

Nutrigenomics: the future of nutrition?



Briefing Number 35
March 2006

The new science of 'nutrigenomics' (nutritional genomics) and the idea of 'personalised nutrition' are being promoted as the solution to chronic diet-related diseases such as heart disease, cancer and diabetes. Personalised nutrition includes the idea of recommending dietary advice, supplements and new 'functional foods' to healthy people who are identified as genetically susceptible to future illness using genetic tests. In future, tests of other biological factors – not just genes – might also be used. Personalised nutrition is part of 'personalised medicine' which aims to achieve a major shift from treatment of disease to 'prediction and prevention' based on an individual's genes.

The advocates of personalised nutrition claim that as well as delaying the onset of disease it could optimise and maintain human health. However, personalised nutrition could also harm health by:

- targeting the wrong dietary advice at the wrong people (either by wrongly identifying those at high genetic risk, or wrongly implying that they have most to gain by changing diet);
- confusing healthy-eating messages (for example, by implying that existing dietary advice is guesswork, and by different companies selling many different products and proffering conflicting advice);
- undermining public health approaches (by implying that only a minority of people with bad genes need to eat a healthy diet);
- medicalising genetic risk (increasing costs and side-effects by encouraging people to buy medicines, supplements and functional foods instead of fruit and vegetables);
- diverting resources (including research resources) from more effective approaches; and
- promoting a false solution to the current epidemic of diet-related disease.

This briefing asks whether tailoring our diets to our individual genetic make-up, or to other individual biological differences, will be good for health.

Personalised diets: the marketing strategy

'Achieving optimal nutrition by using functional foods aims at optimising the physiological functions of each of us to ensure maximum well-being, health and quality lifespan. A diet might also have to match our unique biochemical needs. Accordingly, an optimal selection of nutrients in such a diet will rely on a better understanding of the interactions among genes, nutritional factors and disease, because these can determine the responsiveness of a specific individual to both the beneficial and adverse effects of his or her diet.'

The International Life Sciences Institute (ILSI), 2002.¹

'As it becomes possible to assess an individual's genetic susceptibility to disease, it will become possible to create special foods and medical treatments uniquely tailored to help manage that susceptibility.'

The European Food Information Council (EUFIC), 2003.²

To the food industry, nutrigenomics provides an opportunity to design new products, attempt new 'personalised' marketing strategies (based on genetic test results, or other types of tests) and to claim that it is responding to public concern about the growing epidemic of diet-related disease. The aim is to 'prevent disease and improve quality of life through functional foods and tailored diets'.³ However, the business model relies on 'patent protected, value-added products' commanding a premium price.⁴ Future marketing is expected to operate via customised communication directed towards individuals (for example, using direct or internet marketing or home delivery).

A wide range of companies is expected to play a role in personalised nutrition, as a means of adding value to the food supply chain (Table 1).

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Table 1. Personalised nutrition and the food industry supply chain⁵

Company type	Example companies	Role in personalised nutrition
Biotech/genetic testing companies	Sciona/Celf IL Genetics/Alticor	Gene-based testing of consumers
Processed food and supplement companies	Kraft General Mills Nestlé Danone Wyeth Shaklee	Product formulation, testing and manufacturing
Value-added food and feed ingredients companies	DeGussa/Galapagos DSM/Roche Danisco/Wellgen Kemin BASF	Production of biotech-derived oils, nutrients, phytochemicals and other functional food ingredients
Primary processors	ADM Cargill Fonterra Campina Tyson Foods Bunge	Processing to concentrate or extract desirable food components
Agricultural biotechnology companies	DuPont Cargill/Metamorphix Syngenta BASF Dow Agro Sciences	Genomics and genetics applied to crops and meat-producing animals to increase components with human health value

Genetic testing companies

Genetic testing companies currently involved in nutrigenomics are shown in Table 2. Some are already marketing genetic tests, often combined with supplements, but others are still at the research and development stage.

Although currently small and unprofitable, biotech companies like these are seen by governments as a key part of the 'knowledge-based' economy and therefore have considerable political support. However, other, much larger companies have much more power to decide how nutrigenomics develops.

The food and chemical industries

'We are moving from an agrifood business to an R&D-driven nutrition, health and wellness company.'

Luis Cantarell, head of nutrition division, Nestlé, 2003.¹¹

... while the first generation of genetically modified food products were designed to increase crop yields, the next generation of genetic modification might be aimed at making these foods healthier in a person's diet. Foods might even be designed with the specific genetic profiles of different categories of people in

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that people should simply follow the 'expert' recommendations and consume the products sold to them on the basis of their test results. However, real choice requires empowering people and tackling vested interests, rather than genetic tests.⁴⁷

Selling medication to treat risk factors rather than diseases is immensely profitable for the pharmaceutical industry

Medicalisation. Selling medication to treat risk factors rather than diseases is immensely profitable for the pharmaceutical industry: for example, statins (to lower cholesterol levels) are now the biggest selling prescription drugs in the world. While these drugs can save lives, expanding their use to ever larger numbers of people has been criticised by some doctors because lifestyle changes are usually cheaper and more effective and avoid the risk of side-effects. One argument used in favour of functional foods is that they provide a better or cheaper alternative to medication such as statins. However, an alternative view is that functional foods contribute to 'medicalisation' and to the idea that healthy people are all patients at risk of becoming sick. If this is the case, it is more likely that people encouraged to feel at high risk (because of genetic tests or other types of tests) will be sold both medication *and* functional foods *and* supplements.

Patenting and profiteering. The business driver for personalised nutrition is that new 'functional foods' can be patented and can command a premium price. This means that companies will claim monopolies over these new foods or their ingredients (typically for 20 years or more), just as pharmaceutical companies do with medicines. Genetic tests are also patented. This means that 'genetic information' is treated as an invention and subject to intellectual property rights, even though patenting gene sequences is extremely controversial and may distort research.

Costs and resources. With the whole population potentially 'at risk' and eligible for preventive medication, the cost implications of 'genetic susceptibility' testing have been described as 'staggering'.⁴⁸ However, it is difficult to analyse cost-effectiveness when the validity and usefulness of genetic tests have not been assessed and people's responses to the results are largely unknown. Because the costs of diet-related disease are so high, even a small reduction in the effectiveness of public health measures (by confusing healthy-eating messages, or diverting resources) could be substantial.

People encouraged to feel at high risk because of genetic tests or other types of tests will be sold both medication and functional foods and supplements

Conclusions

Many scientists, funded by the food industry, biotech companies and governments, have stated that the fundamental goal, and the next great challenge, of the nutritional sciences is to *tailor nutritional requirements to the individual* and thereby optimise diets for health.¹⁴ However, personalising diets is a deeply questionable research priority. The focus on genetics and genomics as a means to tackle diet-related disease is technology- and market-driven – it has not been informed by an assessment of the likely benefits to health. Rather than shifting the focus of research from medicines to public health, this strategy seeks to turn foods into medicines and prevention into personalised marketing.

An alternative aim for nutrition science is 'to contribute to a world in which present and future generations fulfil their human potential, live in the best of health, and develop, sustain and enjoy an increasingly diverse human, living and physical environment'.⁴⁹ This approach recognises the importance of the politics of food: such as where food comes from and who has access to healthy food, and the importance of improving the health of populations, by changing their social, environmental and economic circumstances.

Amid the commercial enthusiasm for nutrigenomics and personalised nutrition,

Table 2. Genetic testing companies directly involved in nutrigenomics

Company	Products	Marketing & future plans
Alpha-genics (USA) www.alpha-genics.com	'JeneJuice' is a 'sports and performance beverage blended to match your genetic make-up' (to be launched in spring 2006). Vending machines will mix the drink on the spot based on the person's genetic profile and activity.	The company plans to track and evaluate up to 1 million people in real time, combining gene expression data with data about diet and health.
Genecare (South Africa) www.genecare.co.za	For heart disease, tests 12 gene variants in ten genes in a single nutrigenomic assessment. Includes: lipid metabolism; folate and homocysteine metabolism; iron homeostasis; thrombosis; hypertension and inflammation. For cancer, the NutriGene test includes: detoxification; dietary folate uptake; oxidative stress; oestrogen exposure.	Has trained more than 400 dieticians in South Africa to implement diet and lifestyle information based in part on genetic test results.
GeneLex (USA) www.healthanddna.com	The company's nutritional genetic test includes 19 genes for heart health, bone health, B vitamin, detoxification, antioxidants, inflammation and insulin sensitivity. Costs US\$395, or \$525 with in-depth nutritionist's view of results, or \$645 with a DNA diet consultation.	Via the internet. Many other types of genetic tests also sold.
GeneLink (USA) www.bankdnacom	Sells a 'Nutrigenetic Profile' for oxidative stress, circulatory and heart health, bone health, immune function and the ability to combat environmental toxins.	Markets via partner companies direct to consumers.
Genova Diagnostics (USA) www.genovations.com	Sells 'Osteo', 'Cardio', 'Detoxi', 'Immuno' and 'Neuro' genomic profiles. Genova Diagnostics (formerly Great Smokies Diagnostics Laboratory) has been criticised by geneticists for the claims made for its tests. ⁶	Markets mainly via alternative health practitioners and supplement distributors.
IL Genetics (USA) www.ilgenetics.com	Currently marketing via dentists a test for genetic susceptibility to gum disease (IL-1 gene). This is not a nutritional genetic test, but its medical value has been criticised by scientists ⁷	IL Genetics has a strategic alliance with the direct-marketing company Alticor (USA) to develop and market novel nutritional and skincare products.
IntegraGen (France) www.integragen.com	Currently offers tests for a rare inherited form of type 2 diabetes (MODY) - a valid test currently used by genetic health services - but plans to market susceptibility tests in future.	Future marketing strategies unclear, but is involved in the EU's DiOGenes research project on gene-diet interactions in obesity (www.diogenes-eu.org).
Nutrigenetics (USA) www.nutrigenetics.com	Plans to market a nutrigenetic test.	
Nutrigenomics (USA) www.nutrigenomics.com	Not yet marketing tests but involved in R&D.	Its management team is active in promoting the idea of personalised nutrition ⁸
Progenika (Spain) www.progenika.com	Developed 'Lipochip' for the pharmaceutical company Lacer, to diagnose the inherited condition familial hypercholesterolaemia (a recognised genetic disorder, see Box B).	Is now marketing its 'IBD chip', which tests 61 genetic mutations linked with inflammatory bowel disease.
Sciona (USA) www.sciona.com	'Cellf' test kits include: heart health (12 genes); bone health (4 genes); insulin resistance (5 genes); antioxidant and detoxification (5 genes); inflammation health (6 genes). Each kit costs US\$126.	Marketed by four retailers (pharmacies) in the USA. Claims to have sold over 10,000 tests prior to launching Cellf in August 2005. Originally a UK company, Sciona was forced to withdraw genetic tests combined with dietary advice from the Body Shop in 2001, following criticism from leading scientists. ^{9,10} It has since relocated to the USA.
TLC International (South Africa) www.wellbeing.co.za/genetics.asp	The 'TLC-DNA Program' includes susceptibility tests for heart disease and cancer, together with dietary and lifestyle advice.	Markets via its 'International Lifestyle Clinics' and its website. Claims to be operating in over 100 countries.

societies' and that in Europe 'optimal nutrition rather than adequate nutrition is the greater problem'. It aims to 'define individual response to nutrients and refine the requirements for population subgroups' including people with diseases such as diabetes but also healthy 'at risk' individuals based on genetic variations. The aim of NuGO's activities is: 'to strengthen the competitive arm of the European food industry, facilitating its growth as a knowledge-based business, targeted at evidence-based healthier food production as well as promoting understanding in the ethical, social legal, economical and scientific issues of concern, for consumers and scientists alike, in defining, creating and choosing diets for optimal health'.¹⁹ NuGO held a major conference 'From Nutrigenomics to Personalised Nutrition' in November 2005.

Commercial enthusiasm for nutrigenomics is also influencing public funding for research

Another example of publicly funded research in partnership with the food and biotech industries is the European Union-funded research project DiOGenes, which includes the food companies Danone, Nestlé and Unilever in its consortium. DiOGenes involves a plan to put about 700 obese/overweight adults and their children on five different diets to try to identify gene–nutrient interactions associated with changes in body weight.²⁰ The project also involves food technology studies to 'develop food characterized by consumer liking and preferences but at the same time by enhanced satiety signals that limit intake'. The researchers claim that the insights gained will 'pave the way for new concepts in the design of functional food products that enhance weight control capability in susceptible people'.

In Britain, the Medical Research Council (MRC) is funding the controversial project UK Biobank to study genes and diet and other environmental factors in disease.²¹ The Department of the Environment, Food and Rural Affairs' (DEFRA) Sustainable Farming and Food Research Priorities Group has also identified the need to prioritise the knowledge base for nutrigenomics²² and the Biotechnology and Biological Science Research Council's (BBSRC) agri-food research programme has a priority theme on 'genotypic variation and response to diet' and a focus on genomics in its diet and health programme.

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Personalised diets: good for health?

'...the relevant features of obesity-promoting diets may not be the percentage of energy from sugar or fat but rather high palatability and low energy cost. These issues are inextricably linked to agricultural commodity prices, imports, tariffs, and trade. Americans are gaining more and more weight while consuming more added sugar and fats and are spending a lower proportion of their income on food. No longer a purely medical issue, obesity has become a societal and public health problem.'

Nutritionists at the universities of Washington and Seattle, 2004.²³

'The group concluded that the science has great potential to increase our understanding of the molecular mechanisms through which diet influences disease. However, researchers believe that there is no evidence at present to support clinical applications involving individualised dietary advice based on gene testing. Further, they agreed that it would be important to exercise caution in modifying nutritional messages aimed at the public as a whole as this would tend to confuse and dilute the message and would probably be detrimental to the population as a whole.'

Report of an expert workshop held at Cambridge University in 2004.²⁴

Genetic tests and functional foods are targeted at the wealthy and do nothing to help lower socio-economic groups or people in poorer countries

In 2000, the WorldWatch Institute estimated that the number of overweight people in the world for the first time matched the number of undernourished people – at least 1.1 billion each. Chronic diseases related to over-eating – such as type 2 diabetes (adult onset diabetes) – are now widely recognised as a major, growing threat to global health. The World Health Organisation (WHO) now refers to a global ‘epidemic’ of obesity and has warned that many low- and middle-income countries are suffering a ‘double burden’ of both under-nutrition and obesity.

Chronic diseases are largely preventable diseases – an estimated 80% of heart disease, stroke and type 2 diabetes, and 40% of cancer could be avoided through healthy diets, regular physical activity and avoidance of tobacco use.²⁵ However, despite the enthusiasm of commercial companies, it is extremely questionable whether personalised nutrition is the approach most likely to reduce the incidence of these diseases. The two main reasons are that:

- genetic tests and functional foods are targeted at the wealthy and do nothing to help lower socio-economic groups or people in poorer countries;
- biology is complex, which makes individual risks inevitably uncertain and hard to predict, and limits the usefulness of targeting dietary advice at ‘high risk’ individuals.

Personalised nutrition and health inequalities

Health inequalities play a significant role in life expectancy and chronic disease, including diet-related diseases. Of the 35 million people who will die in 2005 from heart disease, stroke, cancer and other chronic diseases, only 20% will be in high-income countries. Lack of food, famine and malnutrition are still the biggest problems for poor people in the poorest countries. However, in most middle-income countries the poorest people are now those at the *highest* risk of obesity and chronic diseases, such as heart disease and diabetes.²⁶

In Argentina, for example, the diet of the poor has shifted since the 1960s, from a varied balanced one, to one which depends on only 22 basic products, which are selected to satisfy the appetite but are high in fats and sugars.²⁷ The food industry fosters this behaviour by targeting the poor with mass, low-quality products that are cheaper but higher in fat and sugar. These food marketing practices are global: they also affect low-income families in the UK who suffer from ‘food poverty’. Even in the UK, poorer families tend to eat less healthily, consuming less fruit and vegetables and wholemeal bread and more white bread and processed meat products.²⁸

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Rather than increasing the availability of existing healthy products (such as vegetables), or making regulated reductions in the levels of salt, sugar and saturated fats in processed foods, personalised nutrition means designing new ‘value-added’ products and marketing them as tailored to an individual’s personal risk of future illness. Genetic tests and functional foods are targeted at richer consumers, who can afford the extra cost (sometimes called the ‘worried well’). This does nothing to help lower socio-economic groups who are more likely to be the victims of fat dumping, ‘food deserts’ and segregated marketing: the mass marketing to lower socio-economic groups of cheaper, processed products high in fat and sugar. Nor does it tackle the ‘politics of food’ and issues such as agricultural subsidies which ensure overproduction of unhealthy food ingredients.²⁹

Personalised nutrition: good for health?

The second problem with the idea of personalising nutrition based on genetic tests is that it is unlikely to be effective, and could be harmful, even in those

populations that have access to the tests and associated products. The science of nutrigenomics aims to individualise (and privatise) dietary advice, by marketing genetic tests combined with personal advice on diet and with other products, such as supplements. It also aims to take the current market for functional foods one step further, by designing foods with enhanced health benefits tailored to 'at risk' individuals or groups.³⁰

Although genetic testing combined with dietary advice has been widely promoted as a means to tackle common diet-related diseases, few genes have been identified which could be used reliably in this way. Existing tests that are already being marketed have been widely criticised by scientists as misleading consumers.^{10, 31} In addition, claims for a future of personalised nutrition ignore the increasing scientific recognition of biological complexity, which makes individual risks inevitably uncertain and hard to predict.

The scientific evidence for the role of genes in susceptibility to obesity, type 2 diabetes, heart disease, cancer, allergies, osteoporosis and neurological disorders is weak and contradictory, except in a few special cases.³² Genes do play an important role in the body's cells and how they respond to diet, and gene-diet interactions do appear to exist at the level of individual genes and nutrients. But, in most cases, genetic differences appear to make only small and subtle differences to a person's risk of diet-related disease and hence very little difference to the foods they should eat. Diets contain multiple foods, foods contain multiple nutrients and the body digests these nutrients through multiple biological pathways, involving many different genes and other factors. Because of this complexity, the evidence suggests that the 'individually tailored diet' is more of a marketing concept than a scientific one.

For example, Box A outlines developments in the genetics of obesity and Box B considers the genetics of cholesterol and how people respond to low-fat diets.

Box A: The genetics of obesity

More than 600 different genes and regions of DNA have been associated or linked with human obesity. Some very rare mutations have been found which lead to overeating and extreme obesity in some children. However, common variations in the same genes do not appear to play a role. No common genetic variation has been confirmed to play a significant role in determining who is overweight or obese in the general population.^{33, 34} In the past many scientists believed that obese people had bodies which needed less energy than leaner people – they were thought to have a lower metabolic rate, which meant they stored fat rather than burning it. A type of body tissue – called 'brown adipose tissue' (BAT) or brown fat – was also found which converts energy (especially fat from the diet) into heat, without storing it as body fat. Mutations in a gene called ADRB3, which affects brown fat, were also linked with obesity. However, early excitement about the ADRB3 gene has largely turned to disappointment. Most studies now agree that differences in metabolism when resting do not explain why some people get fatter than others: how much people eat and exercise is probably much more important.³⁵

Box B: Gene-diet interactions and cholesterol

There is a rare inherited form of high cholesterol levels called familial hypercholesterolaemia (FH), which is caused by mutations in the LDL receptor gene (there are over 350 possible mutations). However, it is unclear whether genetic differences are important in affecting cholesterol levels in most people. The biggest area of study has been whether the effectiveness of a low-fat or low-cholesterol diet depends on what genes a person has. The APOE gene has been the most widely studied for gene-diet interactions; however these studies have produced very mixed results and this gene has been found to be of little use in identifying people who respond best to low-fat diets.³⁶ Other genes may also play a role, but the evidence is also contradictory, showing that the biological response to dietary fats is highly complex.³⁷

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Although there are some examples where genes play an important role in diet-related diseases, often the effect is too small for the test to be useful to decide who should eat which foods or take which supplements

It is possible that people identified as at lower risk become complacent and are falsely reassured that they do not need to eat a healthy diet

Even if people can be informed of their genetic risk correctly, and they take the advice they are given, targeting the people with high-risk genes may not be good for population health

Although there are some examples where genes play an important role in diet-related diseases, often the effect is too small for the test to be useful to decide who should eat which foods or take which supplements. For example, one common genetic variation (in the MTHFR gene) is known to play a role in how people respond to folate or folic acid supplements, perhaps leading to an increased risk of heart disease. However, this genetic variation makes so little difference compared to other factors that it is not useful to decide who should take these supplements or change their diet, and the link with heart disease risk is also disputed.³⁸

People's psychological responses to genetic test results are also important, because even if a test genuinely identifies people who have most to gain by changing diets, it might not motivate them to do so. It is possible that people identified as at higher risk could become fatalistic and less likely to change their diets as a result of a genetic test; and/or that people identified as at lower risk become complacent and are falsely reassured that they do not need to eat a healthy diet. In either of these situations, genetic testing could actually *increase* the number of cases of disease in the population tested, or it could make testing ineffective or not cost-effective compared to other approaches. Only two US studies have examined the potential behavioural consequences of genetic testing for obesity risk and ease of weight loss: one of these suggested that some people may be falsely reassured by a negative genetic test result that they do not need to change their diets.^{39, 40} Some recent research has suggested that genetic tests for familial hypercholesterolaemia (Box B) may lead people to believe more strongly in cholesterol-lowering medication and less strongly in the efficacy of changing diet.⁴¹

Even if people can be informed of their genetic risk correctly, and they take the advice they are given, targeting the people with high-risk genes may not be good for population health. There are three main reasons for this:

- (i) *targeting the high-risk group is often much less effective than changing the diet of the whole population.* Unless the bad health effects of a high-risk diet occur only in the people with high-risk genes, there will be people with low-risk genes who also get the diet-related disease. In many cases, *more* people in this group will get the disease, because there will usually be more people in it. In situations like this, most cases of disease will be missed by targeting dietary advice at the people at high genetic risk;⁴²
- (ii) *the people who have most to gain by changing diets may not be the same as those who are at the highest genetic risk.* This depends on whether the *reduction in risk* that can be achieved by changing diets is larger for the people at high genetic risk than the people at low genetic risk. If it is, there is said to be a 'gene–diet interaction'. However, there is no consensus on the magnitude of gene–diet interactions, except for the major food intolerances (to milk, fava beans and alcohol), and complex interactions may prove impossible to quantify;⁴³
- (iii) *deciding who to target may be difficult if the dietary factor being studied causes more than one disease.* Unhealthy diets can cause many different diseases (for example, eating lots of sugary foods can increase the risk of dental caries, type 2 diabetes and obesity, and the latter increases the risk of other diseases, such as some cancers). It is possible (even likely) that people who are more susceptible to some of these diseases will be less susceptible to others. For example, a diet based on junk foods high in fat, sugar and salt will increase the risk of most of the 'big killer' diseases. This means that more genetic research is unlikely to change the basic message – everyone should try to avoid too much of these junk foods, whatever genes they have.

There may be exceptions for particular diseases, or special cases of ‘familial’ (largely inherited) forms of some diseases, where mutations in a single gene dominate an individual’s risk. But tailoring dietary advice to these genetic tests is useful only in a few specific cases: where a genetic test is a good predictor of a disease and where gene–diet interactions are large (so that people at ‘high genetic risk’ have most to gain by changing their diets). Lactose intolerance is one example, although it does not necessarily need a genetic test for diagnosis.

The focus on genetics and genomics as a means to tackle diet-related disease is technology and market driven

Some nutrigenomics research may help increase understanding of diet-related diseases, by helping to identify the different biological factors and dietary factors that may be involved. However, this does not mean that ‘personalised’ or genetically tailored diets will be a good approach to tackling the growing incidence of chronic diet-related disease. This is because small and uncertain differences in risk may be enough to help researchers find clues to our biology: but large, well quantified differences in risk are needed before it makes sense to tailor diets to our genes.

The focus on genetics and genomics as a means to tackle diet-related disease is technology and market driven – it has not been informed by an assessment of the likely benefits to health. Tailoring diets to genetic make-up therefore raises major concerns because privatising and individualising dietary advice could easily confuse and undermine healthy-eating messages. Genetic testing also involves significant potential for consumers to be misled about their health because of the lack of regulation of genetic tests and the confusing and contradictory information that people will be sold.⁴⁴

Broader social implications

As well as concerns about the implications of personalised nutrition for health, there are broader social and economic implications. These include:

Privacy, stigma and discrimination. For example: how personal genetic data will be stored and used, including for research or ‘direct marketing’ of products; whether the police or governments will be given access to commercial genetic databases; whether people will be required to reveal genetic test results to insurers or employers; and how people with adverse genetic test results will be treated by society.

Ethnicity and race. Historically, genetic explanations for disease have been used against ethnic minority groups, causing stigma and discrimination, and have been used to justify colonialism and eugenics. Studies of the genetics of diet-related disease and appetite have focused on Native American and Pacific Island populations, where the incidence of obesity and type 2 diabetes is extremely high. However, the emphasis on genetic explanations can detract from the social and economic factors that lead to poor health in these marginalised populations – including the role of food aid and ‘fat dumping’.⁴⁵ For example, a number of studies have found a sense of fatalism (or surrender to factors seen as beyond people’s control) to be a barrier to preventing diabetes in American Indian populations⁴⁶ Unless genetic testing is genuinely useful to guide treatment, promoting genetic explanations for diet-related disease can be counter-productive – wrongly implying that nothing can be done to change the situation.

The emphasis on genetic explanations can detract from the social and economic factors that lead to poor health in these marginalised populations

‘Personalised choice’ – a contradiction? The vision of personalised diets implies that people should trust genetic testing companies and food manufacturers to tell them what their ideal diet is. Despite the rhetoric of choice, the implication is

that people should simply follow the 'expert' recommendations and consume the products sold to them on the basis of their test results. However, real choice requires empowering people and tackling vested interests, rather than genetic tests.⁴⁷

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Medicalisation. Selling medication to treat risk factors rather than diseases is immensely profitable for the pharmaceutical industry: for example, statins (to lower cholesterol levels) are now the biggest selling prescription drugs in the world. While these drugs can save lives, expanding their use to ever larger numbers of people has been criticised by some doctors because lifestyle changes are usually cheaper and more effective and avoid the risk of side-effects. One argument used in favour of functional foods is that they provide a better or cheaper alternative to medication such as statins. However, an alternative view is that functional foods contribute to 'medicalisation' and to the idea that healthy people are all patients at risk of becoming sick. If this is the case, it is more likely that people encouraged to feel at high risk (because of genetic tests or other types of tests) will be sold both medication *and* functional foods *and* supplements.

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Costs and resources. With the whole population potentially 'at risk' and eligible for preventive medication, the cost implications of 'genetic susceptibility' testing have been described as 'staggering'.⁴⁸ However, it is difficult to analyse cost-effectiveness when the validity and usefulness of genetic tests have not been assessed and people's responses to the results are largely unknown. Because the costs of diet-related disease are so high, even a small reduction in the effectiveness of public health measures (by confusing healthy-eating messages, or diverting resources) could be substantial.

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An alternative aim for nutrition science is 'to contribute to a world in which present and future generations fulfil their human potential, live in the best of health, and develop, sustain and enjoy an increasingly diverse human, living and physical environment'.⁴⁹ This approach recognises the importance of the politics of food: such as where food comes from and who has access to healthy food, and the importance of improving the health of populations, by changing their social, environmental and economic circumstances.

Amid the commercial enthusiasm for nutrigenomics and personalised nutrition,

public health research has been neglected despite its enormous importance in reducing the incidence of disease. Obesity research, for example, has been targeted mainly at individuals, where most interventions result in only small amounts of weight loss and have little impact on the obesity epidemic: social and environmental interventions have largely been ignored. In 2003 the Health Development Agency found that not more than 0.4% of medical research output (measured by academic publications) is relevant to public health intervention research.⁵⁰

The predicted global epidemic of obesity, heart disease, diabetes and some types of cancer is a situation that requires urgent political action. If all nations become 'fast food nations', premature deaths and disability from diet-related disease will inevitably increase, adversely affecting the lives of literally millions of people. GeneWatch UK recommends that governments:

- Prioritise public health (the social and economic determinants of health), not personalised nutrition, and tackle the politics of food;
- Tackle inequalities, empower people to change their diets and health, and involve them in deciding what action and research would help to make a difference;
- End gene patenting, which distorts the 'knowledge-based' economy, and stop commercial interests from dominating the research agenda;
- Require medical oversight and statutory regulation of genetic tests – including an independent pre-market assessment of whether they are valid and useful for health;
- Adopt new legislation to prevent genetic discrimination and protect privacy.

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If all nations become 'fast food nations', premature deaths and disability from diet-related disease will inevitably increase

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