher category of each respondent, points were assigned for the number of sources consulted for nutritional information and for whether nutritional labels were referred to before making a new food purchase. Total points were then assigned to five categories ranging from Very Heavy to Not an Information Searcher.

** The definition of these CNI groups includes an "or" statement. For example, Group 6 comprises those who are heavy information searchers, have made 1-2 small diet changes, and use supplements weekly or never OR those who are heavy information searchers, have made no diet changes, and use supplements weekly.

*** These CNI groups (12 and 17) include two or more distinct groups of people that have been combined into one. Because so few people fit these definitions, several small, related groups were combined to create a group with a share of the population sufficient for comparison..

Source: Institute for the Future, U.S. Household Survey 2002.

Appendix B

The Numbers Behind the Forecast

We used the information and formula in Table B-1 to arrive at our forecast of the personalized nutrition market in 2010.

The table has five columns. The first is the CNI group that reflects nutrition information gathering activities and dietary behaviors. The second column lists the share of the total adult population each group represents. The third is the share of each group that we forecast will absorb nutrigenomics information and take some action on it; the numbers are also presented in Table 5-2. In column four, we account for the demographic shifts likely to occur in the next eight years. Because of the age composition of each group—there are more people in the 50-64 and the 65+ age ranges among the groups on the left of our spectrum—we expect these groups to grow in share relative to those on the right side.

Finally, column five shows the percent of the population likely to participate in the personalized nutrition market in 2010. The sum of the 18 groups gives us the total share participating in the personalized nutrition market in 2010—34%.

Table B-1
Calculating the Size of the Personalized Nutrition Market in 2010

CNI Group ^a	Percent of Population in 2002	X	Percent Likely to Respond	X	Weighting for Demographic Factors ^b	=	Percent Responding in 2010
1	5.1		0.85		1.10		4.77
2	5.6		0.70		1.10		4.31
3	5.6		0.70		1.00		3.92
4	7.1		0.60		1.05		4.47
5	3.4		0.50		1.10		1.87
6	5.6		0.50		1.10		3.08
7	6.4		0.50		1.00		3.20
8	5.2		0.30		1.00		1.56
9	6.7		0.30		1.10		2.21
10	5.9		0.20		1.05		1.24
11	5.1		0.20		0.90		0.92
12	5.6		0.15		0.90		0.76
13	7.6		0.10		1.00		0.76
14	5.4		0.05		0.90		0.24
15	3.1		0.05		0.90		0.14
16	4.4		0.03		1.00		0.13
17	6.6		0.00		0.90		0.00
18	5.5		0.00		0.90		0.00
Total							33.58

a From Appendix A

b Weights take into account expected shifts in various demographic groups between 2000 and 2010.

Source: Institute for the Future