white lies

The health consequences of consuming cow's milk

A scientific report by Dr Justine Butler,
VVF Health Campaigner

Forewords by Professor T. Colin Campbell and Professor Jane Plant CBE

Vegetarian & Vegan Foundation

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VEGETARIAN & VEGAN FOUNDATION

The Vegetarian & Vegan Foundation (VVF) is a science-based charity that promotes human health through the promotion of a vegetarian or vegan diet. The VVF monitors and interprets research that links diet to health – explaining in simple terms how what we eat affects us, in both positive and negative ways. The VVF communicates this information to the media, the public, health professionals, schools and food manufacturers so providing accurate information on which to make informed choices.

Please note: the welfare aspects of dairy farming are not covered here. For information on British dairy farming and its impact on cow welfare please see Viva!'s referenced report The Dark Side of Dairy (www.milkmyths.org.uk T: 0117 944 1000).

FOREWORD

Professor T. Colin Campbell

There is hardly another controversy in health science more contentious than the role of cow's milk and its products in our daily diet. Some wonder why we would even dare to question whether there are adverse health effects. For them, cow's milk is Nature's most perfect food. It builds strong bones and teeth and is a good source of calcium and protein. Besides, it represents a bucolic side of life where gentle, lowing cows, black and white, roam in lush green pastures. I know this, for I was raised on a family dairy farm, milking cows and walking those green pastures, then combining grain and putting up hay for the winter. I drank the milk, lots of it, and we often made our own ice-cream and butter.

Early in my research career at Massachusetts Institute of Technology and Virginia Tech, I worked to promote better health by eating more meat, milk and eggs, what I believed to be 'high-quality animal protein'. It was an obvious sequel to my own life on the farm and I was happy to believe that the American diet was the best in the world.

However, later I was the Campus Coordinator at Virginia Tech of a project in the Philippines working with malnourished children. The primary goal of the project was to ensure that the children were getting as much protein as possible.

In this project, however, I observed something quite unusual. Children who ate the highest protein diets – and particularly animal protein – were the ones most likely to get liver cancer. I began to review other reports from around the world that reflected the findings of my research in the Philippines.

Although it was heretical to say that animal protein wasn't healthy, I started an in-depth study into the role of nutrition in the cause of cancer.

The research project culminated in a 20-year partnership of Cornell University, Oxford University, and the Chinese Academy of Preventive Medicine, a survey of diseases and lifestyle factors in rural China and Taiwan. More commonly known as the China Study, this project eventually produced more than 8,000 statistically significant associations between various dietary factors and disease.

This opportunity arose from a Chinese government survey of cancer mortality rates in 2,400 Chinese counties that showed remarkable concentrations of cancer in certain counties and much less so in others. We then organised an additional and unusually comprehensive and unique survey of diet and lifestyle characteristics that might help to explain these unusual geographic concentrations of cancer. Personally, I was interested in the broad based hypothesis that animal and plant-based foods, as characterised by their nutrient profiles, have opposing effects on the chronic, so-called Western diseases like cancer.

The results from this massive study, when considered in relation to our earlier research and that of others, convinced me that the diet having the broadest range of health benefits is one that is comprised of a variety of whole plant-based foods, but one that is also low in added fat, salt, sugar and highly processed foods. Remarkably, relatively low intakes of animal-based foods (such as dairy products and meat) in rural China were associated with biological conditions that favour the occurrence of the chronic diseases typically found in Western industrialised countries.

Then it was on to discovering how broad might be this dietary effect. My son, Tom, and I turned our attention to the research investigations of others. The published literature of these investigations is unimaginably huge. Moreover, the breadth of the health benefits of a plant-based diet is even far greater than our own research had indicated, with it reducing the risk of additional cancers, various cardiovascular diseases, diabetes (types I and II), multiple autoimmune diseases, osteoporosis, psycho-neural diseases (eg attention deficit disorder, clinical depression, Alzheimer's, cognitive dysfunction), eye disorders, kidney diseases, skin ailments and obesity amongst others.

Importantly, animal-based foods, as a group, have substantially different nutritional characteristics from plant-based foods and it is these nutritional characteristics, highly integrated at the metabolic level, that are chiefly responsible for the opposing effects of plant and animal-based foods on health and disease. Moreover, these effects involve countless food chemicals and exist throughout the range of consumption of these foods.

Of course, dairy foods have nutritional characteristics and disease associations that are consistent with other animal-based foods. Indeed, if anything, cow's milk and its products appear to be even more problematic than other animal-based foods.

Unfortunately the scientific literature on the characteristics and associations of dairy with health and disease seem to have been more obscured from public view than is the case for other animal-based foods. For example, research 40-60 years ago had shown that cow's milk proteins (casein and lactalbumin) markedly elevated blood cholesterol and its parallel formation of atherosclerotic plaques. More recently, much more evidence on the adverse health effects of cow's milk have accumulated, and much of it has been ably reviewed in this excellent report which is timely, broad in scope and profound in its consistency.

And finally, two other observations need attention. First, it is likely that the adverse dairy effects observed in many studies are underestimated because they have been observed in humans where the dairy-like nutritional effect already has been maximised by other animal-based foods. Second, imprecise measurement of risk factors and outcomes will mathematically attenuate the real effect.

It is not that these various dairy effects are independently proven to be true beyond doubt, any more than tobacco use is independently proven to cause lung cancer and heart disease. Rather, it is the weight and breadth of the evidence, along with its biological plausibility, that should determine the reliability of the evidence. Using these criteria, there is no doubt that this evidence on dairy is sufficient, at a minimum, to question the rather specious claims of health for cow's milk that have been made by the industry and its supporters and apologists.

I know well that this information deeply troubles many people, as it did me. But, at some point, we must give public voice to these observations and, if necessary, to sponsor discourse that is candid, openly transparent and, as much as possible, free of commercial bias.

T. Colin Campbell, PhD
Jacob Gould Schurman Professor Emeritus of Nutritional Biochemistry
Cornell University, Ithaca, NY
April 2006

Professor Jane Plant CBE (DSc)

I was delighted to be asked to write a foreword for this excellent and well-researched report into the adverse health impacts of dairy consumption on human health. My book, *Your Life in Your Hands*, describes how giving up dairy produce has helped me and other women to overcome metastatic breast cancer. When it was first published in 2000, I faced a barrage of criticism from orthodox doctors, charities and nutritionists. All of them, for whatever reason, poured scorn on the idea that consuming dairy could be bad for health. This may have been because, as Dr Justine Butler shows in this report, we have all been subjected to relentless publicity from the industry that tries to persuade us that dairy is wholesome, natural and good for our health. It is a measure of how far medical opinion has changed in the last few years that in 2005 I was awarded a life fellowship of the Royal Society of Medicine in recognition of my contribution to science through my books. We have a long way to go, however, until the truth about dairy is generally accepted, so this report is both timely and very welcome.

When I was carrying out the research for *Your Life in Your Hands*, which includes more than 500 references from the peer reviewed scientific literature, I was astonished at just how much information was available on the role of dairy produce in promoting disease – not only breast, prostate, ovarian and other cancers but also other conditions ranging from eczema and other allergic conditions to heart disease and diabetes. Despite all the criticism of my books, no one has presented a single scientific fact that persuades me to change one sentence of what I wrote in 2000 – and as a trained scientist I would have done that had I been given convincing evidence that I was wrong or had misunderstood some issue. Instead, the evidence against consuming dairy produce has continued to mount, as I detailed in the second and third editions of *Your Life in Your Hands*, and in my other books, *Prostate Cancer, Osteoporosis* (yes – there is even a compelling case against dairy produce, especially cheese, in the development of this crippling bone disease) and *Eating for Better Health*. This new report takes the evidence on the adverse human health impacts of dairy further.

What I had not appreciated until I attended the excellent and thought-provoking lecture given by Juliet Gellatley of Viva! and the Vegetarian & Vegan Foundation at the Incredible Veggie Show in London last year was the true nature of the modern dairy industry. It is hard to forget some of the images of cruelty that she presented then. This report exposes the nature of the modern industrialised dairy industry and the serious implications that this has for our health. I do hope that *White Lies* receives the recognition it deserves and that this will embolden politicians to take a stand against the dairy industry. To do so would improve human health, improve the environment, address serious issues of animal welfare and save the taxpayer a great deal of money spent in subsidising an industry that was the centre of the BSE crisis, the foot and mouth disease disaster and now the bovine tuberculosis problem.

Cow's milk is a perfect food for a rapidly growing calf but that doesn't mean it is good for human babies – or adults! If you want to improve your health by making just one change to your diet, I recommend you eliminate all dairy from the diet.

Professor Jane Plant CBE (DSc, CEng)
Life Fellow of the Royal Society of Medicine
Professor of Applied Geochemistry
Imperial College, London
March 2006

Introduction

The foods we consume are of immense importance to our health and well-being. The recent increase in television and media coverage of food and health issues has improved our understanding of the links that exist between diet and health. The types of food that we eat are strongly linked to our culture and food issues can cause emotional responses. In the UK and other northern European countries as well as North America, we have developed a strong emotional attachment to the idea that milk is a natural and healthy drink for us, even as adults.

Milk is the first food that we consume, our mother's breast milk if we are fortunate, if not then specially formulated substitutes based on cow's or soya milk are generally used in the UK. We associate milk with comfort and nurturing and consider milk to be a wholesome nutrient-rich component of the diet that is essential for normal growth and development, which for a baby it is. However, all other mammals on the planet are weaned off milk at an early age, whereas some humans continue drinking milk into adulthood. Not only that, we drink the milk of another species, something no other mammal does. To be fair, contrary to popular belief, most people in the world do not drink milk; it would make many of us ill. But in the UK, we are a nation of milk drinkers, along with most other northern European countries and North America. Infants, the young, adolescents, adults and the aged all consume large quantities of milk, cheese, butter and yogurt every year. But why are we so convinced that milk is some kind of wonder food?

Milk, it seems, can help you lose weight; it can also make you gain weight. Milk promotes healthy skin; it may also cause acne. You need milk for good bone health, but the incidence of osteoporosis is highest in countries that consume the most milk. These conflicting reports leave us confused and unsure who to believe. The dairy industry invests millions in milk advertising and promotion. It could be argued that they present a biased view motivated by financial interest. An increasing amount of scientific evidence now shows that cow's milk is not the wonder food the dairy industry would have us believe. This research goes further in linking the consumption of cow's milk to a wide range of health problems. Many people, even health professionals, may find it hard to be objective about the detrimental impact of dairy products on health described in this report because of the emotional attachment many of us have to the idea that milk is natural and healthy.

The aim of this report is to redress the balance by presenting and reviewing the research on the health effects of cow's milk and dairy products.

What is a healthy diet?

A healthy diet contains a wide range of fresh fruit and vegetables, whole grains, pulses, nuts and seeds. It is rich in important disease-busting antioxidants that protect against a number of illnesses and diseases including certain cancers and cardiovascular disease (Genkinger *et al.*, 2004; Joshipura *et al.*, 2001; Liu *et al.*, 2000). It has been suggested that the high concentration of antioxidants in blood may be one of the reasons for the lower incidence of chronic diseases in people consuming a plant-based diet rich in fruit and vegetables (Waldman *et al.*, 2005). A healthy diet provides plenty of fibre protecting against a range of diseases including colorectal cancer. It is rich in vitamins and minerals, again protecting health. A healthy diet should contain a good source of essential polyunsaturated fatty acids including the omega-3 fatty acids known to protect heart health.

On the other hand, a healthy diet should be low in saturated fat, animal protein and cholesterol for which we have no dietary requirement. Indeed the Government now advises that it is more important to replace saturated fat with unsaturated than to cut down on total fat (FSA, 2005). This means eating more avocados, nuts and seeds and plant-based oils and spreads such as flax seed oil and soya spread.

Cow's milk, cheese, butter, cream, ice-cream and milk chocolate all contain the unhealthy saturated kind of fat associated with an increased risk of heart disease. Some of these foods contain considerable amounts of saturated fat. For example, Cheddar cheese contains around 35 per cent fat, of which over 60 per cent is saturated. Similarly, butter contains over 80 per cent fat, of which over 60 per cent is saturated (FSA, 2002). This means that a 10 gram serving of butter contains over five grams of saturated fat! The Food Standards Agency describes five grams of saturated fat per 100 grams as 'a lot' (FSA, 2005), so the five grams of saturated fat contained in just 10 grams of butter makes this food remarkably unhealthy. Plant-based polyunsaturated fat spreads contain less total fat (around 60 per cent) of which less than 20 per cent is saturated. They tend to contain more of the valuable polyunsaturated fatty acids and so provide a much healthier option.

Saturated fats from animal foods such as whole milk, cream and butter increase the amount of cholesterol in the blood which in turn increases the risk of heart disease and diabetes. Research shows that a plant-based diet contains significantly less saturated fat. The extensive EPIC Oxford study comprising 33,883 meat-eaters, 10,110 fish-eaters, 18,840 vegetarians and 2,596 vegans showed that while the total fat intake was highest in the meat-eaters and lowest in vegans, the difference between the groups was relatively small. However, the percentage of energy from saturated fat was strikingly different across the four diet groups: saturated fat intake was highest in meat-eaters, almost identical in fish-eaters and vegetarians and significantly lowest among the vegans (Davey *et al.*, 2003). So significant is the lower saturated fat content of a plant-based diet that it can be used to control weight without worrying about calorie counting. In one clinical trial, adoption of a low-fat vegan diet was shown to help weight loss despite the absence of prescribed limits on portion size or energy intake (Barnard *et al.*, 2005). Other research confirming that vegetarians and vegans have a lower risk of being overweight or obese than meat-eaters shows that consuming more plant foods and less animal products may help individuals control their weight (Newby, *et al.*, 2005). Being overweight or obese increases the risk of many health problems including type 2 diabetes, heart disease, asthma, infertility, high blood pressure and many cancers.

Milk and other dairy products contain many biologically active molecules including hormones and growth factors. Cow's milk has been shown to contain over 35 different hormones and 11 growth factors (Grosvenor *et al.*, 1992). Some researchers are particularly concerned about the oestrogen content of cow's milk (Ganmaa and Sato, 2005), suggesting that cow's milk is one of the important routes of human exposure to oestrogens. The milk consumed now is very different to the milk consumed a century ago. Unlike their pasture-fed counterparts of old, modern dairy cows are usually pregnant and continue to lactate during the latter half of pregnancy, when the concentration of oestrogens in blood, and hence in the milk, increases. Although there is a paucity of research in this field, early evidence suggests the increase in exposure to cow's oestrogen may be linked to an increased incidence of certain cancers. In one study, cancer incidence was correlated with food intake in 40 countries (Ganmaa and Sato, 2005). Results showed that both cow's milk and cheese increased the risk of hormone-dependent cancers such as breast and ovarian cancer. Among the dietary risk factors identified, these researchers were most concerned with milk and dairy products because, as already stated, the milk drunk today tends to come from pregnant cows among whom oestrogen and progesterone levels are markedly elevated.

Another bioactive component of cow's milk receiving an increasing amount of attention is the growth factor called insulin-like growth factor 1 (IGF-1). The amount of IGF-1 present is higher in milk produced by pregnant cows. The concern is that because IGF-1 in cows is identical to human IGF-1, this growth factor could cross the gut wall and trigger an abnormal response, for example increasing the risk of certain cancers. Indeed, over the last decade IGF-1 has been linked to an increased risk of childhood cancers, breast cancer, lung cancer, melanoma and cancers of the pancreas and prostate (LeRoith *et al.*, 1995; Chan *et al.*, 1998) and gastrointestinal cancers (Epstein, 1996).

Interestingly, one study observed a 10 per cent increase in blood serum levels of IGF-1 in subjects who increased their intake of non-fat milk (Heaney, 1999) while another study noted that vegan men had a nine per cent lower serum IGF-1 level than meat-eaters and vegetarians (Allen *et al.*, 2000). Whether the consumption of cow's milk and dairy products raises IGF-1 levels directly (by crossing the gut wall), or indirectly (by triggering an increased production of human IGF-1 in the body), evidence suggests that some component of milk causes an increase in blood serum levels of IGF-1. It has even been suggested that IGF-1 may be used as a predictor of certain cancers, in much the same way that cholesterol is a predictor of heart disease (Campbell and Campbell, 2005).

In summary, a diet containing saturated fat, cholesterol, animal protein, hormones and growth factors is not a healthy diet. Cow's milk, butter, cheese, cream, ice-cream and other dairy products contain all these unhealthy components whereas substantial evidence shows that a plant-based diet rich in fruit and vegetables, whole grains and unsaturated fats (including omega-3 fatty acids) offers significant health benefits. By adopting a healthy diet, together with regular physical exercise and avoiding smoking, many of the so-called modern Western diseases can be prevented. As part of its global strategy on diet, physical activity and health, the World Health Organisation (WHO) claims that up to 80 per cent of cases of coronary heart disease, 90 per cent of type 2 diabetes cases and one-third of cancers can be avoided by changing to a healthier diet, increasing physical activity and stopping smoking (WHO, 2006c).

PART ONE: THE HISTORY, GEOGRAPHY AND BIOLOGY OF MILK

The origins of dairy farming

Although sheep, cattle and goats are thought to have been domesticated in parts of the Middle East and central Asia over 9,000 years ago there is no direct evidence that these animals were used to supply milk. Written texts, paintings and drawings from around 6,000 years ago provide the earliest firm evidence of dairy farming (Pringle, 1998). Molecular and stable isotope evidence for dairy fat residues in pottery suggests that the exploitation of animals for milk was already an established practice in Britain when farming began in the fifth millennium BC (Copley *et al.*, 2003). Although this sounds like a long time ago, in evolutionary terms it is very recent history and early dairy farming would have been practised on a relatively small scale. Hominid (modern humans and our forerunners) fossils date back to nearly seven million years ago (Cela-Conde and Ayala, 2003). If seven million years were represented as a twelve-hour clock, starting at midday, humans would have started dairy farming 37 seconds before midnight.

Furthermore, it is important to note that around 70 per cent of people in the world do not consume cow's milk, even if they wanted to, it would make them ill due to lactose intolerance (see Lactose intolerance page 52).

Dairy farming today

Milk production today is big business. Currently in the UK 2.2 million cows are held in 22,000 dairy holdings. The total value of the production of milk in the UK is estimated to be £2.7 billion. This is more than the value of production of beef, lamb, pig or poultry meat and around three times the value of the production of fresh vegetables (Defra, 2005). Excluding suckled milk, each cow now produces around 20 litres of milk per day, which equates to around 7,000 litres of milk yearly (Defra, 2005). Selective breeding and high protein feed has increased the average yield per cow from nine litres (16 pints) per day to 22 litres (39 pints) per day in just a few cattle generations.

A common misconception is that it is natural for cows to produce milk constantly. This is not the case; just like us, cows only produce milk after a nine-month pregnancy and giving birth. Today's large-scale intensive dairy farming employs a highly regulated regime of cycling pregnancy and lactation concurrently, meaning that cows are both pregnant and being milked at the same time for most of each year. This intensive physical demand puts a tremendous strain on the dairy cow and, as she gets older, infertility and severe infections causing mastitis and lameness cuts short her economic and productive life (The Dairy Council, 2002). The average lifespan of a modern dairy cow is only about five years – that is after three or four lactations, when naturally she may live for 20 to 30 years.

Who drinks milk?

Since 1960, global milk production has nearly doubled (Speedy, 2003). *Around three-quarters of the world's population do not drink milk*, but among those who do, the pattern of consumption varies widely between countries. Data collected by the United Nations Food and Agriculture Organisation (UNFAO) in 2002 provides figures for the consumption of milk (excluding butter) in kilograms per capita per year for over 170 countries (FAOSTATS, 2002).

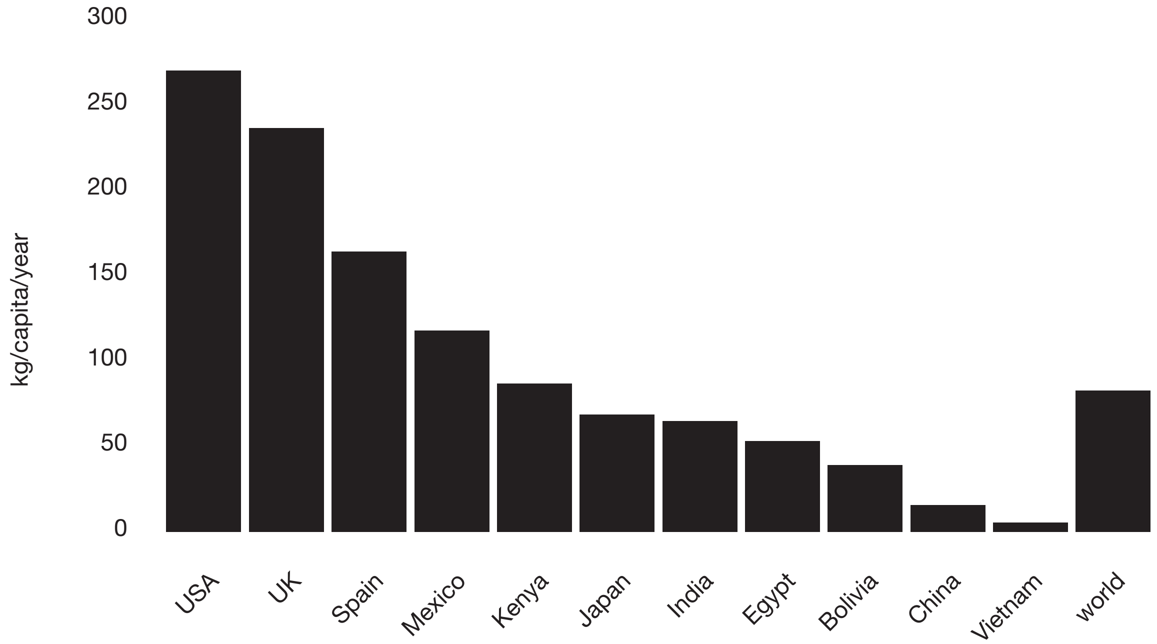

Figure 1.0 Consumption of milk in selected countries compared to world consumption. Data from FAOSTATS, 2002.

As shown in Figure 1.0 the level of milk consumption varies widely between countries, even between neighbouring countries in the same continent. For example, in Portugal 219.7kg of milk is consumed per person per year whereas in Spain the figure is considerably lower at just 158.3kg per person per year.

The highest levels of consumption are seen in Europe. In Sweden for example, a massive 369.4kg of milk is consumed per person per year, with Finland close behind at 350.6kg. Other countries consuming large volumes of milk include the Netherlands (345.7kg), Switzerland (332.4kg), Albania (298.8kg), Austria (293.3kg), Ireland (279.5kg), France (275.5kg) and Norway (275.1kg). In the US 261.8kg of milk is consumed per person per year, and in the UK the figure is 230.9kg. Whereas the average amount of milk consumed per person per year on a global scale is just 79kg.

The lowest levels of consumption are seen in Africa and Asia. In the Democratic Republic of the Congo a mere 1.6kg of milk is consumed per person per year. Other countries consuming small volumes of milk include Liberia (1.8kg), the Democratic People's Republic of Korea (3.9kg), Mozambique (4.5kg), Vietnam (5kg), China (13.3kg) and Thailand (18.8kg). With levels this low, it is reasonable to assume that many people in these countries and others do not consume any milk or milk products at all.

It could be argued that the low level of milk consumption seen in developing countries just reflects the fact that people cannot afford to buy milk. However, in Japan for example (not a developing country), milk consumption is very low at only 67.1kg. Most people in the world do not drink milk; their reasons may be cultural, economical, historical or biological. For example, most of the world's population are lactose intolerant (see Lactose intolerance page 52). But many of us think of milk as a fundamental component of a healthy diet. Why is this? Is milk the only source of some obscure essential nutrient? Or is milk unique in that it contains all the nutrients that we require?

A comparison between human milk and cow's milk

The composition of milk varies according to the animal from which it comes, providing the correct rate of growth and development for the young of that species, thus for human infants, human milk is obviously more suitable than cow's milk. Indeed, the popular consensus among health care professionals is that ordinary cow's milk, goat's milk, condensed milk, dried milk, evaporated milk, or any other type of milk should not be given to a child under the age of one. This is because of differences in the composition of milk that have been revealed by research over the last decade or so. While cow's milk and human milk contain a similar percentage of water, the relative amounts of carbohydrate, protein, fat, vitamins and minerals vary widely.

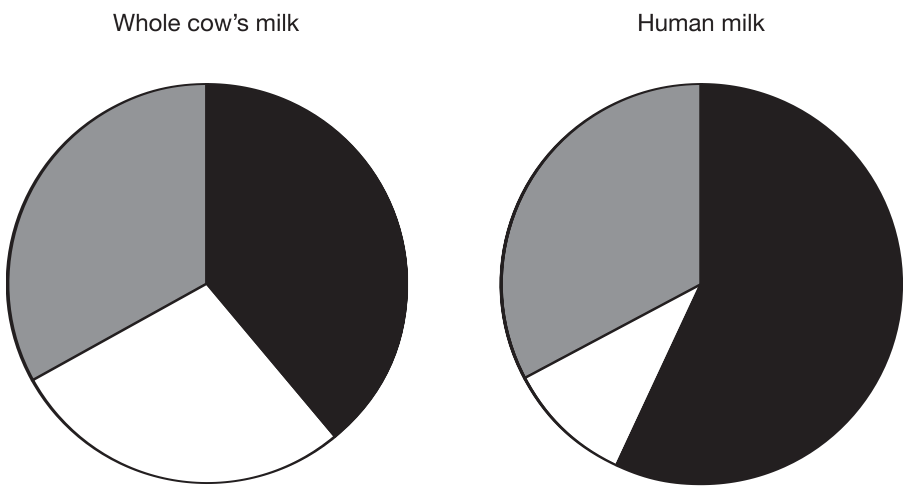

Figure 2.0 A comparison of the carbohydrate (black), protein (white) and fat (grey) components of whole cow's milk and human milk. Source: FSA, 2002.

Protein

The carbohydrate, protein and fat content of milk from one species is finely tuned to meet the nutritional requirements of that particular animal whether human, elephant, buffalo, camel or dog. Figure 2.0 shows that the protein content in 100g of whole cow's milk (3.3g) is more than double that of human milk (1.3g); this is because the amount of protein in milk is linked to the amount of time it takes that particular species of animal to grow in size. Growing calves need more protein to enable them to grow quickly. Human infants on the other hand need less protein and more fat as their energies are expended primarily in the development of the brain, spinal cord and nerves.

The proteins in milk can be divided into two categories: caseins and whey proteins. Human milk contains these in a ratio of 40:60 respectively; while in cow's milk the ratio of casein to whey proteins is 80:20. Given that the amount of total protein in cow's milk is more than double that of human milk, cow's milk clearly contains considerably more casein than human milk. Casein can be difficult to digest, in fact it is used as the basis of some glues! Infant milks are formulated to contain more whey than casein (the ratio of whey to casein in these milks is similar to that of human milk), and this is why it is thought to be easier for new babies to digest. Casein has been linked to a range of diseases and allergies, including type 1 diabetes (see Diabetes page 42).

Fat

The amount and type of fat present in the milk similarly reflects the requirements of the species of animal producing that milk. Whole milk from a cow contains around four per cent fat whereas milk from the grey seal contains over 50 per cent fat (Baker, 1990); this is because baby seals need more body fat to survive in cold water. Figure 2.0 shows that 100g of whole cow's milk and human milk contain similar amounts of fat (3.9g and 4.1g respectively). While these

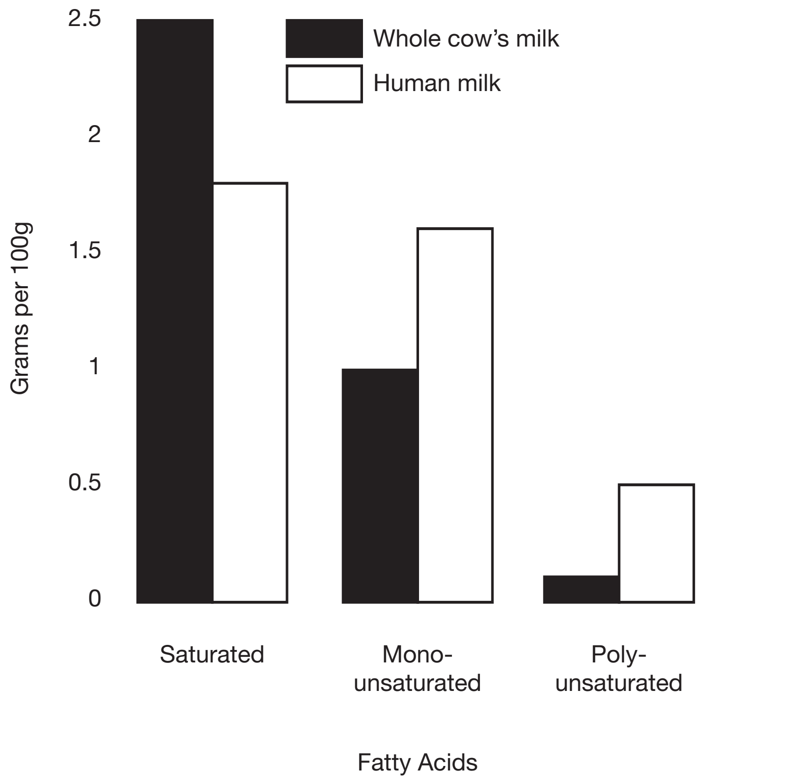

Figure 3.0 The fatty acid composition of whole cow's milk and human milk. Source: FSA, 2002.

values are close, the types of fat vary. Figure 3.0 shows that cow's milk contains more saturated fat while human milk contains more unsaturated fat.

Figure 3.0 shows that 100g of whole cow's milk contains 2.5g saturated fat, 1.0g monounsaturated and 0.1g polyunsaturated fat, while human milk contains 1.8g saturated fat, 1.6g monounsaturated fat and 0.5g polyunsaturated fat (FSA, 2002). These figures demonstrate the higher level of saturated fat in cow's milk compared to human milk, and the higher level of unsaturated fat in human milk compared to cow's milk. This imbalance contributes to the unsuitability of cow's milk for human infants.

The higher level of unsaturated fatty acids in human milk reflects the important role of these fats in brain development. In humans the brain develops rapidly during the first year of life, growing faster than the body and tripling in size by the age of one. The brain is largely composed of fat and early brain development and function in humans requires a sufficient supply of polyunsaturated essential fatty acids. The omega-6 fatty acid arachidonic acid (AA) and the omega-3 fatty acid docosahexaenoic acid (DHA) are both essential for brain development and functioning. Both are supplied in human milk but not in cow's milk (currently AA and DHA-enhanced infant formulas are available, although not mandatory, throughout most of Europe).

A review of 20 studies of cognitive function of breast fed infants compared to that of formula fed infants concluded that the nutrients in breast milk may have a significant effect on neurological development in infants (Anderson *et al.*, 1999). Cow's milk tends to be low in the types of fat essential for human brain development; a rapid increase in body size is more of an imperative for cows than rapid brain development, so cows produce milk that is high in body-building saturated fats to help their calves grow rapidly in size.

Similarly, the fatty acid composition of cow's milk is more suited to a calf than to a person. Attempts to alter the fatty acid composition of cow's milk, and so increase the nutritional value of cow's milk to humans, have involved experiments feeding cows fish meal and soya beans (AbuGhazaleh *et al.*, 2004) and flax seed (Petit, 2002). Feeding flax seed resulted in a lower omega-6 to omega-3 fatty acid ratio, which is thought might improve the nutritional value of milk from a human health point of view by reducing the potential risk of disease. Of course you could just eat the flax seed oil yourself to improve the balance of omega-3 and omega-6 oils in your diet while avoiding the undesirable components of milk.

Calcium

The calcium content of cow's milk (120mg per 100ml) is nearly four times that of human milk (34mg per 100ml). This discrepancy occurs for good reason; calves grow much more quickly and have a larger skeleton than human babies and therefore need much more calcium (FAO, 1997). Cow's milk is specifically designed to meet this high demand. According to the American Academy of Pediatrics Policy Statement on calcium requirements of infants, children and adolescents, the available data demonstrates that the bioavailability of calcium from human milk is greater than that from both infant formulas and cow's milk (Baker *et al.*, 1999). So although human milk contains less calcium than cow's milk, the calcium in human milk is better absorbed into the body than the calcium in cow's milk, again illustrating why human milk is the best source of nutrition during the first year of life.

Iron

Cow's milk contains very little iron (FSA, 2002) which is another reason why cow's milk is deemed to be unsuitable for infants under the age of one. Indeed a one-year-old attempting to meet the reference nutrient intake (RNI) of 5.3mg of iron would have to drink over 30 pints of cow's milk per day if it were to be used to meet their iron requirement. Furthermore, cow's milk is low in vitamin C and vitamin D (Department of Health, 1994), and contains less vitamin A than human milk.

Table 1.0 Comparison of the mineral and vitamin components of cow's milk and human milk.

	Cow's Milk (semi-skimmed, pasteurised) per 100g	Human Milk (mature) per 100g
Sodium (mg)	43	15
Potassium (mg)	156	58
Calcium (mg)	120	34
Magnesium (mg)	11	3
Phosphorus (mg)	94	15
Iron (mg)	0.02	0.07
Copper (mg)	Trace	0.04
Zinc (mg)	0.4	0.3
Chloride (mg)	87	42
Manganese (mg)	Trace	Trace
Selenium (µg)	1	1
Iodine (µg)	30	7
Retinol (µg)	19	58
Carotene (µg)	9	(24)
Vitamin D (µg)	Trace	Trace
Vitamin E (mg)	0.04	0.34
Thiamin (mg)	0.03	0.02
Riboflavin (mg)	0.24	0.03
Niacin (mg)	0.1	0.2
Vitamin B6 (mg)	0.06	0.01
Vitamin B12 (µg)	0.9	Trace
Folate (µg)	9	5
Pantothenate (mg)	0.68	0.25
Biotin (µg)	3.0	0.7
Vitamin C (mg)	2	4

( ) = estimated value. Source: FSA, 2002.

The high protein, sodium, potassium, phosphorus and chloride content of cow's milk present what is called a high renal solute load; this means that the unabsorbed solutes from the diet must be excreted via the kidneys. This can place a strain on immature kidneys forcing them to draw water from the body thus increasing the risk of dehydration. The renal solute load of infants fed cow's milk has been shown to be twice as high as that of formula fed infants (Martinez *et al.*, 1985).

Allergic reactions to the proteins in cow's milk are common among infants, and cow's milk-induced intestinal bleeding as an allergic response is a well-recognised cause of rectal bleeding in infancy (Willetts *et al.*, 1999). This blood loss can affect the iron nutritional status of the infant (Ziegler *et al.*, 1990) and in many cases may lead to anaemia. This condition will deteriorate if iron-rich foods are excluded by the continued consumption of milk, a food very low in iron (see Allergies – Gastrointestinal bleeding, page 18).

The health problems caused by the early consumption of 'normal' off-the-shelf cow's milk are so well documented now that parents and caregivers are actively encouraged to delay the introduction of cow's milk until at least nine months of age or older in many countries including the UK (Department of Health, 1994), the US (American Academy of Pediatrics, 1992), Denmark (National Board of Health, Denmark, 1998) Canada (Canadian Paediatric Society, 1998), Sweden (Axelsson *et al*., 1999) and New Zealand (Soh *et al*., 2004).

The composition of cow's milk

Cow's milk composition can vary widely between different breeds and during different stages of lactation. In the first few days after birth, a special type of milk called colostrum is excreted which is rich in fats and protein. Colostrum also contains important infection-fighting antibodies which strengthen the immune system of the young mammal. The transition from colostrum to true milk occurs within a few days following birth.

Water

All milk produced by animals contains carbohydrate, protein, fat, minerals and vitamins but the major component is water. Water dilutes the milk allowing its secretion from the body; without water it would be impossible to express milk. Additionally, the water in milk is essential to the newborn for hydration. Cow's milk contains a similar amount of water to human milk – around 87 per cent.

Carbohydrate

The major carbohydrate in mammalian milk is a disaccharide (or sugar) called lactose. For lactose to be digested, it must be broken down in the intestine by the enzyme lactase to its component monosaccharides glucose and galactose. Glucose can then supply energy to the young animal. Many people are unable to consume cow's milk and dairy products because they are unable to digest lactose after weaning. Most infants possess the enzyme lactase and can therefore digest lactose, but this ability is lost in many people after weaning (commonly after the age of two). *In global terms lactose intolerance is very common, occurring in around 90-100 per cent of Asians, 65-70 per cent of Africans, but just 10 per cent of Caucasians* (Robbins, 2001). **Therefore most of the world's population are unable to digest milk after weaning**.

Protein

Protein provides energy and is required for the growth and repair of tissue such as skin and muscle. Caseins are the primary group of proteins in cow's milk, making up around 80 per cent of the total protein content. The remaining portion is made up from whey proteins. There are four types of casein (alpha-, beta-, gamma- and kappa-casein) that combine to make up a structure known as a casein micelle. The micellar structure of casein is important in the production of cheese; it also plays a significant role in cow's milk allergies (see Allergies, page 16).

Fat

The principal fat in milk is a complex combination of lipids called triglycerols (esters of three fatty acids with one molecule of glycerol). There are more than 400 fatty acids in cow's milk ranging in carbon atom chain length from four carbon atoms to 26 (National Dairy Council, US, 2005). Fatty acids are described as saturated or unsaturated depending on the amount of hydrogen in the carbon chain of the molecule; milk contains both saturated and unsaturated fatty acids. Unsaturated fatty acids may be further classified as monounsaturated or polyunsaturated (depending on the number of double bonds in the carbon chain of the fatty acid molecule). Again, milk contains fatty acids from both groups but most of the fat in whole cow's milk (around 65 per cent) is the saturated type.

Polyunsaturated fats include fatty acids called the omega-6 and omega-3 fatty acids (these names refer to the position of the double bond in the carbon chain of the fatty acid molecule). Milk contains the omega-6 essential fatty acid linoleic acid and the omega-3 fatty acid linolenic acid. These are called essential fatty acids because they are essential to health but cannot be made within the body and so must be obtained from the diet. While milk does contain linoleic acid and linolenic acid (both with chains of 18 carbon atoms) it does so at relatively low levels.

There has been much excitement recently about the so-called conjugated linoleic acids (CLAs) in cow's milk. The term 'conjugated' refers to the molecular arrangement of the molecule. CLAs are described as positional and geometric isomers of linoleic acid; this means that CLAs are made up of exactly the same components as normal linoleic acid, just in a different arrangement. CLA in one particular configuration (cis-9, trans-11 CLA) is believed to possess a range of potential health benefits for humans (McGuire and McGuire, 2000). However, the majority of studies on weight loss, cancer, cardiovascular disease, insulin sensitivity and diabetes and immune function have been conducted on animals and it has been acknowledged that variations exist between different animals' responses to CLAs. A recent review of 17 studies on humans concluded that CLA does not affect body weight or body composition and has a limited effect on immune function (Tricon *et al.*, 2005). Furthermore some detrimental effects of CLA have been observed in mice and some reports suggest that CLAs can elicit pro-carcinogenic effects (Wahle *et al.*, 2004). Despite warnings from researchers that until we know more, CLA supplementation in humans should be considered with caution, the dairy industry sees this molecule as a new marketing opportunity and research into producing CLA-enriched milk by manipulating the diet of dairy cows has already begun (Lock and Garnsworthy, 2002).

In addition to the fatty acids discussed there are small amounts of phospholipids and other fats present in milk including fat soluble vitamins.

Minerals and vitamins

Minerals found in cow's milk include sodium, potassium, calcium, magnesium, phosphorus and chloride, zinc, iron (although at extremely low levels), selenium, iodine and trace amounts of copper and manganese (FSA, 2002). Vitamins in cow's milk include retinol, carotene, vitamin E, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate, pantothenate, biotin, vitamin C and trace amounts of vitamin D (FSA, 2002). In the US, milk is fortified with additional vitamin D; this has important implications as we shall see later (see Osteoporosis, page 57).

Although cow's milk contains all these nutrients it is important to note that *these vitamins are contained at very low levels*. Furthermore, the mineral content is so out of balance with human biochemistry that it is difficult for us to absorb the optimum amounts required for health.

Fibre

Milk contains no dietary fibre.

The undesirable components of milk and dairy products

Whole milk, cheese, butter and many other dairy products contain high levels of saturated fat, cholesterol and animal protein all of which are not required in the diet and have been linked to a wide range of illnesses and diseases. For example, excess saturated fat and cholesterol in the diet is associated with an increased risk of heart disease and stroke. Cross cultural studies show that as the consumption of saturated fat, cholesterol and animal protein increases from country to country, so does the incidence of the so-called diseases of affluence such as obesity, heart disease, diabetes, osteoporosis and certain cancers. It has been suggested that this is because of genetic differences between different races. However, when people migrate from an area of low incidence of the so-called affluent diseases to an area of high incidence, they soon acquire the same high incidence shared by the population into which they have moved. This correlation must then be attributed, at least in part, to environmental factors such as diet and lifestyle. So if you can increase the risk of disease by changing your diet and lifestyle, it stands to reason that you can reduce the risk of disease by changing your diet and lifestyle. The WHO state that there are major health benefits in eating more fruit and vegetables, as well as nuts and whole grains and moving from saturated animal fats to unsaturated vegetable oil-based fats (WHO, 2006c).

In addition to saturated fat, cholesterol and animal protein, a wide range of undesirable components occur in cow's milk and dairy products. The modern dairy cow is prone to both stress and disease. In the UK, cows suffer from a range of infectious diseases including brucellosis, bovine tuberculosis, foot and mouth disease, viral pneumonia and Johne's disease. As a result of an infectious disease a wide range of contaminants can occur in milk. Mastitis (inflammation of the mammary gland) is a widespread condition affecting cattle in the UK in which all or part of the udder suffers from an infection caused by bacteria entering through the teat (MDC, 2004). Mastitis may be referred to as subclinical (no symptoms) or clinical whereby symptoms include swelling, pain, hardness, milk clots or discoloured milk. The cow responds to the infection by generating white blood cells (somatic cells) which migrate to the affected area in an effort to combat the infection. These cells, along with cellular debris and necrotic (dead) tissue, are a component of pus and are excreted into the milk.

The number of somatic cells in the milk (the somatic cell count) provides an indication of the level of infection present. The somatic cell count usually forms part of a payment structure to farmers with defined thresholds of concentration determining the qualification for bonus payments or penalty charges (Berry *et al.*, 2003). In the European Union the somatic cell limit is a maximum of 400,000 cells per ml in bulk milk (Dairy Products (Hygiene) Regulations, 1995). **This means that milk containing 400 million pus cells per litre can be sold legally for human consumption. So one teaspoonful of milk could contain up to two million pus cells!** It could be even worse, as concerns have been raised about the efficiency of cell counting techniques (Berry *et al.*, 2003).

Mastitis effects the quality of milk in many ways; the total protein content is decreased, the amounts of calcium, phosphorus and potassium content are decreased, the taste deteriorates (becomes bitter), and the levels of undesirable components rise. These include enzymes such as plasmin and lipase, immunoglobulins (Blowey and Edmondson, 2000) and microbes. Mastitis is treated with antibiotics delivered directly into the udder. These drugs can also end up in the milk, so milk from treated cows must not be marketed until the recommended withholding period has elapsed (MDC, 2004). Mastitis occurs in around 50 per cent of cows in the UK (Blowey and Edmondson, 2000).

Milk contains many biologically active molecules including enzymes, hormones and growth factors. In 1992, Pennsylvania State University endocrinologist Clark Grosvenor published an extensive review of some of the known bioactive hormones and growth factors found in a typical glass of milk in the US. The list included seven pituitary (an endocrine gland in the brain) hormones, seven steroid hormones, seven hypothalamic (another brain endocrine gland) hormones, eight gastrointestinal peptides (chains of two or more amino acids), six thyroid and parathyroid hormones, 11 growth factors, and nine other biologically active compounds (Grosvenor *et al.*, 1992). Other biologically important proteins and peptides in milk include immunoglobulins, allergens, enzymes, casomorphins (casein peptide fragments) and cyclic nucleotides (signalling molecules). The concern here is that these signalling molecules that have evolved to direct the rapid growth of a calf into a cow may initiate inappropriate signalling pathways in the human body that may lead to illnesses and diseases such as cancer.

All milk produced by mammals is a medium for transporting hundreds of different chemical messengers. It has been suggested that milk actively communicates between the maternal mammary epithelia and the infant's gastrointestinal system directing and educating the immune, metabolic and microflora systems within the infant (German *et al.*, 1992). Indeed, research indicates that many of these molecules survive the environment of the infant's gut and are absorbed into the circulation where they may exert an influence on the infant's immune system, gastrointestinal tract, neuroendocrine system, or take some other effect. This has evolved as a useful mechanism between mothers and infants of the same species, but the effects of bioactive substances in milk taken from one species and consumed by another are largely unknown. The concern is that the bioactive molecules in cow's milk may direct undesirable regulation, growth and differentiation of various tissues in the human infant. Of particular concern for example is the insulin-like growth factor 1 (IGF-1) which occurs naturally in milk and has been linked to several cancers in humans (see IGF-1, page 49).

Breast is best

The WHO states that as a global public health recommendation, infants should be exclusively breast fed for the first six months of life to achieve optimal growth, development and health (WHO, 2001). They conclude that in general this is the healthiest start to life for a baby. It is interesting to note that when given the choice between human breast milk and cow's milk infant formula, newborn babies demonstrate a preference (by turning their head and mouthing) for human milk regardless of their individual postnatal feeding experience (Marlier and Schaal, 2005).

Breast feeding is important for many reasons. Babies receive an important boost to their immune system in the first few days of breast feeding as important antibodies are passed from the mother to the infant in the colostrum (the fluid expressed before the so-called true milk). These antibodies protect the baby from infection. Breast fed babies are less likely to suffer many serious illnesses including gastroenteritis, respiratory and ear infections, eczema and asthma as children. Adults who were breast fed as babies are less likely to have risk factors for heart disease such as obesity, high blood pressure and high cholesterol levels (UNICEF, 2005). This was confirmed recently in a study of over 2,000 children from Estonia and Denmark. It was found that that children who were breast fed as infants had lower blood pressure than those who were not; the longer the child was breast fed, the greater the difference (Lawlor *et al.*, 2005). The implications are that breast feeding plays a role in reducing heart disease in adults.

Furthermore, breast feeding is free! You do not need to wash and sterilise an endless number of bottles. You will not be up in the night mixing and testing the milk to see if it is cool enough; breast milk comes ready mixed at the perfect temperature. The act of breast feeding is also important for bonding the mother and baby relationship. Yet British breast feeding rates are amongst the lowest in Europe. At birth, only 69 per cent of UK babies are breast fed and this figure falls rapidly to 55 per cent at one week (Hamlyn *et al.*, 2002).

The use of formula milk while in hospital is a strong indicator for a mother giving up breast feeding after leaving hospital; 40 per cent of breast feeding mothers whose babies had been given formula milk in hospital stopped breast feeding within two weeks compared to only 13 per cent of breast feeding mothers whose babies had not been given formula milk (Hamlyn *et al.*, 2002). Regrettably, at six months of age, just one in five babies in the UK are still receiving breast milk, despite the fact that the WHO, UNICEF and the UK Government all recommend that babies should be fed only breast milk for their first six months of life.

Infant formula

Some mothers are unable to, or choose not to, breast feed and in these circumstances infant formula milk is used. Formula milk is designed to meet the nutritional requirements of the infant and must comply with strict UK and EC legislation which specifies the nutritional composition of the feeds. Soya-based infant formulas provide a safe feeding option for most infants that meet all the nutritional requirements of the infant with none of the detrimental effects associated with the consumption of cow's milk formulas. Under no circumstances should a child under 12 months be given 'normal' cow's, goat's, soya or any other milk that is not specifically formulated for an infant (for a review on the safety of soya see Appendix I page 63).

Milk in schools

In 1924, local education authorities (LEAs) in the UK were permitted to provide children with free milk. This was the start of the movement to introduce milk to school-aged children that would continue to this day. In a recent paper published in the *Economic History Review*, Dr Peter Atkins of Durham University reviewed the motivations behind the introduction of cow's milk in schools during the first half of the twentieth century (Atkins, 2005). Atkins stated that the nutritional benefits of school milk were debatable, possibly even negative in those areas where it replaced other foods, but noted that the dairy industry did well, creating new markets at a time of depression (Atkins, 2005).

In 1946, the School Milk Act provided free milk to all school children. A third of a pint of milk was provided to all children under the age of 18 years until 1968 when Harold Wilson's Government withdrew free milk from secondary schools. This policy was extended in 1971 when Margaret Thatcher (then secretary of state for education) withdrew free school milk from children over seven. This was an economic decision, not one based on a nutritional assessment of the value of milk, and for this she earned the nickname 'Thatcher, Thatcher, milk snatcher' – although many children were delighted at not having to drink the warm sickly odorous milk at school anymore!

The school milk scheme was introduced in 1977 by the European Union (EU) to encourage the consumption of milk in schools. The scheme requires member states to make subsidised milk available to primary and nursery schools wishing to take part, but participation is entirely a matter for the school or LEA. The European Commission had originally indicated that it wished to abolish the subsidy because the scheme was not providing value for money. The UK did not accept these conclusions and fought hard to retain the scheme. A compromise was secured whereby in 2001 the subsidy rate was reduced from 95 to 75 per cent. The UK Government tops up the subsidy to its original level in England, up to a maximum total expenditure of £1.5 million each year. In the academic year 2003 to 2004, around one million school children in England drank 34.9 million litres of subsidised milk at a cost of around £7 million (Defra, 2005a).

The move to increase milk consumption in schools is gathering momentum; the School Milk Project (TSMP), set up in 1998 by the Women's Food and Farming Union, aims to increase the uptake of milk in primary schools. It receives funding from the Milk Development Council (MDC) which was established following the re-organisation of the milk industry in 1994. The MDC is funded by a statutory levy on all milk sold off farms in Great Britain; the annual income from the levy is over £7 million (MDC, 2005). Primarily the MDC funds research and development into milk production methods, it also funds TSMP which employs 'facilitators' to promote the uptake of school milk through direct contact with LEAs, schools and dairy suppliers.

The charity Milk For Schools (MFS) was founded in 1994. Set up to educate the public in the field of school based nutrition, MFS is a registered member of the United Nations Food and Agriculture Organisation (UNFAO) School Milk Network, which initiated the first World School Milk Day on 27th September 2000. In October 2004 Dairy UK was established as a cross-industry body representing processors and distributors of liquid milk and dairy products, as well as milk producer co-operatives. In 2005 the EU and Dairy UK joined forces with the MDC to promote milk consumption in primary schools (Dairy UK, 2005). Schools were targeted with 'Teacher's Guides to Health and Fitness' and School Milk Week commenced on 10th October 2005. Previous school milk weeks have generated over 6,000 new school milk drinkers or as Dairy UK put it "over one million new serving opportunities per annum" (Dairy UK, 2005).

There is undoubtedly some very clever marketing going on here, in fact the 30-year decline in milk consumption may be coming to an end. Liz Broadbent, director of market development at MDC, points out that this growth (worth £4 million to Britain's dairy farmers), is the first credible and seemingly sustainable rise in the past three decades. Research indicates the extra milk is being in used in porridge, tea and coffee. Evidence suggests this rise is due to successful promotion and marketing of specific products. This explains the industry's recent move to abandon generic promotions (just telling everyone to drink more milk) instead choosing to focus on specific products for specific groups, hence the MDC's latest campaign specifically targeting teenage girls. The research has also discovered a growing number of low milk consumers among the more affluent members of the population including single professionals and young parents who did not receive free milk themselves at school.

This group, that are not passing on a milk-drinking habit to the next generation the MDC notes, account for around half of the population but consume only a quarter of the volume. The MDC targets particular groups in an attempt to generate new consumers, who will, in turn, make new consumers of their children. Broadbent states that convenience, innovation and habit are the key, and while cost is not an issue for this group, providing milk in a form they like is. The other route Broadbent suggests is through the school milk programmes which are redeveloping the milk drinking habit at an early age.

MDC's school milk project and match-funded school milk bar initiative have generated half a million new milk drinkers and accounts for 20 million litres of milk. But its real value to the dairy industry is the reinstatement of milk as a 'normal' commodity for regular family consumption now and in the future. The policy of introducing school milk begs the question, are the dairy industry nurturing our children? Or simply nurturing a future loyal adult consumer base?

PART TWO: DAIRY CONSUMPTION AND HEALTH

The suggestion that the consumption of cow's milk can lead to a wide range of health problems, illnesses and diseases strikes at the core of many people's thinking. How can such a natural food be unhealthy? Well the answer lies in the question; milk is not a natural drink for adults. Furthermore, **cow's milk is not a natural drink for humans**. In nature, milk is consumed from a mother up until weaning, which is when the mother normally stops producing milk. Consuming milk from a pregnant mother is not the normal course of events. Furthermore, in nature, mammals consume the milk of their own species, not that of another. In a commentary published in the *Journal of the American Academy of Dermatology*, New Hampshire dermatologist Dr F.W. Danby states that the human consumption of large volumes of another species' milk, especially when that milk comes from pregnant cows during the human's normally post-weaned years, is essentially unnatural (Danby, 2005).

As previously stated, cow's milk is designed to help a small calf grow into a big cow in less than a year. In order to sustain this rapid physical growth, the composition of cow's milk has evolved to contain the specific types of nutrients required, at the specific levels required. These are not necessarily natural or healthy for humans. For example, whole milk and certain dairy products such as butter and cheese, contain considerable amounts of saturated fat, cholesterol and animal protein, the detrimental health effects of which are now well-documented. In addition to this, the vitamin and mineral content of cow's milk is not well-suited to human requirements, especially those of the human infant. To meet the rapid skeletal growth requirements of a calf, cow's milk contains four times the amount of calcium as human milk. This does not mean that cow's milk is a good source of calcium for the human infant, far from it; this level of calcium coupled to the high levels of other minerals in cow's milk represents what is called a high renal solute load which means that the young human infant's kidneys cannot cope with 'off the shelf' cow's milk.

In addition to the unsuitable nutritional composition of cow's milk, there are many other reasons why cow's milk and dairy products are not natural foods for humans, for example, the increasing body of evidence linking bioactive molecules in milk (hormones and growth factors) to disease. While the dairy industry would have us believe that milk is an essential part of the diet, much of the research used to promote this view is industry-sponsored. Furthermore, given that around 70 per cent of people in the world do not drink milk, just how essential can it be? The list of illnesses and diseases associated with the consumption of milk and dairy products is quite extensive. These health problems tend to occur at levels that relate directly to how much milk is drunk in a particular region or country. Furthermore, as milk consumption spreads to areas where previously it was not drunk, these diseases follow. Some of these problems are discussed in detail below.

Acne

Acne is a skin condition that affects many teenagers and in a small number of cases it may occur in adulthood. About 80 per cent of people will have some degree of acne between the ages of 11 and 30 (NHS Direct, 2005). Acne can be a very serious problem causing distress and depression in some sufferers who report feeling suicidal because of bullying or lack of self-confidence.

Acne is caused by a combination of factors. Hormonal changes can increase the secretion of an oily substance called sebum from the skin's sebaceous glands which are frequently located adjacent to hair follicles. If skin cells build up and block the opening of hair follicles, subsequent clogging of the sebaceous gland can contribute further to the development of acne. The problem is often made even worse by the colonisation of the skin by the bacterium *Propionibacterium acnes* which can become trapped in the hair follicles. Inflammation then may lead to the eruption of large pus-filled spots characteristic of acne. Acne tends to occur on the face, upper arms, upper back and chest.

In general doctors tend to dismiss the possibility of a causal link between the diet and the incidence of acne. However, a large body of scientific evidence now supports such a link. A recent review published in the US journal *Seminars in Cutaneous Medicine and Surgery* linked diet (either directly or indirectly) to these principal causes of acne (Cordain, 2005). Further to this, a study of 47 acne patients confirmed a causal link between diet and acne. Results suggest that refined grains, sugars, potatoes, processed foods, milk, yogurt and ice-cream together with diets characterised by a high omega-6 to omega-3 fatty acid ratio underlie the development of acne. In these dietary intervention tests all dairy foods, virtually all processed foods, refined grains and sugar were eliminated from the diet which was then comprised primarily of lean meats, fish, fresh fruits and vegetables. Subjects who followed this diet showed immediate improvement in symptoms and eventually became completely clear of acne. The results of this year long experiment will be published in a series of papers in the next year (Cordain, 2005a).

A report linking teenage acne directly to the consumption of dairy foods was published in the *Journal of the American Academy of Dermatology* in 2005 (Adebamowo, 2005). A link between the intake of milk during adolescence and the incidence of acne was observed in 47,355 women who completed questionnaires on high school diet and teenage acne (as diagnosed by a doctor). Because the link between teenage acne and milk consumption was strongest for skimmed milk, it would seem that the saturated fat content of milk is not the causal factor. The authors hypothesise that the hormonal content of milk may be responsible for causing acne in teenagers. Cow's milk contains the hormones oestrogen and progesterone along with certain hormone precursors (androstenedione, dehydroepiandrosterone-sulphate, and 5^{a}-reduced steroids like 5^{a}-androstanedione, 5^{a}-pregnanedione and dihydrotestosterone), some of which have been implicated in the development of acne. The levels of these hormones in cow's milk vary depending on whether the cow is pregnant or not, and if so at what stage of the pregnancy she is. At least two-thirds of cow's milk in the UK is taken from pregnant cows (Danby, 2005).

Milk also contains bioactive molecules that act on the sebaceous glands and hair follicles (such as glucocorticoids, IGF-1, transforming growth factor-ß (TGF-ß), neutral thyrotropin-releasing hormone-like peptides, and opiate-like compounds), some of which survive pasteurisation. The bioavailability of the factors involved may be altered during pasteurisation. In other words, heat-induced changes in the shape or structure of the molecule may alter the way it behaves in the body and, until we know more, it is difficult to say exactly what role these bioactive molecules play in causing acne and other health problems.

Allergies

The body's immune system has to constantly discriminate between many different unfamiliar molecules, some of which may be toxic substances while others are harmless components of food. An allergy results from an inappropriate immune response to such a substance (or allergen) such as dust, pollen or a component of food. An allergic reaction occurs as the body attempts to launch an attack against the foreign 'invader' perceived to be a threat to health. In such an attack, the body releases a substance called histamine, which dilates and increases the permeability of the small blood vessels. This results in a range of symptoms including local inflammation, sneezing, runny nose, itchy eyes and so on. These types of reactions may give rise to the so-called classic allergies: asthma, eczema, hay fever and urticaria (skin rash). These responses are called anaphylactic reactions and they vary widely in their severity. The most severe type of reaction (anaphylactic shock) may involve difficulty in breathing, a drop in blood pressure and ultimately heart failure and death.

Initial sensitisation to the allergen precedes an allergic reaction and this first exposure may not generate any perceivable symptoms. In fact initial sensitisation may result not from the direct exposure to an allergen but from exposure to dietary allergens during breast feeding. Evidence suggests that this process, known as atopic sensitisation, can occur in exclusively breast fed infants whose mother's breast milk contains dietary allergens. For example, a Finnish study reported that a maternal diet rich in saturated fat during breast feeding might be a risk factor underlying the later development of allergies (Hoppu *et al*., 2000). More recently the same research group reported that breast milk rich in saturated fat and low in omega-3 fatty acids might be a risk factor for eczema (Hoppu *et al*., 2005). While numerous studies now show that breast feeding can protect against the development of allergies, and the majority of studies are strongly in favour of breast feeding, it may be prudent to avoid suspected allergens in the diet while breast feeding especially if allergies such as asthma, eczema and hay fever run in the family.

Allergies are now so common in the UK, affecting around one in three people, that the increasing occurrence is referred to by some as an epidemic (Royal College of Physicians, 2003). Food allergy is increasingly widespread and the most common of these is cow's milk allergy, affecting around two per cent of all infants under the age of one. Symptoms include excessive mucus production resulting in a runny nose and blocked ears. More serious symptoms include asthma, eczema, colic, diarrhoea and vomiting.

Asthma

Asthma is a chronic, inflammatory lung disease characterised by recurrent breathing problems. Asthma is a common condition that affects around one in eight children and one in 13 adults in the UK (NHS Direct, 2005). The number of children with asthma has risen steeply over the last decade; in the 1970s just one in 50 children had asthma. During an asthma attack, the lining of the airways becomes inflamed and the airways become narrower causing the characteristic symptoms of asthma: coughing, wheezing, difficulty in breathing and tightness across the chest. Asthma can start at any age and the causes are thought to include a combination of factors including a genetic predisposition (asthma in the family), diet and environmental triggers such as cigarette smoke, chemicals and dust mites.

As stated previously, allergies tend to run in families, so asthma, eczema or hay fever in some family members may increase the risk of others developing the same or another allergy. But a genetic predisposition is not the only cause, as stated asthma is caused by a combination of factors. In the past, the rise in childhood asthma has been attributed to an increase in air pollution. However, this seems unlikely as many of the most polluted countries in the world, such as China, have low rates of asthma, whereas countries with very good air quality, such as New Zealand, have high rates of asthma (ISAAC, 1998). The 'hygiene hypothesis' has gained popularity as a causal factor for the increase in asthma. This hypothesis blames the increasing asthma rates on the extreme levels of cleanliness found in many homes. Increased hygiene means that our immune systems are being challenged less and less. It has been suggested that this causes us to overreact to allergens such as dust mites.

It has been estimated that food allergies are responsible for approximately five per cent of all asthma cases (James *et al.*, 1994) and as cow's milk is a primary cause of food allergies, it may therefore be useful to consider the possibility of cow's milk allergy in the treatment of asthma.

Eczema

Cow's milk allergy is a risk factor for many allergic conditions including asthma and eczema (Saarinen, 2005). There is an increasing amount of interest in the role of the diet in the development of eczema. Over the last decade, the links between certain foods and eczema has become better understood. Eczema can be caused by several environmental factors including dust mites, grasses and pollens, stress and certain foods. It is thought that in about 30 per cent of children with eczema, food may be a trigger, and in a smaller group (about 10 per cent), food is the main trigger (National Eczema Society, 2003). The most common foods linked to eczema are cow's milk and eggs, other foods associated include soya, wheat, fish and nuts (National Eczema Society, 2003).

Hay fever

Hay fever (seasonal allergic rhinitis) is an allergic reaction to grass or hay pollens. A minority of cases may be caused by later flowering weeds or fungal spores, and some research suggests pollution can worsen symptoms. In response to exposure to pollen, the immune system releases histamine which gives rise to a range of symptoms including a runny nose, sneezing and itchy eyes and throat. Again, you are more likely to get hay fever if there is a history of allergies in the family, particularly asthma or eczema (NHS Direct, 2005). Some evidence suggests that altering the diet can help some people with asthma and allergic rhinitis (Ogle and Bullock, 1980). However, the effects of diet on hay fever symptoms have not yet been well studied.

Gastrointestinal bleeding

As stated previously cow's milk-induced gastrointestinal bleeding as an allergic response is a well-recognised cause of rectal bleeding in infancy (Willetts *et al.*, 1999). One of the main causes of gastrointestinal bleeding is dietary protein allergy, the most common cause of which is cow's milk protein (casein). Gastrointestinal bleeding from milk allergy often occurs in such small quantities that the blood loss is not detected visually, but over prolonged time these losses can cause iron-deficiency anaemia in children. In one trial of 52 infants, 31 of whom had been breast fed, and 21 fed formulas up to the age of 168 days of age, the introduction of cow's milk (rather than formula milk) was associated with an increased blood loss from the intestinal tract and a nutritionally important loss of iron (Ziegler *et al.*, 1990).

Frank Oski, former paediatrics director at Johns Hopkins School of Medicine, estimates that half the iron-deficiency in infants in the US results from cow's milk-induced gastrointestinal bleeding (Oski, 1996). This represents a staggering figure since more than 15 per cent of US infants under the age of two suffer from iron-deficiency anaemia.

The only reliable treatment for cow's milk allergy is to avoid all cow's milk and dairy products such as cheese, yogurt, butter and cream. Also products with hidden milk content should be avoided, these include products labelled as skimmed milk or skimmed milk powder, milk solids, non-fat milk solids, milk sugar, whey and casein. Casein is difficult to avoid as it is commonly used in the production of bread, processed cereals, instant soups, margarine, salad dressings, sweets and cake mix. Calcium-enriched soya, rice and oat milks can be used as alternatives to cow's milk. (For other gastrointestinal problems associated with cow's milk see Lactose intolerance, page 52).

Arthritis

The most common form of arthritis is called osteoarthritis, a degenerative disease where articular cartilage gradually becomes thinner as its renewal does not keep pace with its breakdown. Eventually the bony articular surfaces come into contact and the bones begin to degenerate. This condition tends to occur in older people; around 12 per cent of people over 65 in the UK are affected (NHS Direct, 2005). Osteoarthritis can develop after an injury to a joint; this can happen months or even years after the injury. The most frequently affected joints are in the hands, knees, feet, hips and spine.

The next most common type of arthritis is rheumatoid arthritis, a chronic inflammatory disease of the joints. This type of arthritis affects up to three per cent of the UK population, and tends to occur in people between the ages of 30 and 50. Women are three times as likely to develop this condition as men (NHS Direct, 2005). Rheumatoid arthritis is a chronic condition characterised by hot painful swelling in the joints. In many diseases inflammation can help towards healing but in rheumatoid arthritis it tends to cause damage. For some people the pain and discomfort caused by this condition has a serious impact on their lives. Rheumatoid arthritis is thought to be an autoimmune disease, caused by a fault in the immune system that causes the body to attack its own tissues. This condition usually starts in the wrists, hands and feet but can spread to other joints in the body.

Other forms of arthritis include ankylosing spondylitis, cervical spondylitis, fibromyalgia, lupus, gout, psoriatic arthritis and Reiter's syndrome (NHS Direct, 2005). Arthritis can also affect children but the causes of juvenile arthritis are poorly understood. It has been suggested that genetic factors or viral infections may be responsible (NHS Direct, 2005).

Until recently there has been little scientific research into the links between diet and arthritis but recent research suggests that diet may be involved in its development. It is important for people with arthritis to maintain a healthy well-balanced diet. Arthritis Care (the UK's largest voluntary organisation working with and for people with arthritis) suggest a diet high in fruit, vegetables, pasta, fish and white meat and low in fatty foods such as red meat, cream and cheese can help (Arthritis Care, 2004). Indeed most people could benefit from eating less sugar and saturated fat and eating more complex carbohydrates, fibre, vitamins and minerals.

If you suffer from arthritis it is important to keep as healthy as possible by ensuring that the diet provides all the important nutrients including minerals such as calcium and iron. Some people are concerned that their calcium intake may drop if they cut out dairy foods. Arthritis Care suggests that if you don't like or are unable to eat dairy products, you should obtain enough calcium from non-dairy sources (Arthritis Care, 2004a). They list several non-dairy sources of calcium including bread, green leafy vegetables and baked beans (also see page 59). They also warn people with arthritis to be careful not to have too much animal protein, salt or caffeine as excessive quantities of these can reduce the body's ability to absorb or retain calcium (Arthritis Care, 2004a). Others are worried about iron, particularly people who have recently stopped eating red meat. This should not be a concern as vegetarians and vegans are no more likely to become iron deficient than meat-eaters. Indeed one of the largest studies of vegetarians and vegans in the world (the EPIC Oxford cohort study) looked at over 33,883 meat-eaters, 18,840 vegetarians and 2,596 vegans and found that the vegans had the highest intake of iron, followed by the vegetarians then the meat eaters (Davey *et al*., 2003). It should be stressed that milk and milk products are an extremely poor source of iron, whereas pulses, dried fruits and dark leafy vegetables are good sources.

The Arthritis Research Campaign (ARC) founded in 1936, raises funds to promote medical research into the cause, treatment and cure of arthritic conditions. ARC has produced dietary guidelines for people with arthritis and they suggest that one of the most important links between diet and arthritis is being overweight. The extra burden on the joints can make symptoms considerably worse. Losing weight can have a dramatic effect in improving the condition. In order to lose weight, you need to use more energy than you consume in the diet. Research shows that vegetarians and vegans weigh less than meat-eaters and ARC suggests that a lacto-vegetarian diet might help some people with rheumatoid arthritis. They also go further to state that a vegan diet may also help (ARC, 2002). Cutting down on sugar and taking regular (even gentle) exercise will help control weight as well.

Saturated fats are the most important kind of fat to cut down on. The body does not require saturated fats and they may aggravate arthritis whereas essential fatty acids (EFAs) have been shown to help some people with arthritis as the body uses EFAs to make substances that help control inflammation (ARC, 2002). When trying to lose weight, it is important to maintain a good intake of vitamins and minerals. This means consuming plenty of fruit and vegetables. A healthy balanced diet containing plenty of fruit and vegetables, pulses and whole grain carbohydrate foods (such as wholemeal bread, brown rice and whole wheat pasta) provides a good supply of vitamins and minerals (and fibre). A diet lacking in fruit and vegetables, and containing processed carbohydrates (such as white bread, white rice and white pasta) does not provide such a good source of these essential nutrients. This can have a deleterious effect on health as the ARC states that a good diet can still help even if strong drugs are being taken to treat arthritis (ARC, 2002).

The subject of food allergy and arthritis is quite controversial. However, research has shown that, in some people, rheumatoid arthritis can be made worse by certain foods including milk products and food colouring (ARC, 2002). If you think you are allergic to a particular food ARC recommend cutting it out of your diet for one month then reintroducing it to see if it makes a difference. In 2001, Swedish researchers reported that nine out of 22 patients with rheumatoid arthritis showed significant improvements in their condition compared to one patient out of 25 after following a gluten-free, vegan diet (Hafstrom *et al.*, 2001). Of course it is difficult to say whether eliminating milk was the reason these patients improved as they eliminated all animal foods and gluten from the diet. However, this work does provide evidence that dietary modification can benefit arthritis patients.

Bovine somatotrophin (BST)

In cows, milk production is influenced by the complex interaction of a range of hormones. Bovine somatotrophin (BST) is a natural growth hormone that occurs in cattle and controls the amount of milk that they produce. In 1994 Monsanto began marketing a synthetic version of BST, known as recombinant BST (rBST), which was sold as Posilac. Injecting dairy cows with rBST alters the metabolism to increase milk production by up to 15 per cent. Since its introduction in 1994, Posilac has become the largest selling dairy animal pharmaceutical product in the US. Sold in all 50 states, rBST is used in around one-third of the nine million dairy cows in the US (Monsanto, 2005).

While the US Food and Drug Administration (FDA) permit the use of rBST, its use is associated with severe welfare problems, for example increasing the incidence of lameness and mastitis. For reasons of animal health and welfare, the use of rBST in the EU was prohibited in 2000. Indeed Canada, Japan and many other countries have banned the use of rBST because of its effects on animal health and welfare. However, there are no restrictions on the import of rBST dairy products, or any requirement to label them.

The Government's Veterinary Medicines Directorate does not carry out any testing of imported milk (Defra, 2006). Furthermore, Defra confirmed in correspondence with the VVF, that since the EU is a single market once a product has entered, if it is transported on to another country within the EU, then the origin of the product will be the EU country rather than the originating country (Defra, 2006). In 2005, the UK imported over 1,000 tons of dairy products (mainly ice-cream) from the US (Defra, 2006a); these figures have declined from over 5,000 tons in both 2001 and 2002 but still remain a concern, especially as the consumer has a limited chance of discriminating against imports from the US. The sensible option is to avoid all dairy products.

Concern has been expressed over several health issues associated with the use of rBST. The increased incidence of lameness and mastitis in rBST-treated cows inevitably leads to an increased use of antibiotics to treat these and other infections. Over half of the antibiotics that are produced in the US are used for agricultural purposes (Mellon *et al.*, 2001). Antibiotic use is known to promote the development of antibiotic resistance. Thus the widespread use of these drugs has contributed to the high frequency of resistant bacteria in the intestinal flora of farmed animals (Lipsitch *et al.*, 2002). This raises concerns about the development of antibiotic resistant infections in humans. A study in the *New England Journal of Medicine* in 2000 reported that the emergence of antibiotic-resistant strains of *Salmonella* is associated with the use of antibiotics in cattle. This study described how a new antibiotic-resistant strain of *Salmonella* was isolated from a 12-year-old boy admitted to hospital with abdominal pain, vomiting and diarrhoea. The boy lived on a ranch in Nebraska and subsequent investigation revealed the presence of the identical strain of bacteria, resistant to the antibiotic ceftriaxone, among cattle on his family's ranch and nearby ranches that had suffered outbreaks of salmonellosis. The cattle had been treated with ceftriaxone. This evidence suggests that the boy's gastrointestinal infection was acquired from cattle (Fey *et al.*, 2000). The obvious concern here is that the widespread use of antibiotics in cattle can lead to an increase in antibiotic-resistant strains that may subsequently transmit to humans. This is a public health concern and the question must be asked: how much evidence of harm do we need before we much further restrict the use of antibiotics in farm animals?

Milk production increases in cows treated with rBST because it promotes the production of the naturally occurring growth hormone insulin-like growth factor 1 (IGF-1) which then stimulates the glands in the cow's udders to produce more milk. Research shows that rBST use on dairy cows can substantially increase the levels of IGF-1 in their milk (Prosser *et al.*, 1989). This raises concerns about the potential biological action of IGF-1 from cow's milk in humans especially because IGF-1 from cows is identical to human IGF-1. Professor Samuel Epstein, an international leading authority on the causes and prevention of cancer, warns that converging lines of evidence incriminate IGF-1 in rBST milk as a potential risk factor for both breast and gastrointestinal cancers (Epstein, 1996).

So why should this concern us if we do not allow the use of rBST in the UK? Well in terms of human health, the concern is that milk and milk products imported from countries that permit the use of rBST may lead to the consumption of foods that promote increased levels of IGF-1 in humans. In 1999, the minister of state, Baroness Hayman, referred to a report from the Veterinary Products Committee (VPC) which stated that while the use of rBST does not increase the level of BST found naturally in cow's milk, there is a two-to-five fold increase the level of IGF-1 in the milk, which she acknowledged may be implicated in the occurrence of colonic cancer. However, Hayman reiterated the VPC's view that the risk to human health was likely to be extremely small. Hayman also suggested that just 0.3 per cent of total milk and milk products imported into the UK come from the US where rBST is authorised for use (UK Parliament, 1999). (See IGF-1, page 49).

Cancer

One in four people in England will die of cancer. More than one in three people will develop cancer at some stage in their lives. Over 200,000 people are diagnosed each year with the disease; that is 600 new cases each day. Cancer is now the single most common cause of death in men and women in the UK (Department of Health, 2000). Whichever way the statistics are presented cancer remains the disease that people fear most.

Mortality from cancer over the last 50 years has remained fairly constant (Department of Health, 2000). This is very worrying when you consider the vast improvement in both cancer diagnosis techniques and cancer treatment methods. It means that even more people are getting cancer and the medical profession are running just to stand still.

Most people now recognise that smoking is the biggest single preventable risk factor for cancer. Indeed smoking causes one third of all cancers including cancers of the lung, mouth, nasal passages, larynx, bladder and pancreas. Smoking also plays a role in causing cancers of the oesophagus, stomach, kidney and in leukaemia. Smoking kills around 120,000 people in the UK per year (Department of Health, 2000). Stopping smoking, even when middle-aged, can dramatically reduce the risk of developing cancer.

However, it is less well known that a poor diet is the second largest preventable risk factor for cancer, coming close behind smoking. It is becoming clearer as research continues that nutrition plays a major role in cancer (Donaldson, 2004). A diet rich in saturated animal fats, cholesterol, animal protein, sugar, salt and processed foods has been shown to increase the risk of certain cancers. Indeed a poor diet may be responsible for up to a third of all cancer deaths (Department of Health, 2000). Cancers specifically linked to diet include cancers of the bowel, stomach, mouth, larynx and oesophagus. A poor diet can also greatly contribute to the risk of many other cancers including breast and prostate cancer (Cancer Research UK, 2005). There is an increasing amount of evidence linking the consumption of cow's milk to certain cancers. One of the reasons for this is the increasing levels of hormones and other bioactive compounds present in the milk that result from intensive farming practices (taking milk from pregnant cows). In other words, in an effort to increase milk production, the dairy industry has intensified farming techniques to such a high level that between 75 per cent and 90 per cent of marketed milk and milk products are derived from pregnant cows (Danby, 2005). (See The undesirable components of milk and dairy products, page 10).

A plant-based diet containing less saturated animal fats, cholesterol, animal protein, sugar, salt and processed foods protects against cancer. Confirmation of the protective role of a vegetarian diet came in 1994 in a landmark study published in the *British Medical Journal* (Thorogood, 1994). Researchers found that vegetarians suffer 40 per cent less cancer mortality than the population average, even with controls for smoking, body weight and socio-economic status. The authors of this study stated that while their data do not provide justification for encouraging meat-eaters to change to a vegetarian diet, those who do might expect reductions in premature mortality due to cancer. In other words, you might choose not to give up eating meat but if you do, you will probably live longer.

In Professor T. Colin Campbell's extensive China Study (one of the largest studies in the world on the effects of diet on health) a startling observation is made. Based on previous work and his own studies, Campbell saw a direct link between dietary protein intake and cancer; the more protein in the diet, the higher the risk of certain cancers, such as liver cancer. But this was not all protein, just animal protein. Campbell decided to look at the relationships between animal protein intake and the incidence of cancer in different cultures.

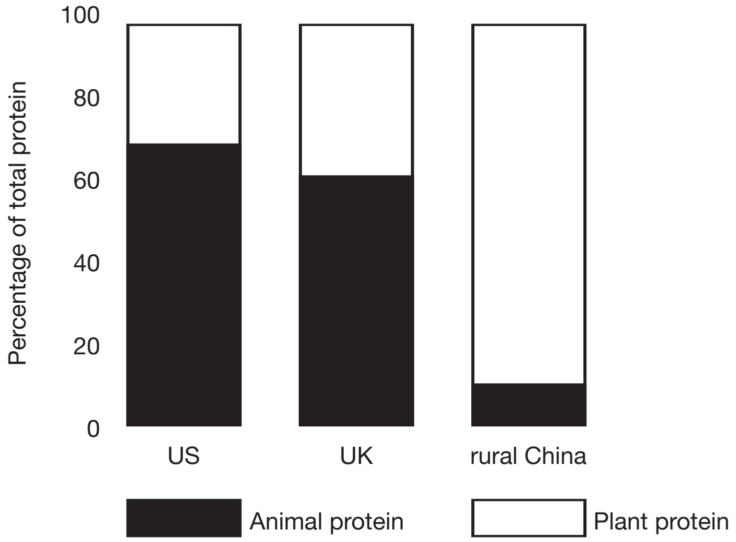

Figure 4.0 A comparison of animal protein intake in the US, the UK and rural China. Source: Campbell and Campbell, 2005; FSA, 2003a.

Colorectal cancer is the fourth most common cancer in the world; it is the second most common in the US. Campbell notes that while North America, Europe, Australia and wealthier Asian countries such as Japan and Singapore have relatively high rates of colorectal cancer, Africa, Asia and most of Central and South America have much lower rates. For example the Czech Republic has a death rate of 34.19 per 100,000 males, while in Bangladesh the figure is just 0.63 per 100,000 males (Campbell and Campbell, 2005). Campbell is not alone in revealing the enormous differences in the incidences of certain cancers between countries. The International Agency for Research on Cancer (IARC) provides startling figures comparing the incidence of breast cancer and prostate cancer in England and Wales to that in rural China. In 1997, in England and Wales, the IARC reported the incidence rate of breast cancer in women was 68.8 per 100,000 compared to just 11.2 per 100,000 in rural China. Similarly the incidence of prostate cancer in men in England and Wales was 28.0 per 100,000 compared to just 0.5 per 100,000 in rural China (IARC, 1997).

It is widely acknowledged that the incidence of certain cancers is much greater in some countries than others, what intrigued Campbell was the relationship between these cancers and dietary animal protein. Figure 4.0 shows the differences in animal protein intake between the US, the UK and rural China. In the US, over 15 per cent of total energy intake comes from protein of which 70 per cent is animal protein (Campbell and Campbell, 2005). In the UK, over 16 per cent of food energy comes from protein, and of this, 62 per cent comes from animal foods (FSA, 2003a). While in rural China, the figures are quite different; nine to 10 per cent of total energy comes from protein and only 10 per cent of that is from animal protein (Campbell and Campbell, 2005).

It could be argued that the difference in cancer incidence between cultures reflects genetic differences between ethnic groups rather than environmental (dietary) effects. However, migrant studies have shown that as people move from a low-cancer risk area to a high-cancer risk area, they assume an increased risk within two generations (WCRF/AICR, 1997). Therefore these vast differences in cancer rates must be largely attributable to environmental factors such as diet and lifestyle. Campbell concludes that animal-based foods are linked to an increased cancer risk whereas a whole grain plant-based diet including fibre and antioxidants is linked to lower rates of cancer (Campbell and Campbell, 2005). One possible mechanism for this may be the different composition of animal and plant proteins.

Plant proteins contain a different balance of amino acids than animal proteins. More specifically, plant proteins contain less of the essential amino acids methionine and lysine than animal protein and more of the non-essential amino acids arginine, glycine, alanine and serine. It has been suggested that consuming mostly a plant-based diet has a knock-on effect of limiting the biological activity of certain chemical substances involved in cancer development and that a sufficient consumption of plant proteins has a protective role against cancer (Krajcovicova-Kudlackova, 2005). So a vegetarian diet is a healthier option, not just because it excludes meat and other animal foods but because of the range of beneficial, protective factors present. Vegetarian diets contain less saturated fats and more of the good fats (omega-3 and omega-6 unsaturated fatty acids), more complex carbohydrates, more fibre and more vitamins, minerals and antioxidants. These factors help to explain the reduced risk of cancer in vegetarians.

Increasing your fruit and vegetable consumption is considered the second most effective strategy to reduce the risk of cancer (after stopping smoking). Indeed, one of the most important messages of modern nutrition research is that a diet rich in fruits and vegetables protects not only against cancer, but against many other diseases too including heart disease and diabetes (Donaldson, 2004). It has been estimated that eating at least five portions of fruit and vegetables a day could reduce the risk of death from chronic diseases such as heart disease, stroke and cancer by up to 20 per cent (Department of Health, 2000). In 1998, the Department of Health's Committee on Medical Aspects of Food Policy and Nutrition reviewed the evidence and concluded that a higher vegetable consumption would reduce the risk of both colorectal and gastric cancer. There was also some evidence that higher fruit and vegetable consumption would reduce the risk of breast cancer (Department of Health, 1998). According to the WHO, low fruit and vegetable intake is estimated to cause about 31 per cent of ischaemic heart disease and 11 per cent of stroke worldwide. Furthermore, they estimate that up to 2.7 million lives could potentially be saved each year if fruit and vegetable consumption was sufficiently increased (FAO/WHO, 2004). This is particularly important for children who eat even more unhealthily than adults in the UK (Cancer Research UK, 2004). Children's consumption of fruit and vegetables is generally low, with children from disadvantaged families consuming far less than those from high income families. One in five children does not eat any fruit in a week, and three in five eat no leafy green vegetables (Department of Health, 2000).

In a joint report the American Institute for Cancer Research and the World Cancer Research Fund estimate that recommended diets, together with maintenance of physical activity and appropriate body mass, can in time reduce cancer incidence by 30 to 40 per cent. At current rates, on a global basis, this represents between three to four million cases of cancer per year that could be prevented by altering diet and lifestyle (WCRF/AICR, 1997). Increasing our understanding and awareness of the importance of diet and influencing the choices people make about their own diets may significantly reduce the risk of cancer.

There are a number of other factors that can contribute to the development of cancer, including obesity (breast and endometrial cancer), alcohol (mouth, throat, liver and breast cancer), sunlight (skin cancer), radon (lung cancer) and physical activity can protect against some cancers (colorectal).

Cancers of the breast, lung, colorectum and prostate constitute around 50 per cent of all cases of and deaths from cancer in the UK (Department of Health, 2000). The role of cow's milk and dairy products in breast, colorectal, ovarian and prostate cancer is discussed in more detail.

Breast cancer

One in nine women in the UK will develop breast cancer at some point in their lives. In 2003 nearly 40,000 new cases were diagnosed, representing a third of all cancers in women, and in the same year around 10,500 women died from this disease. Between 1971 and 2003, the incidence rates of breast cancer have increased by 80 per cent (National Statistics, 2005). Figure 5.0 shows that while the incidence of breast cancer has risen sharply, mortality from breast cancer has remained fairly constant over the same period thanks largely to improved diagnostic methods and more efficient treatment.

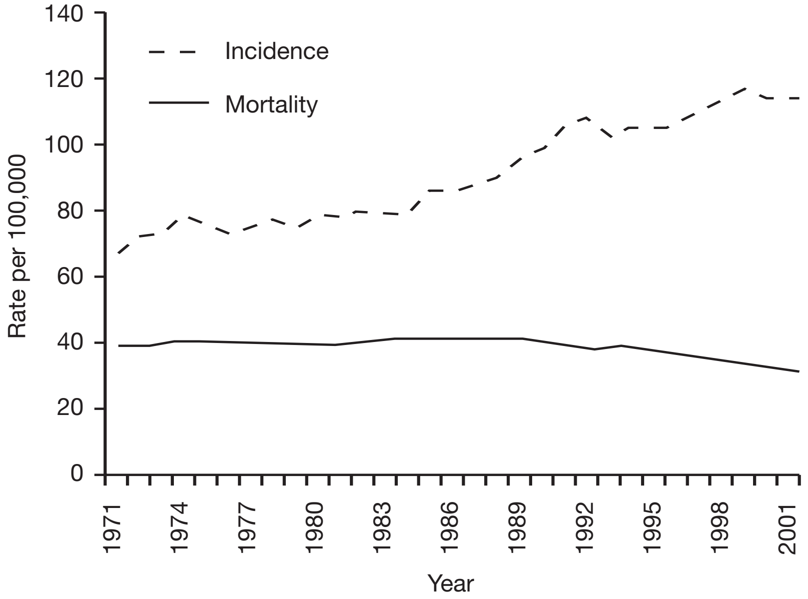

Figure 5.0 Incidence of and mortality from breast cancer in England and Wales between 1971 and 2001. Source: National Statistics, 2005.

Much has been made of the link between genes and breast cancer. The genes BRCA1 and BRCA2 have received the most attention since they were first discovered in 1994 and 1995 respectively. There are two other very rare genes which probably only account for less than two per cent of all breast cancers: the P53 gene and the AT (ataxia telangiectasia) gene. These recent discoveries linking genetics to cancer has given rise to a certain degree of genetic fatalism. However, current estimates are that only about five per cent of breast cancers are due to abnormal genes (BACUP, 2005). This means that the vast majority of cancers (95 per cent) are not caused by abnormal genes. Secondly, it is important to remember that having an abnormal gene does not mean that a person will definitely develop breast cancer, but does mean they are considerably more at risk of developing the condition than someone who does not have one of the abnormal genes (BACUP, 2005).

The age-adjusted incidence rates per 100,000 for breast cancer differ markedly from one country to another. For example, Uruguay has a very high rate at 114.9, followed by 92.1 in the US and 87.1 in Israel. Much lower rates are seen in Korea at just 12.7, 20.0 in Mali and 16.1 in Thailand (Ganmaa and Sato, 2005). In response to this discrepancy, an increasing amount of attention is now focusing on the links between diet and breast cancer, particularly the relationship between the consumption of cow's milk and dairy products and breast cancer.

Studying cancer incidence among particular groups of people can provide useful insights into the links between diet and disease. Researchers from the London School of Hygiene and Tropical Medicine recently reported breast cancer incidence is substantially lower, and survival rates higher, in South Asians living in the UK than other women (Farooq and Coleman, 2005). No data on diet was collected but the authors of this study suggested that differences in diet and lifestyle could explain the different rates observed. Earlier research published in the *British Journal of Cancer* also showed that South Asian women living in the UK are less likely to be diagnosed with breast cancer than other women, but found that the risk varied according to their specific ethnic subgroup. This research showed that Muslim women from India and Pakistan are almost twice as likely to develop breast cancer as Gujarati Hindu women. This study did examine the diet and found that the Gujarati Hindu women were more likely to be vegetarian and therefore had more fibre in their diet due to their higher intake of fruit and vegetables (McCormack *et al.*, 2004). There are several mechanisms by which the diet might influence breast cancer risk. One possible mechanism is through an effect on hormones: increasing the amount of fibre in the diet may reduce breast cancer risk by altering the levels of female hormones (oestrogens) circulating in the blood (Gerber, 1998).

A number of studies show that women with breast cancer tend to have higher levels of circulating oestrogens. Prospective studies follow groups of people over time. Generally these people are alike in many but not all ways (for example, young women who smoke and young women who do not). The prospective cohort study will then look for a link between their behaviour and a particular outcome (such as lung cancer). A prospective study conducted on the island of Guernsey examined serum levels of the oestrogen hormone oestradiol in samples taken from 61 postmenopausal women who developed breast cancer an average of 7.8 years after blood collection. Compared to 179 age-matched controls, oestradiol levels were 29 per cent higher in women who later developed breast cancer (Thomas *et al.*, 1997). Another prospective study (this time from the US), compared oestrogen levels in 156 postmenopausal women who developed breast cancer, after blood collection, with two age-matched controls for each cancer patient. Results showed increased levels of the hormones oestradiol, oestrone, oestrone sulphate and dehydroepiandrosterone sulphate in women who subsequently developed breast cancer thus providing strong evidence for a causal relationship between postmenopausal oestrogen levels and the risk of breast cancer (Hankinson *et al.*, 1998). A review of studies carried out over a 10 year period in the Department of Clinical Chemistry at the University of Helsinki in Finland suggested that the Western diet (characterised by milk and meat products) increases levels of these types of hormones and concluded that the hormone pattern found in connection with a Western-type diet is prevailing in breast cancer patients (Adlercreutz, 1990).

While some research has identified dietary factors that reduce the risk of breast cancer, such as fibre, other studies have identified dietary factors that increase the risk, such as dietary fat. Case-control studies use a group of people with a particular characteristic (for example older women with lung cancer). This particular group is selected and information collected (for example, history of smoking), then a control group is selected from a similar population (older women without lung cancer) to see if they smoked or not, then a conclusion is drawn (smoking does or does not increase risk of lung cancer). A combined analysis of 12 case-control studies designed to examine diet and breast cancer risk found a positive association between fat intake and this disease. The reviewers estimated that the percentage of breast cancers that might be prevented by dietary modification in the North American population was 24 per cent for postmenopausal women and 16 per cent for premenopausal women (Howe *et al.*, 1990).

In 1999 researchers at the Department of Preventive Medicine at the University of Southern California Medical School in Los Angeles published a review of 13 dietary fat intervention studies that were conducted to investigate the effect of fat intake on oestrogen levels. The results showed decreasing dietary fat intake (to between 10 and 25 per cent of the total energy intake) reduced serum oestradiol levels by between 2.7 and 10.3 per cent. It was concluded that dietary fat reduction can result in a lowering of serum oestradiol levels and that such a dietary modification may offer an approach to breast cancer prevention (Wu at al., 1999).

However, other studies of fat intake and the incidence of breast cancer have yielded conflicting results. The discrepancy in results may reflect the difficulties of accurately recording fat intake. Dr Sheila Bingham of the Dunn Human Nutrition Unit in Cambridge has developed a data-collection method which may overcome these problems. Bingham used food frequency questionnaire methods with a detailed seven-day food diary in over 13,000 women between 1993 and 1997. The study concluded that those who ate the most animal saturated fat (found mainly in whole milk, butter, meat, cakes and biscuits) were almost twice as likely to develop breast cancer as those who ate the least. It was also concluded that previous studies may have failed to establish this link because of imprecise methods (Bingham *et al.*, 2003).

In a subsequent prospective cohort study involving over 90,000 premenopausal women, researchers from Harvard Medical School confirmed that animal fat intake was associated with an elevated risk of breast cancer. Red meat and high-fat dairy foods such as whole milk, cream, ice-cream, butter, cream cheese and cheese were the major contributors of animal fat in this cohort of relatively young women. Interestingly, this research did not find any clear association between vegetable fat and breast cancer risk; the increased risk was only associated with animal fat intake. It has been suggested that a high-fat diet increases the risk of breast cancer by elevating concentrations of oestrogen. However, the author of this study, Dr Eunyoung Cho, suggests that if this were true a diet high in animal fat and a diet high in vegetable fat should both lead to higher rates of cancer, and that was not the case in this study. Cho suspects that some other component such as the hormones in cow's milk might play a role in increasing the risk of breast cancer (Cho *et al*., 2003).

Such conclusions have led many research groups to focus on the endogenous hormonal content of milk (hormones produced by the cow and excreted in the milk), which has not been widely discussed. The milk produced now is very different from that produced 100 years ago; modern dairy cows are frequently impregnated while still producing milk (Webster, 2005). Two-thirds of milk in the UK is taken from pregnant cows with the remainder coming from cows that have recently given birth. This means that the hormone (oestrogen, progesterone and androgen precursor) content of milk varies widely. It is the high levels of hormones in milk that have been linked to the development of hormone-dependent cancers such as ovarian and breast cancer.

In a review of the relationship between breast cancer incidence and food intake among the populations of 40 different countries, a positive correlation was seen between the consumption of meat, milk and cheese and the incidence of breast (and ovarian) cancer. Meat was most closely correlated with breast cancer incidence, followed by cow's milk and cheese. By contrast, cereals and pulses were negatively correlated with the incidence of breast cancer. This review concluded that the increased consumption of animal foods may have adverse effects on the development of hormone-dependent cancers. Among dietary risk factors of particular concern were milk and dairy products, because so much of the milk we drink today is produced from pregnant cows, in which oestrogen and progesterone levels are markedly elevated (Ganmaa and Sato, 2005).

In addition to animal fat and various chemical contaminants, cow's milk and dairy products contain hormones and growth factors, which have been implicated in the proliferation of human breast cancer cells. In a review of the evidence linking dairy consumption with breast cancer risk, researchers from Princeton University in New Jersey concluded that milk may promote breast cancer by the action of the growth factor IGF-1, which has been shown to stimulate the growth of human breast cancer cells in the laboratory (Outwater *et al*., 1997). In another review, examining the role of IGF-1 in cancer development, Yu and Rohan state that IGFs play a critical role in regulating cell growth and death. This function has led to speculation about their involvement in cancer development. Laboratory experiments demonstrate the ability of IGFs to stimulate growth of a wide range of cancer cells and to suppress cell death or apoptosis (Yu and Rohan, 2000). The concern here is that if IGF-1 can cause human cancer cells to grow in a Petri dish in the laboratory, they might have a cancer-inducing effect when consumed in the diet. IGF-1 is present in all milk and is not destroyed during pasteurisation. Dr J.L. Outwater of the Physicians Committee For Responsible Medicine (PCRM) in Washington, DC, warns that IGF-1 may be absorbed across the gut and cautions that regular milk ingestion after weaning may produce enough IGF-1 in mammary tissue to encourage cell division thus increasing the risk of cancer (Outwater *et al*., 1997).

In her book *Your Life in Your Hands*, Professor Jane Plant CBE, the chief scientist of the British Geological Survey, describes a very personal and moving story of how she overcame breast cancer by excluding all dairy products from her diet (Plant, 2000). Plant was diagnosed with breast cancer in 1987. She had five recurrences of the disease and by 1993 the cancer had spread to her lymphatic system. She could feel the lump on her neck, and was told that she had just three months to live, six if she was lucky. However, Plant was determined to use her scientific training to find a solution to this 'problem'. She began researching breast cancer in other cultures and found a much lower incidence in China. The data showed that in rural China breast cancer affects just one in 10,000 women compared to one in 10 British women (now one in nine). However, Plant observed that among wealthy Chinese women with a more Western lifestyle (for example in Malaysia and Singapore), the rate of breast cancer is similar to that in the West. Furthermore, epidemiological evidence shows that when Chinese women move to the West, within one or two generations their rates of breast cancer incidence and mortality increase to match those of their host country. This suggested that diet and lifestyle (rather than genetics) must be a major determinant of cancer risk.

Plant decided to investigate the role of diet in breast cancer risk. She examined the results of the China-Cornell-Oxford project on nutrition, environment and health (Campbell and Junshi, 1994). This project was based on national surveys conducted between 1983 and 1984 in China. The project was a collaboration between T. Colin Campbell at Cornell University in the US, Chen Junshi from the Chinese Academy of Preventative Medicine, in Beijing, China, Li Junyao at the Chinese Academy of Medical Sciences, Beijing, and Richard Peto from Oxford University in the UK. The project revealed some surprising insights into diet and health. For example, it showed that people in China tend to consume more calories per day that people in the US, but only 14 per cent of these calories come from fat compared to a massive 36 per cent in the West. This coupled to the fact that Chinese people tend to be more physically active than people in the West, is why obesity affects far more people in the West than in China. However, Plant's diet had not been particularly high in fat; indeed she describes it as very low in fat and high in fibre. Then Plant had a revelation: the Chinese don't eat dairy produce. Plant had been eating yogurt and skimmed organic milk up until this time, but within days of ceasing all dairy, the lump on her neck began to shrink. The tumour decreased and eventually disappeared, leading her to the conviction that there is a causal link between the consumption of dairy products and breast cancer. Although Plant received chemotherapy during this time, it did not appear to be working and so convinced was her cancer specialist that it was the change in diet that saved her life, he now refers to cancer mortality maps in his lectures and recommends a dairy-free diet to his breast cancer patients.

Plant eventually defeated cancer by eliminating dairy products from her diet, replacing them with healthy alternatives and making some lifestyle changes. Plant advises that if you do only one thing to cut your risk of breast cancer, make the change from dairy to soya (Plant, 2000). Providing breast cancer patients with sound dietary advice could greatly increase survival rates. Taken together, these observations show that a plant-based diet can reduce many of the risk factors associated with breast cancer.

Colorectal (bowel) cancer

Cancers of the colon and rectum account for around one in every eight newly diagnosed cancers in the UK and one in every nine deaths from cancer (National Statistics, 2005a). In the UK it is the third most common cancer in men, and the second most common cancer in women (Cancer Research UK, 2005). Colorectal cancer occurs when the process of cell renewal in the bowel goes wrong. Abnormal cells can form polyps (small growths) which may develop into cancer. Risk factors for colorectal cancer include poor diet, obesity, alcohol and smoking.

Although the causes of colorectal cancer are not known, it is thought that there may be a link with a diet high in animal fats and protein and low in fibre (NHS, 2006). To reduce the risk of developing colorectal cancer, the Government recommends a healthy, balanced diet including plenty of fresh fruit and vegetables (NHS, 2006). It is also important to take regular physical exercise, maintain a healthy weight and avoid alcohol and smoking.

The protective role of a whole grain plant-based diet containing plenty of fruit and vegetables (and therefore fibre) is well-documented. Two large-scale studies (both published in the *Lancet*) have examined the relationship between diet and colorectal cancer; both confirmed that as dietary fibre intake increases, the risk of colorectal cancer decreases. In the first of these two studies, a research team from the National Cancer Institute in the US compared fibre intake of 3,591 people with at least one bowel adenoma or polyp (a benign growth that may or may not transform to cancer), with that of 33,971 people without polyps. They found that the participants in the top 20 per cent for dietary fibre intake had 27 per cent lower risk of adenoma than people in the lowest 20 per cent (representing a difference in fibre intake of 24 grams per day). It was concluded that dietary fibre, particularly from grains, cereals and fruits, was associated with a decreased risk of colorectal adenoma (Peters *et al.*, 2003). In the second even larger study, researchers from the European Prospective Investigation into Cancer and Nutrition (EPIC) prospectively examined the association between dietary fibre intake and incidence of colorectal cancer in 519,978 individuals aged between 25 and 70 years-old, recruited from 10 different European countries. Participants completed a dietary questionnaire between 1992 and 1998 and were followed up for cancer incidence on average 4.5 years later. Again, people with the highest fibre intake (35 grams per day) had a 40 per cent lower risk of colorectal cancer compared to those with the lowest intake (15 grams per day). In populations with low average intake of dietary fibre, an approximate doubling of total fibre intake from foods could reduce the risk of colorectal cancer by 40 per cent (Bingham *et al.*, 2003a). These studies provide convincing evidence that increasing the amount of whole grains and fruit and vegetables in the diet reduces the risk of colorectal cancer.

While it has been demonstrated that dietary fibre can protect again colorectal cancer, evidence suggests that animal foods (animal fat and animal protein) may be associated with increased colorectal cancer risk. In another EPIC study, researchers prospectively followed 478,040 men and women from 10 European countries that were free of cancer between 1992 and 1998. Information on diet and lifestyle was collected and after a mean follow-up of 4.8 years, 1,329 cases of colorectal cancer were documented. An investigation of the relationship between intakes of red and processed meat, poultry and fish revealed that colorectal cancer risk was positively associated with intake of red and processed meat (Norat *et al.*, 2005).

In a recent study, the association between the consumption of dairy foods and calcium and colorectal cancer risk was assessed in a pooled analysis of 10 cohort studies from North America and Europe (Cho *et al.*, 2004). In this study the authors concluded that the consumption of milk and calcium were related to a lower risk of colorectal cancer. However, the inverse association between calcium (and by inference, dairy) intake and colorectal cancer was only statistically significant among those with the highest vitamin D intake. This may be either because vitamin D enhances calcium absorption, or because vitamin D itself may decrease colorectal cancer incidence (Garland, 1999). In contrast to these findings, most prospective studies show only a moderate and not statistically significant decrease in the risk of colorectal cancer with increased dietary calcium intake (Ma *et al.*, 2001).

Furthermore, as with breast cancer, there are growing concerns that the consumption of cow's milk raises levels of IGF-1 in the blood (either directly or indirectly). For example, in a study of 204 healthy men and women aged 55 to 85 years, three servings of non-fat milk per day over 12 weeks increased blood serum levels of IGF-1 by 10 per cent (Heaney, 1999). Because elevated levels of IGF-1 are associated with increased risk of colorectal cancer (Ma *et al.*, 1999; Giovannucci *et al.*, 2000; Kaaks *et al.*, 2000), an increase in IGF-1 attributable to the consumption of milk could potentially counter any protective effect conferred by dietary calcium (and vitamin D in US fortified milk). It may be that plant-based sources of calcium, including non-oxalate dark green leafy vegetables, dried fruits, nuts, seeds and pulses as well as fortified foods such as calcium-set tofu (soya bean curd) and calcium-enriched soya milk, provide a safer source of calcium. Vitamin D can be either obtained from the diet or synthesised in the skin following exposure to sunlight.

Ovarian cancer

Ovarian cancer is the fourth most common cancer among women in the UK. Around 6,900 new cases are diagnosed each year (Cancer Research UK, 2006). The ovaries are two almond shaped organs located on either side of the uterus. They produce eggs and the reproductive hormones (oestrogen and progesterone). The cause of ovarian cancer is unknown however some risk factors have been identified. There may be an increased risk for this disease among women: over the age of 65; who have never been pregnant; who started having periods at an early age; who had their first child after the age of 30 or who go through the menopause after the age of 50. Furthermore, the prolonged use of fertility drugs might increase the risk of ovarian cancer (Cancer Research UK, 2006). Taking the combined contraceptive pill reduces the risk of ovarian cancer: the longer you take the pill, the more the risk is reduced (NHS Direct, 2006). Taken together, these risk factors suggest that hormonal factors are involved in the development of ovarian cancer although the precise mechanisms remain unclear. Additional risk factors include a genetic component; a small number of ovarian cancers (five to 10 per cent) are caused by an inherited faulty gene (NHS Direct, 2006). The use of talcum powder in feminine hygiene (direct application to the genital area) has also been implicated (Cramer *et al.*, 1999).

It has been suggested that the milk sugar lactose is a risk factor for ovarian cancer. A positive relationship between ovarian cancer and dairy products was first reported in the *Lancet* in 1989 when it was suggested that lactose consumption may be a dietary risk factor for ovarian cancer (Cramer *et al.*, 1989). More recently, data collected from the Harvard Nurses Health Study was used to assess the lactose, milk and milk product consumption in relation to ovarian cancer risk in over 80,000 women. Over 16 years of follow-up, 301 cases of one particular type of ovarian cancer were confirmed in this study group. Results showed that women who consumed the most lactose had twice the risk of this type of ovarian cancer than women who drank the least lactose. It was suggested that galactose (a component of lactose) may damage ovarian cells making them more susceptible to cancer (Fairfield *et al.*, 2004).

In the same year, Susanna Larsson and colleagues of the Karolinska Institute in Stockholm, Sweden, published a study in the *American Journal of Clinical Nutrition* that examined the association between intakes of dairy products and lactose and the risk of ovarian cancer. In this study of 61,084 women aged 38 to 76 years, the diet was assessed over three years and after 13.5 years 266 participants had been diagnosed with ovarian cancer. Results showed that women consuming four or more servings of dairy a day had double the risk of ovarian cancer compared to low or non-dairy consumers. Milk was the dairy product with the strongest positive association with ovarian cancer. The authors of this study observed a positive association between lactose intake and ovarian cancer risk and concluded that high intakes of lactose and dairy products, particularly milk, are associated with an increased risk of ovarian cancer (Larsson *et al.*, 2004).

Larsson subsequently compared two groups of studies: three prospective cohort studies and 18 case-control studies. The results of the three prospective cohort studies showed a strong link between the intake of total dairy foods, low-fat milk and lactose and the risk of ovarian cancer. In contrast, the data from the 18 case-control studies failed to show such a link. It was a stalemate with no clear conclusion (Larsson *et al.*, 2005). The differences between the findings of the cohort and case-control studies might be explained by a number of factors including selection bias (choosing individuals that are not representative of the norm) or changes in the diet following cancer diagnosis. Alternatively, the differences between the findings may be due to the time interval between diet assessment and cancer diagnosis. Cohort studies frequently record dietary practices many years before illness occurs, which may make the data more likely to be accurate compared to data collected in case-control studies which tends to be collected at the time of diagnosis.

In a study examining the link between diet and ovarian cancer, ovarian cancer incidence between 1993 and 1997 in different geographical locations was coupled to food consumption data from FAOSTAT Database Collections. The food items used for this study were animal fats, meat (beef, pork, poultry, mutton and goat meat), eggs, butter, milk, cereals, pulses, beans, soya beans, peas, fruits, vegetables, coffee, tea and alcoholic beverages. Results showed that Iceland had the highest rates of ovarian cancer affecting 16.2 women per 100,000, followed by 15.2 in Sweden and 13.7 in the UK. The lowest rate per 100,000 was 1.6 for Korea, followed by 2.1 in Mali and 4.0 in both China and Brazil. Again, results showed a strong link between dairy foods and cancer: milk was most closely correlated with the incidence of ovarian cancer, followed by animal fats and cheese. Conversely, pulses were negatively correlated with the incidence of this cancer (Ganmaa and Sato, 2005). This provides yet more evidence that animal-based foods tend to increase the risk of disease while whole grain plant-based diets reduce the risk.

In conclusion, the consumption of animal-based foods is associated with an increased risk of certain hormone-dependent cancers. Milk and dairy products are of particular concern: as already stated, most milk drunk today is produced from pregnant cows, in which oestrogen and progesterone levels are markedly elevated (Ganmaa and Sato, 2005). While there are several candidate components of milk that may increase the risk of ovarian and other hormone-dependent cancers, the precise mechanisms underlying their action remain unclear. However, as milk and dairy products have been identified as a risk factor for ovarian cancer, it stands to reason that this particular risk can be reduced by switching to a plant-based diet.

Prostate cancer

Prostate cancer is the most common cancer in men and the second most common cause of male cancer deaths after lung cancer. Although it rarely occurs in younger men, one in 14 men in the UK will be diagnosed with prostate cancer at some point in their lives (Cancer Research UK, 2005). Prostate cancer develops from cells within the prostate gland which is the size of a walnut and lies directly under the bladder. The prostate produces a protein called prostate-specific antigen (PSA) which turns semen into liquid form (NHS Direct, 2006). The majority of prostate cancers are slow growing and it may be some time before any symptoms are noticed, which can make this disease less treatable. Prostate cancer risk is associated with increasing age and is higher in people whose father or brother suffered the disease at an early age. Exposure to radioactive substances may increase the risk of prostate cancer. As for other hormone-dependent cancers, the highest incidence rates of prostate cancer occur in the developed world and the lowest rates in Africa and Asia (however, African-American men are more affected than white American men). This suggests that prostate cancer risk is mainly determined by dietary and lifestyle factors. This notion is supported by the observation that vegetarians are half as likely to get prostate cancer as meat-eaters (NHS Direct, 2006). This protection may be partly due to the protective role conferred by selenium and lycopenes (found in vegetables, particularly tomatoes).

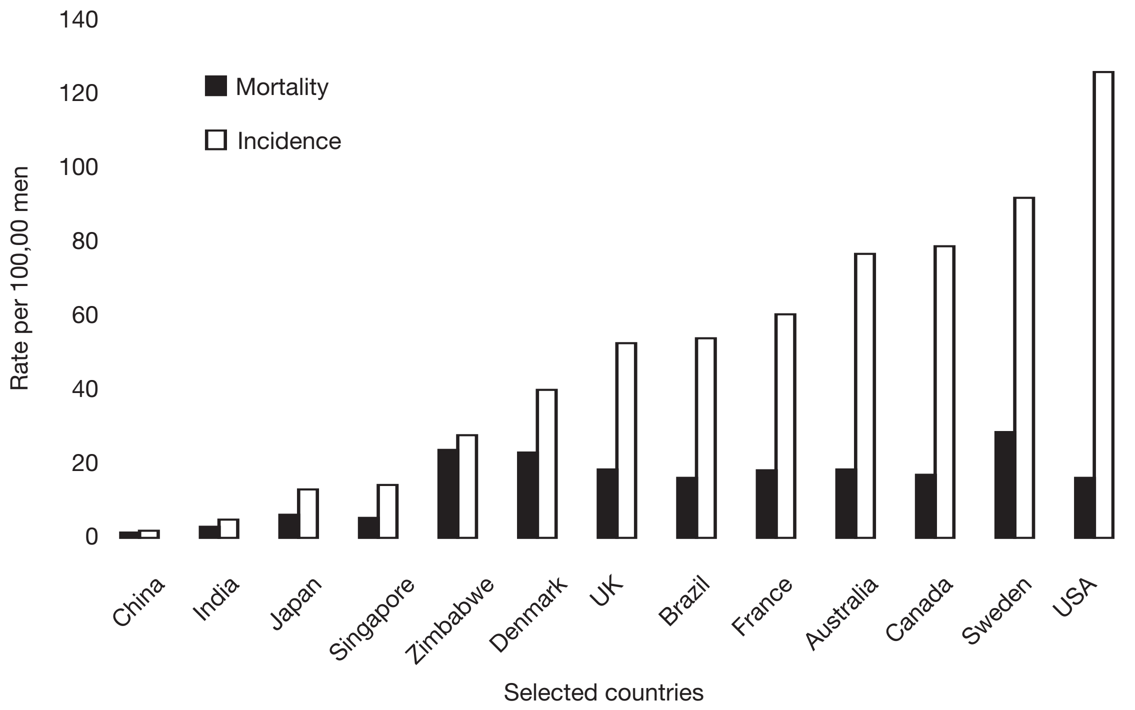

Figure 6.0 Incidence of and mortality from prostate cancer in selected countries in 2002. Source: Cancer Research UK, 2005a.

Figure 6.0 shows how the incidence of prostate cancer varies widely around the world with the highest incidence rates seen in the developed world and the lowest rates occurring in Africa and Asia. The lowest European rates are seen in southern Europe while the highest occur in Finland and Sweden (Cancer Research UK, 2005a). Research shows that prostate cancer rates are lower in countries with low consumption rates of typical Western foods such as meat and dairy.

One of the earliest reports linking dairy consumption to prostate cancer was published in the 1980s when a study of over 27,000 Californian Seventh-Day Adventists who had completed dietary questionnaires 20 years earlier concluded that milk consumption was positively associated with prostate cancer mortality (Snowdon, 1988). Since then many more reports have confirmed an increased risk from the consumption of dairy foods, although the mechanism underlying this action remains unclear.

One possible mechanism for the action of milk in increasing prostate cancer risk may involve the calcium in milk. Researchers from Harvard Medical School have shown that high consumption of calcium is linked to advanced prostate cancer (Giovannucci *et al.*, 1998). However, research on the roles of calcium and vitamin D in prostate cancer are inconsistent. It has been suggested that calcium increases prostate cancer risk by suppressing circulating vitamin D. In a study of 3,612 men observed between 1982 and 1992, 131 prostate cancer cases were identified and dietary intake analysed (Tseng *et al.*, 2005). Results confirmed that dietary calcium was associated with an increased risk whereas vitamin D was not associated.

Another study considered the oestrogen content of milk as a causal factor, having noted that the typical Western diet (characterised by milk and meat products) contains higher levels of oestrogen than the foods eaten by Asian men who suffer much less from prostate cancer. This study measured the hormone contents of two kinds of commercial milks (from Holstein and Jersey cows) and found that levels were markedly higher than they were 20 years ago. This was attributed to modern dairy farming methods whereby around 75 per cent of commercial milk comes from pregnant cows (Qin *et al.*, 2004).

The growth factor IGF-1 has been associated with increased prostate cancer risk in some epidemiologic studies, and as stated previously the diet can influence IGF-1 concentrations in the blood. In a Swedish study, levels of IGF-1 were measured in blood samples from over 800 men, 281 of whom were later diagnosed as having prostate cancer (Stattin *et al*, 2004). A strong correlation between IGF-1 and prostate cancer was observed and it was concluded that circulating IGF-1 levels are associated with an increased risk for this disease. Campbell suggests that IGF-1 is turning out to be a predictor of certain cancers, including prostate, in much the same way that cholesterol is a predictor of heart disease (Campbell and Campbell, 2005).

Interestingly, a study published in the *British Journal of Cancer* noted that vegan men had a nine per cent lower serum IGF-1 level than meat-eaters and vegetarians (Allen *et al.*, 2000). In terms of follow-up on cancer incidence it is still relatively early days, but the EPIC-Oxford researchers intend to follow the long-term health of participants of this and other studies based in the UK and Europe over the next 10 years to identify any associations with dietary factors, with particular emphasis on cancer incidence and mortality rates (Davey *et al.*, 2003).

While the precise molecular mechanism underlying the development of prostate cancer remains unclear, the effects of changing diet have produced positive results. Researchers at the Preventative Medicine Research Institute in California evaluated the effects of dietary changes in 93 volunteers who had chosen not to undergo conventional treatment for early prostate cancer. This was a unique opportunity to observe the effects of diet and lifestyle changes without the confounding effects of radiation or surgery. Participants in the lifestyle-change group were placed on a vegan diet consisting primarily of fruits, vegetables, whole grains and legumes supplemented with soya, vitamins and minerals. Two standard tests were used to assess disease status. The first was a routine blood test measuring PSA levels; this protein produced by the prostate gland can be used to assess disease progression. The second test relied on differences in the growth rates of a human prostate cancer cells (LNCaP) treated with patient serum. This is a standard laboratory test used for evaluating the effects of conventional treatments of prostate cancer.

While none of the experimental (vegan) patients underwent conventional treatment during the study, six control patients underwent treatment due to an increase in PSA and/or progression of the disease on magnetic resonance imaging. PSA decreased four per cent in the experimental group but increased six per cent in the control group. Although the magnitude of these changes was relatively modest, the direction of change may be clinically significant since an increase in PSA predicts clinical progression in the majority of men with prostate cancer. In the second test, the growth of LNCaP prostate cancer cells was inhibited almost eight times more by serum from the experimental than from the control group. Changes in serum PSA and also in LNCaP cell growth were significantly associated with the degree of change in diet and lifestyle. It was concluded that intensive lifestyle changes may affect the progression of early, low grade prostate cancer (Ornish *et al.*, 2005).

Well over a decade ago, increasing the consumption of beans, lentils, peas, tomatoes, raisins, dates and other dried fruit was associated with a significantly decreased risk of prostate cancer (Mills *et al.*, 1989). A more recent study of over 47,000 men confirmed an inverse link between fructose and prostate cancer indicating that eating fruit offers some protection against prostate cancer (Giovannucci *et al.*, 1998). More recently, in a review of diet, lifestyle and prostate cancer it was observed that while meat and dairy are associated with an increased risk, the consumption of tomato products (which contain the antioxidant lycopene), vitamin E and selenium supplements have all been shown to decrease risk. A high level of physical activity was also identified as a factor decreasing the risk of prostate cancer (Wolk, 2005).

In summary, the data linking the consumption of cow's milk and milk products to cancer provides a convincing argument for eliminating animal foods from the diet while increasing the intake of whole grains, pulses, fruit and vegetables.

Colic

Colic was first mentioned in recorded history by the ancient Greeks (Cirgin Ellett, 2003) yet in 2005 the cause remains unknown. Colic occurs in around one in five newborn babies, it is characterised by acute abdominal pain and the associated heart-wrenching crying that any parent of a child with colic will recognise. An otherwise healthy baby who cries excessively or inconsolably is often diagnosed as suffering from colic. While the exact cause is unknown several factors are thought to contribute including poor digestion, lactose intolerance and wind. Colic tends to start at around two to four weeks of age and has usually disappeared by around four months. In spite of all the distress colic can cause to the baby and the parents, babies with colic tend to feed and gain weight normally.

Since the 1970s, numerous studies have indicated that certain components of cow's milk may lead to colic. In a clinical trial to test the effects of cow's milk whey proteins, 24 out of 27 infants with colic showed no symptoms of colic after whey protein was removed from their diet. In fact crying hours per day dropped from 5.6 hours to 0.7 hours (Lothe and Lindberg, 1989). In transient lactose intolerance, the enzyme lactase is not produced while there is illness in the gut, but is manufactured again once the gut has recovered. In a review investigating transient lactose intolerance as a cause of colic, a range of studies showed that crying time was reduced when formula or breast milk was incubated with the enzyme lactase (Buckley, 2000). It has been suggested that infant colic has a multiple aetiology; in other words, colic may be caused by a number of different factors including whey proteins, lactose and others.

The fact that the incidence of colic is similar in formula fed and breast fed infants has led scientists to investigate the role of the maternal diet in this condition and many reports now link the maternal intake of cow's milk to the occurrence of colic in exclusively breast fed infants. The breast milk of mothers who consume cow's milk and milk products has been shown to contain intact proteins from these foods. To test the possible role of cow's milk proteins in breast milk, researchers have investigated the effects of eliminating all dairy products from the mothers' diet. An early report linking cow's milk proteins in human breast milk to infantile colic date back to a letter published in the *Lancet* in the late 1970s (Jakobsson and Lindberg, 1978). The letter described how the symptoms of colic disappeared in 13 out of 19 infants whose mothers eliminated cow's milk from their diet. In a subsequent clinical trial designed by the same researchers, 66 breast feeding mothers of infants with colic were put on a diet free from cow's milk. The colic disappeared in 35 of the infants and subsequently reappeared in 23 of them when cow's milk protein was reintroduced to the mothers' diet (Jakobsson and Lindberg, 1983). The authors suggest that a diet free of cow's milk may be useful as a first trial of treatment of infantile colic in breast fed infants.

Researchers at the Washington School of Medicine in Missouri US found that mothers of infants with colic had significantly higher levels of the cow's milk antibody immunoglobulin G (IgG) in their breast milk than mothers of infants without colic (Clyne and Kulczycki, 1991). The authors of this study suggest that bovine IgG present in breast milk may be involved in the development of colic. This link was confirmed more recently and again it was suggested that the maternal avoidance of milk and dairy products may be an effective treatment for colic in some breast fed infants (Estep and Kulczycki, 2000).

In a substantial review of 27 controlled trials published in the *British Medical Journal*, the elimination of cow's milk protein was deemed to be a highly effective treatment for infantile colic. The reviewers remained uncertain about the effectiveness of low lactose formula milks and the effectiveness of substitution with soya-based formula milks (although no adverse events were reported) while supporting the substitution of normal cow's milk formula for whey or casein protein hydrolysate (hypoallergenic) formulas, in which the milk protein is partially broken down to ease digestion (Lucassen, 1998).

Interestingly, Dr Benjamin Spock, author of the hugely popular book *Baby and Child* (over 50 million copies sold worldwide) warns that the proteins in cow's milk formulas can cause colic (Spock and Parker, 1998). Spock acknowledges that some infants that are allergic to cow's milk formula may be allergic to soya-based infant formula as well and that these infants are often given expensive hydrolysate formulas. However, he states that soya formulas have an important advantage over cow's milk formulas in that they contain none of the animal proteins linked with colic (and type I diabetes) and are free of lactose.

This said, it should be emphasised to parents who breast feed, it is a good idea to continue breast feeding as weaning on to formula milk may make the colic worse. If eliminating cow's milk and milk products from the maternal diet does not help, cutting out other foods may help. Researchers at the University of Minnesota tested a range of foods including cruciferous vegetables (cabbage, cauliflower, sprouts and broccoli) in an elimination diet in mothers of babies with colic. While the results showed that cow's milk had the strongest association with colic, other foods more weakly associated included onions, chocolate, cabbage, broccoli and cauliflower (Lust *et al.*, 1996).

Constipation

Constipation is a condition in which bowel movements are infrequent or incomplete. While it is normal for some people to go to the toilet several times a day, others go less frequently. A change in the normal frequency of trips to the toilet can be an indicator of constipation. Similarly if you are going as frequently but having trouble passing stools, having to strain, this too may indicate constipation. Common symptoms include stomach ache and cramps, feeling bloated, nausea, a sense of fullness, headache, loss of appetite, fatigue and depression (NHS Direct, 2005).

Constipation may be caused by a range of factors including insufficient fluid in the diet, lack of fibre (fruit, vegetables and cereals) in the diet, lack of physical exercise, certain drugs (diuretics or painkillers, antidepressants and antacids that contain iron, calcium or aluminium), too much calcium or iron in the diet, pregnancy, an excessive intake of tea or coffee (this increases urine production and so decreases the amount of fluid in the bowel). Other factors include surgery, haemorrhoids (piles) and psychological problems such as anxiety. Constipation may be a symptom of another medical condition such as irritable bowel syndrome (IBS).

The link between constipation and milk intolerance was first made in medical literature in 1954 (Clein, 1954). More recently there have been several studies published confirming that this link exits. Researchers at the University of Palermo in Italy studied 65 children (aged from 11 to 72 months) suffering from chronic constipation (Iacono *et al.*, 1998). All of these children had been treated with laxatives without success. After 15 days of observations (in a double-blind crossover study) each child received either cow's milk or soya milk for two weeks, and then had a week off when they could eat and drink anything they wanted. Then the feeding order was reversed, so that the group that had previously drunk cow's milk switched to soya and vice versa. The researchers (and children) were unaware of the order of treatment. Careful recordings of the bowel habits were made and a response to the treatment was defined as eight or more bowel movements during the two week treatment period. Results showed that 44 of the 65 children (68 per cent) had a response while receiving soya milk compared to none of the children receiving cow's milk. The results were most dramatic in children who had frequent runny noses, eczema or wheezing, which may have been a symptom of milk allergy in these children. Sometimes however, constipation can be the only symptom of cow's milk intolerance or allergy. More recently further research has confirmed the link between the consumption of cow's milk and constipation (Daher *et al*., 2001; Andiran *et al*., 2003; Turunen, 2004).

Cow's milk may lead to constipation by two distinct modes of action: cow's milk intolerance or cow's milk allergy. In either case, studies suggest that cow's milk intolerance or allergy should be considered as a cause of constipation although the underlying mechanism still requires further investigation. In general it should be noted that dairy products supply children with unnecessary saturated fat while providing no dietary fibre whatsoever. Fibre is essential in the diet to maintain good bowel health through regular movements.

Coronary heart disease

Diseases of the heart and circulatory system are collectively called cardiovascular disease (CVD) and are the main cause of death in the UK, killing one in every three people. Coronary heart disease (CHD) is one of the two main forms of CVD along with stroke. CHD is the most common cause of death in the UK; around one in five men and one in six women die from this disease (Petersen *et al*., 2005).

CHD occurs when there is a build up of fatty deposits (plaques) along the walls of the arteries that supply the heart with oxygenated blood. These plaques build up and clog the arteries making them narrower and restricting the blood flow. Blood clots can form at the site of a plaque in the coronary artery and cut off the blood supply to the heart. This can result in heart attack and sudden death. The plaques that block the arteries are made up of a fatty substance that

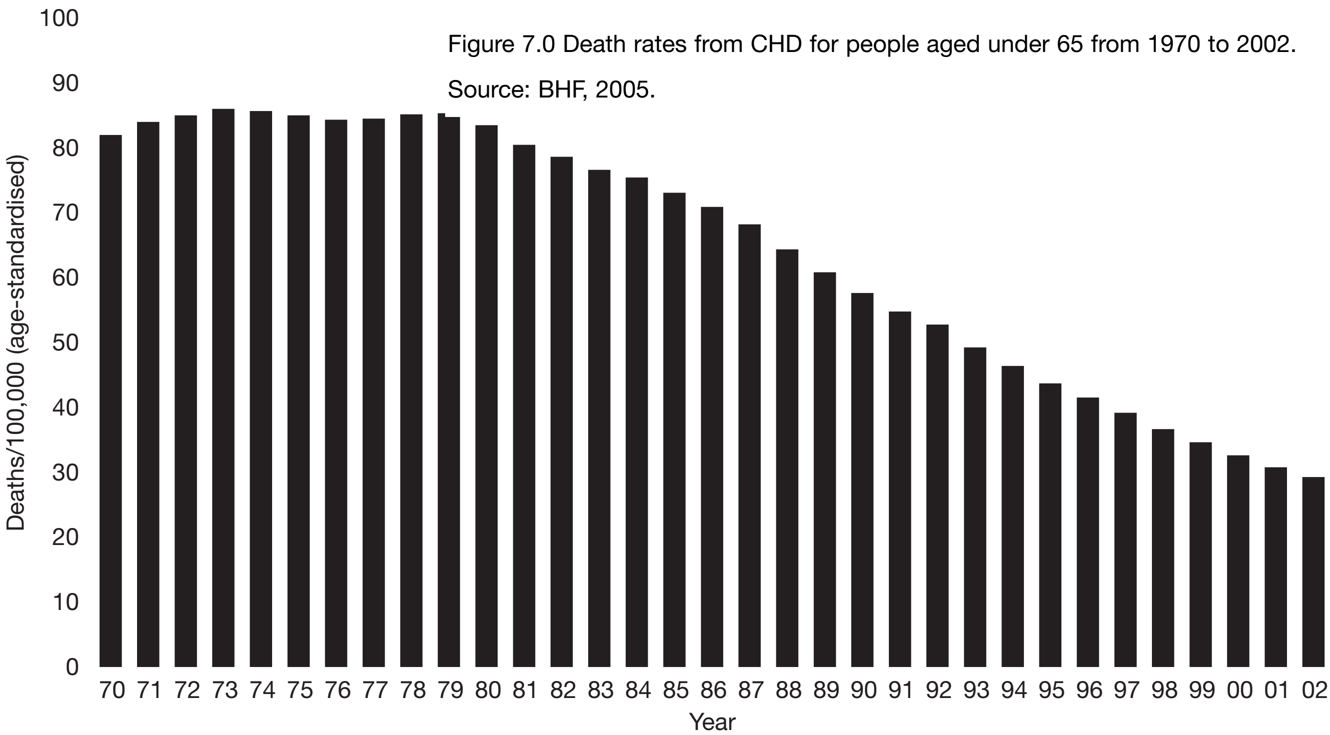

Figure 7.0 Death rates from CHD for people aged under 65 from 1970 to 2002.
Source: BHF, 2005.

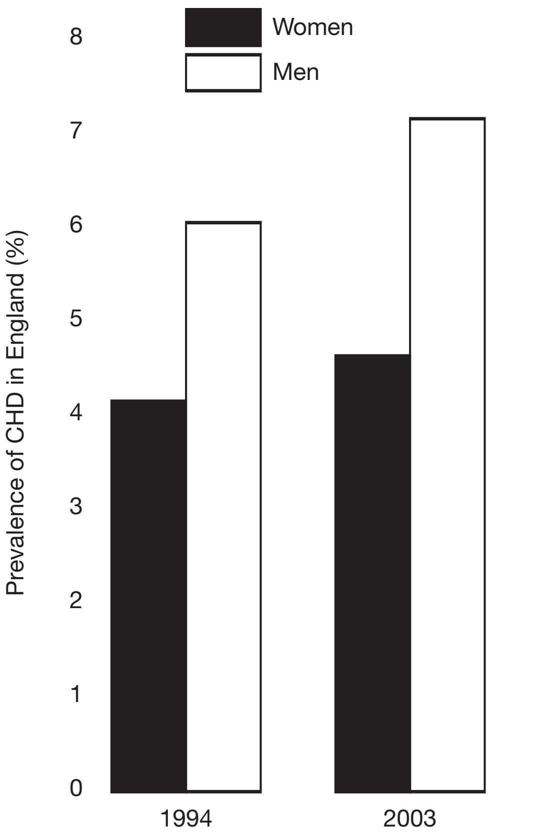

Figure 8.0 Prevalence of CHD in England in 1994 and 2003. Source: BHF, 2005a.

contains cholesterol. Cholesterol is essential for cells but too much can lead to CHD. Lipoproteins carry cholesterol to and from the cells in the blood. Low-density lipoprotein (LDL) takes cholesterol from the liver to the cells, and high-density lipoprotein (HDL) carries excess cholesterol back to the liver for excretion. HDL is known as the 'good fat' while LDL ('bad fat') tends to build up on the walls of the arteries increasing the risk of CHD.

Figure 7.0 shows how the number of deaths from CHD has fallen markedly since the 1970s. This may be because of improvements in treatment and lifestyle. For example a vast improvement has been made in the speed at which so-called clot-busting drugs are applied, which has had a huge impact in preventing death. Furthermore, nearly two million people receive drugs called statins that lower cholesterol levels and reduce the risk of heart disease. Many people have given up smoking, which has a significant effect on lowering the risk of heart disease.

However, while fewer people are dying from CHD, the number of people living with this disease is rising. Figure 8.0 shows that over ten years, between 1994 and 2003, the number of women with CHD increased from 4.1 per cent to 4.5 per cent, and the number of men with CHD increased from 6.0 per cent to 7.4 per cent. There are now an estimated 2.6 million people in the UK facing life with CHD (BHF, 2005a). Furthermore, concerns remain that the decline in deaths from heart disease may be short lived due to the increasing levels of inactivity, the rise in obesity, the increase in cholesterol levels and the rise of type 2 diabetes.

The quest to identify the risk factors for CHD dates back over five decades. In 1946 Los Angeles physician Dr Lester Morrison began a study to determine the relationship of dietary fat intake to the incidence of CHD (Morrison, 1960). He reduced the dietary fat intake of 50 heart attack survivors and compared their health to 50 other heart attack survivors whose fat intake was left unchanged. After eight years, 38 of the control group had died compared to 22 of the low-fat group. After 12 years, the entire control group had died but 19 of the low-fat diet group were still alive. Around the same time, the residents of Framingham, just outside Boston Massachusetts in the US, took part in a study to investigate the role of diet and lifestyle in CHD. The study began in 1948, and by observing who suffered from CHD and who did not, the Framingham Study established the concept of risk factors such as cholesterol, high blood pressure (hypertension), lack of physical exercise, smoking and obesity (Kannal *et al.*, 1961).

In 1985, research published in the *Journal of the American Medical Association* suggested that dairy products are a major source of dietary saturated fat and cholesterol and that ingestion of high-fat dairy products raises both total and LDL 'bad' cholesterol levels (Sacks *et al.*, 1985). It is now widely accepted that diets high in animal fats are unhealthy and that reducing the saturated fat intake is very important for reducing the risk of CHD. The UK Government recommends avoiding or cutting down on fatty foods including egg yolks, red meat, butter, whole milk, cheese, cakes and chips to reduce the intake of saturated fat (NHS Direct, 2006).

Dietary risk factors for CVD do not just apply to adults. A review on infant feeding practices published in the US journal *Pediatrics* suggested that the consumption of whole milk should be discouraged in infants because of its potential role in atherosclerotic heart disease (Oski, 1985). More recently the WHO stated that the current evidence indicates undesirable effects of formula milk on CVD risk factors; this is consistent with the observations of increased mortality among older adults who were fed formula as infants (WHO/FAO, 2002).

A number of risk factors are now firmly associated with CHD including high blood cholesterol levels, high blood pressure, family history of heart disease, diabetes, obesity and smoking. Additionally, there is much evidence linking CHD to poor dietary practices, including the high consumption of saturated fats, salt and refined carbohydrates, and the low consumption of fruits and vegetables (WHO/FAO, 2002).

A certain amount of cholesterol is essential for good health, but high cholesterol levels in the blood are associated with an increased risk of CHD (and stroke). This is because cholesterol contributes towards the build up of fatty plaques on the artery walls which results in the narrowing of the arteries and can lead to a blockage and subsequent failure or death of the organ that the artery provides blood to. The organs affected often include the heart (heart attack) and brain (stroke), but may affect other organs such as the kidneys (kidney failure). But what determines blood cholesterol levels? Contrary to popular belief, most of our cholesterol does not come from the diet but is produced within the body by the liver. Only a small amount of our cholesterol (estimates vary from 15 to 20 per cent) comes from the diet. Cholesterol is found only in animal foods and is particularly concentrated in eggs and organ meats. Even high-fat plant foods, such as avocados, nuts and seeds, contain no cholesterol whatsoever, so a plant-based vegan diet is cholesterol-free. We have no actual dietary requirement for cholesterol, in other words we do not need to eat foods that contain cholesterol as the liver can manufacture as much as is required. However, there is no mechanism limiting the amount of cholesterol produced by the liver and cholesterol production can rise to unhealthy levels.

So what causes high cholesterol production in the liver? The answer lies in the types of foods we eat: diets high in animal protein and saturated animal fats have been shown to increase cholesterol. In *The China Study*, Campbell observes that animal protein intake correlates directly with heart disease incidence, which he attributes to the cholesterol-raising effect of animal protein. Conversely, Campbell notes that eating plant protein lowers cholesterol (Campbell and Campbell, 2005). Studies have shown that replacing animal protein (casein) with soya protein reduces blood cholesterol, even when the fat intake remains unchanged (Lovati *et al.*, 1987; Sirtori *et al.*, 1999). Exactly how soya protein lowers cholesterol is uncertain, although a range of theories have been proposed. One hypothesis suggests that the amino acid composition of soya protein causes changes in cholesterol metabolism (possibly via the endocrine system). Others propose that non-protein components (such as saponins, fibre, phytic acid, minerals and isoflavones) associated with soya protein affect cholesterol metabolism either directly or indirectly (Potter, 1995). The most popular theory currently accepted is that soya protein reduces cholesterol metabolism in the liver by increasing the removal of LDL 'bad' cholesterol. The precise mechanism is thought to involve enhanced LDL-degradation and increased binding of LDL to receptors (Sirtori *et al.*, 1977).

The cholesterol-raising effects of saturated fat have received far more attention than animal protein. In a review of the current literature, researchers from the Department of Nutrition at the Harvard School of Public Health in Boston, Massachusetts, found compelling evidence that the types of fat are more important than total amount of fat in determining the risk of CHD (Hu *et al.*, 2001). Here the culprit is saturated fat, and controlled clinical trials have shown that replacing this type of fat with polyunsaturated fat is more effective in lowering cholesterol and reducing the risk of CHD than reducing total fat consumption. Foods high in saturated fat include: meat pies, sausages and fatty cuts of meat, butter, ghee, lard, cream, hard cheese, cakes and biscuits and foods containing coconut or palm oil (FSA, 2006). Like saturated fats, trans fats can also raise cholesterol levels. Trans fats are found in foods that contain hydrogenated fats, including processed foods such as biscuits, cakes, fast food, pastry, margarines and spreads (FSA, 2006).

The good news is that there are foods that can reduce blood cholesterol. Eating a diet that contains plenty of soluble fibre could also help to reduce the amount of cholesterol in the blood. Good sources of soluble fibre include oats, beans, peas, lentils, chickpeas, fruit and vegetables (FSA, 2006). Dr Dean Ornish, best known for his Lifestyle Heart Trial, investigated the role of a low-fat, high-fibre diet coupled to lifestyle changes in heart disease patients. Ornish treated 28 heart disease patients with diet and lifestyle changes alone. They followed a low-fat plant-based diet including unrestricted amounts of fruits, vegetables and grains. They also practised stress management techniques and exercised regularly. After one year 82 per cent of the test group experienced regression of their heart disease, including a 91 per cent reduction in the frequency of heart pain compared to 165 per cent increase in the control group (Ornish *et al.*, 1990). No conventional drug or surgery related therapies compare with these results (Campbell and Campbell, 2005).

A study published in the *Journal of the American College of Nutrition* investigating the risk factors associated with CHD found that African-American vegans exhibit a more favourable serum lipid profile (a healthier balance of fats in the blood) compared to vegetarians who ate milk, milk products and eggs (Toohey *et al.*, 1998). This means that the vegans had healthier levels of total cholesterol, LDL and HDL in their blood compared to the vegetarians. The major factors contributing to this result were thought to be the lower saturated fat intake and higher fibre intake of vegans.

Examining the incidence of CHD in other cultures allows us to draw conclusions about the role of diet in disease. Several studies have shown that certified death rates from CHD are linked country-by-country with milk consumption (Moss and Freed, 2003).

In *The China Study*, Campbell was astonished at the low rates of CHD in the southwest Chinese provinces of Sichuan and Guizhou; between 1973 and 1975 not one single person died of CHD before the age of 64 among 246,000 men and 181,000 women (Campbell and Campbell, 2005). Campbell suggests these figures reflect the important protective role of low blood cholesterol levels observed in rural China.

A joint report between the Medical Research Council and the British Heart Foundation states that the average blood total cholesterol level for people aged 16 and above in the UK is about 5.5mmol/l. In China (where there is much less heart disease), mean total cholesterol levels in the cities are about 4.5mmol/l for men and women aged 35-64, and levels in the countryside are even lower (MRC/BHF, 2006). According to the WHO, about 56 per cent of global heart disease is attributable to total cholesterol levels above 3.2mmol/l (WHO, 2006). It could be argued that genetic differences between races may affect the risk factors for CHD and other diseases. However, Campbell's observations that Japanese men in Hawaii and California have much higher levels of blood cholesterol and incidence of CHD than Japanese men in Japan confirms that some risk factors are environmental rather than genetic.

Since the early 1990s the amino acid homocysteine has become the subject of much interest among the scientific community. Evidence suggests that homocysteine damages the lining of blood vessels and enhances blood clotting. Elevated concentrations of homocysteine in the blood have been linked to an increased risk for both heart disease and stroke. Some studies suggest it may have an even more important role in determining the health of individuals than cholesterol (Walsh, 2003). Homocysteine is converted into the amino acid methionine in the presence of B12. In the same reaction, methyltetrahydrofolate is converted to folate which is used in the synthesis of DNA. This entire reaction relies on sufficient supplies of B12, B6 and folate. In B12 deficiency, the amount of homocysteine in the body can escalate to potentially dangerous levels and has been linked to a range of disorders including depression, dementia, damage to the inner lining of the artery walls and may be a trigger for CHD. While increased homocysteine levels have been observed in vegetarians and vegans they do not occur in those ensuring an adequate B12 intake of three micrograms per day, whereas elevated homocysteine levels are not uncommon among meat-eaters due to a low folate intake (Walsh, 2003). Additionally, elevated serum homocysteine levels tend to increase in the elderly as incidence of B12 deficiency occurs more frequently. Interestingly, a recent study showed how a daily serving of breakfast cereal fortified with folic acid, B6 and B12 not only contributed to the plasma status of these vitamins but significantly reduced homocysteine concentrations in a randomly selected group of relatively healthy 50-85-year-olds (Tucker *et al.*, 2004).

The role of a vegetarian and vegan diet in nutrition and health was examined among a large group of vegetarians in the Oxford Vegetarian Study (Appleby *et al.*, 1999). This was a prospective study of 6,000 vegetarians and 5,000 non-vegetarian controlled subjects recruited in the UK between 1980 and 1984. In this study vegans had lower cholesterol levels than meat-eaters (vegetarians and fish-eaters had intermediate or similar values). Meat and cheese consumption were positively associated, and dietary fibre intake was inversely associated, with cholesterol levels. After 12 years of follow-up, mortality from heart disease was positively associated with estimated intakes of total animal fat, saturated animal fat and dietary cholesterol. A subsequent review of the literature comparing the health of Western vegetarians to non-vegetarians found that vegetarians had lower cholesterol levels (by about 0.5mmol/l) and a lower mortality from heart disease (by about 25 per cent). It was suggested that widespread adoption of a vegetarian diet could prevent approximately 40,000 deaths from heart disease in Britain each year (Key *et al.*, 1999).

Taken together, the evidence shows that a plant-based diet reduces the risk of CHD. This may be for a range of reasons including the cholesterol-lowering effect of fibre. It has been suggested that the antioxidants (beta-carotene and vitamins C and E) contained in fruit and vegetables and cereals prevent saturated fats from being converted into cholesterol in your body (NHS Direct, 2006). Whatever the precise mechanism, the evidence is clear: a plant-based diet containing plenty of fruits and vegetables and whole grains reduces the risk of CHD. There is much speculation about how the consumption of animal foods increases the risk of CHD. Again, the precise mechanisms involved may be unresolved, but it is clear that the more animal foods a person eats, the higher their risk. In summary, animal protein and saturated animals fats increase blood cholesterol and the risk of CHD while plant protein and fibre lowers cholesterol and reduces the risk. Therefore, to reduce the risk of CHD we should reduce the amount of animal foods in the diet and eat more whole grain, plant-based foods.

There are of course other factors that can contribute to the risk of CHD. Exercise is extremely important as it increases HDL cholesterol levels, which in turn helps keep LDL cholesterol levels down. Exercise also helps control weight. As stated, smoking is a major risk factor of CHD as it hardens the arteries, causing them to narrow. Alcohol consumption can increase the risk so it should be limited and binge drinking avoided.

Crohn's disease

Crohn's disease is a chronic inflammatory bowel disease (IBD). Its symptoms are similar to other bowel conditions such as irritable bowel syndrome (IBS) and another IBD ulcerative colitis. Crohn's disease commonly occurs in the ileum (the lower part of the small intestine), but it can affect any part of the bowel. In fact it can occur anywhere along the entire alimentary tract from the mouth to the anus. In most cases though, Crohn's disease occurs in sections of the bowel which become inflamed, ulcerated and thickened. Symptoms include diarrhoea, abdominal pain, weight loss and tiredness. According to the National Association for Colitis and Crohn's Disease, the disease affects about one in every 1,600 people in the UK. Other studies have reported higher figures; up to one in 690 in one regional study. A reasonable ballpark figure may be around one in every 1,000 people (FSA, 2002a). Crohn's disease affects men and women equally but occurs more commonly in white than black people. It usually occurs in the age group between 15 and 40 although it can affect people of any age.

Although the cause of Crohn's disease remains unclear, it may be due to a combination of factors including a genetic predisposition, an abnormal immune response and environmental factors, probably relating to a response to microorganisms in the bowel but also possibly related to other dietary factors (FSA, 2002a).

It has been proposed that an environmental factor leading to Crohn's disease is a pathogenic bacterium. The most popular candidate is the infectious bacterium *Mycobacterium avium* subspecies *paratuberculosis* (MAP). MAP infection is widespread in domestic livestock and is present in commercial pasteurised cow's milk in the UK. There are concerns that water supplies may also be contaminated. MAP is a robust and versatile pathogen which has been shown to cause chronic inflammation in the intestines of many species of animal, including primates. MAP causes a chronic gastrointestinal infection called Johne's disease in cattle and other ruminants. However, the link between MAP and Crohn's has remained somewhat controversial.

An increasing amount of evidence now supports the causal link between MAP and Crohn's disease. Researchers at the University of Wisconsin used a range of modern molecular techniques to search for and confirm the presence of MAP in patients with IBDs including Crohn's (Collins *et al.*, 2000). The results showed MAP was present in around 20 per cent of Crohn's patients compared to less than seven per cent of controls (without Crohn's). Although these results may not have provided the substantive evidence initially anticipated the researchers concluded that MAP (or some similar species) infects a subset of IBD patients.

More recently, Professor John Hermon-Taylor and colleagues at St George's Hospital Medical School in London tested a group of patients with and without Crohn's disease for MAP (Bull *et al.*, 2003). Using improved molecular methods that increased the sensitivity of the tests, this time 92 per cent of patients with Crohn's disease tested positive compared to 26 per cent of the controls. These patients were from the UK, Ireland, US, Germany and United Arab Emirates, suggesting exposure to this pathogen occurs on an international basis. The discovery that MAP is present in the majority of Crohn's patients would suggest a causal link between this bacterium and the condition. Since then, additional reports have confirmed MAP as a predominant feature of Crohn's disease (Autschbach *et al.*, 2005; Sechi *et al.*, 2005).

But how does MAP infection occur? The answer may lie under our very noses, depending on what we are drinking. MAP can survive the pasteurisation process, indeed an FSA-commissioned survey in 2002 found MAP in two per cent of pasteurised milk on sale in the UK (FSA, 2002a). However, researchers from the Department of Surgery at St

George's Hospital Medical School in London detected MAP in 22 of 312 (seven per cent) of samples of whole pasteurised cow's milk obtained from retail outlets throughout central and southern England from September 1991 to March 1993. Alarmingly this study revealed the presence of peak periods in January to March and in September to November, when up to 25 per cent of samples tested positive for MAP (Millar *et al*., 1996). Taken together with data on the prevalence of MAP infection in herds in the UK, the known secretion of MAP in milk from infected animals, and the inability of laboratory conditions simulating pasteurisation to ensure the killing of all these slow-growing organisms, the authors of this study concluded that there is a high risk, particularly at peak times, that residual MAP will be present in retail pasteurised cow's milk in England. In response to concerns about the presence of MAP in retail milk, the FSA devised a strategy to control MAP in milk at all stages of the food chain (FSA, 2003). This strategy aims to ensure hygienic milking practices and effective pasteurisation of milk and reduce the level of MAP in dairy herds. Of course the overall aim is to reduce the likelihood of consumers being exposed to MAP. However, this strategy does not consider alternative routes of exposure.

MAP is a robust organism which can survive for months or even years in the environment which is a cause of much concern as infected animals excrete huge numbers of MAP in their faeces. In South Wales, researchers sampled river water from the Taff which runs off the hills and through the city of Cardiff and detected MAP in 32.3 per cent of the samples (Pickup *et al*., 2005). The hills are grazed by livestock in which MAP is endemic. Previous research in Cardiff has shown a steep increase in the incidence of Crohn's disease. Given that inhalation is a probable route of MAP infection in cattle, it was suggested that the pattern of clustering of Crohn's disease in Cardiff may be due to people inhaling aerosols carrying MAP from the river. Avoiding dairy products alone may not be enough to ensure avoiding exposure to MAP (although if everyone reduced their intake of animal products there would be fewer cattle and therefore less MAP present in the environment).

For patients that have developed Crohn's disease avoiding foods that precipitate the symptoms has proved to be a successful way of avoiding drug (corticosteroid) therapy. In the *Lancet* in 1993, researchers from a Cambridge hospital reported that altering the diet was as effective in producing remission of Crohn's disease as corticosteroid treatment thus providing an alternative therapeutic strategy to treating Crohn's. The research showed that the food intolerances were predominantly to cereals, dairy products and yeast (Riordan *et al*., 1993). Manipulating the diet rather than relying on drug therapy may be particularly important as corticosteroid treatment in patients with Crohn's disease has been linked to osteoporosis (Dear *et al*., 2001).

Diabetes

Diabetes mellitus is a chronic disease caused by too much sugar (glucose) in the blood. Blood sugar levels rise when there is not enough insulin in the blood or the insulin that is in the blood does not work properly. Insulin is an important hormone secreted by the beta cells of the islets of Langerhans in the pancreas. It regulates blood sugar levels by, for example, promoting the uptake of glucose into the cells. When things go wrong, high levels of glucose in the blood can cause damage to the nerves and blood vessels. Without treatment diabetes can lead to long-term health problems including kidney failure, gangrene, sensory loss, ulceration, blindness, cardiovascular disease and stroke.

There are two main types of diabetes. Type 1 (insulin-dependent diabetes) occurs when the body produces little or no insulin. People who have type 1 diabetes must check the levels of glucose in their blood regularly and will need treatment for the rest of their lives. Type 1 diabetes is sometimes called juvenile-onset diabetes because it tends to develop before the age of 40, often in the teenage years. The peak age for diagnosis in the UK is between 10 and 14 years but is becoming younger with a steep rise in the under fives (Williams and Pickup, 2004). Symptoms include a frequent urge to urinate, extreme thirst and hunger, weight loss, fatigue, irritability and nausea. The cause of type 1 diabetes is poorly understood, but some evidence suggests it involves a combination of genetic factors and environmental triggers. Type 1 diabetes is usually treated with regular injections of insulin to regulate blood sugar levels.

Type 2 diabetes occurs either when the body does not produce enough insulin or when it cannot use the insulin produced. This type of diabetes is linked with obesity. Over 80 per cent of people with type 2 diabetes are overweight (NHS Direct, 2005). Type 2 diabetes occurs mostly in people over the age of 40, but is now increasingly affecting people at a much younger age. Symptoms include tiredness, irritability, nausea, hunger, weight loss, recurrent skin infections, blurred vision, tingling sensations in the hands and feet and dry, itchy skin. Not all symptoms occur and those that do might be subtle and may go unnoticed for years. Blood sugar levels in type 2 diabetes can be controlled by lifestyle changes including regular exercise coupled to diet control and weight loss. Type 2 diabetes accounts for over 80 per cent of all cases of diabetes seen. While rising obesity levels have contributed to the increase in the incidence of type 2 diabetes, the increase in obesity does not explain the threefold increase in the number of cases of type 1 diabetes seen over the last 30 years. This is the most common form of the disease in children; over 90 per cent of children under the age of 16 with diabetes have type 1.

A third type of diabetes, gestational diabetes, develops in some women during pregnancy but usually disappears after giving birth.

Diabetes affects over one million people in the UK but there may be as many as a million others who have the disease but do not know it yet. The WHO describes the global rise in diabetes as epidemic (WHO, 2006a). In 1985 an estimated 30 million people worldwide had diabetes; a decade later this figure had increased to 135 million and by 2000 an estimated 171 million people had diabetes. It is predicted that at least 366 million people will have diabetes by 2030 (WHO, 2006a). The increase in diabetes is attributed to a range of factors including population growth, ageing, unhealthy diets that are high in saturated fat and cholesterol, obesity and lack of physical exercise.

Diabetes has become one of the major causes of premature illness and death in many, but not all, countries. Indeed, diabetes occurs much more in some parts of the world, principally in developed countries. Diabetes tends to occur more in cultures consuming diets high in animal fats and less in cultures consuming diets high in complex carbohydrates. As carbohydrate intake increases and saturated animal fat intake decreases from country to country, the number of deaths from type 2 diabetes plummets from 20.4 to 2.9 people per 100,000 (Campbell and Campbell, 2005).

In England and Wales, the rates of diabetes fell markedly between 1940 and 1950. This is because during the Second World War, and in the period following it, people tended to eat less fat and sugar and more plant foods, and therefore more fibre, antioxidants, complex carbohydrates, vitamins and minerals (Trowell, 1974). All available land was used; many people grew their own vegetables and vegetable patches were cultivated all over the country. Gardens, flowerbeds and parks were dug up and planted with vegetables; even the moat around the Tower of London (drained in 1843) was used for growing vegetables. Then as rationing came to an end and people moved away from whole grains towards a more processed diet, rates of diabetes increased again (Trowell, 1974). The conclusion must be that a high-carbohydrate, low-fat plant-based diet offers some protection against type 2 diabetes.

The risk factors for type 2 diabetes (obesity, poor diet and lack of exercise) are well-documented and there are many steps people can take to limit their chances of developing type 2 diabetes. One obvious step is to reduce the amount of saturated fat in the diet, this means cutting down on meat and dairy and increasing the intake of fruit, vegetables, whole grains, pulses, nuts and seeds. Large, population-based studies in China, Canada, USA and several European countries suggest that even moderate reduction in weight and half an hour of walking each day reduces the risk of diabetes considerably (WHO, 2006a).

A study of the relationship between diet and chronic disease in a cohort of 34,192 California Seventh-day Adventists revealed that the vegetarian Adventists were much healthier than their meat-eating counterparts: the meat-eaters were twice as likely as the vegetarians to suffer from diabetes (Fraser, 1999). This study also revealed that obesity increased as meat consumption increased; the difference between vegetarian and non-vegetarian men and women was 6.4kg and 5.5kg respectively (Fraser, 1999).

The importance of high-fibre diets in diabetes has been studied extensively since the 1970s by James Anderson, Professor of Medicine at the University of Kentucky. Anderson used a high-fibre, high-carbohydrate low-fat diet to treat 25 type 1 and 25 type 2 diabetics (Anderson, 1986). The experimental diet consisted mostly of whole plant foods (although it did contain a small amount of meat). After three weeks, Anderson measured blood sugar levels, weight and cholesterol levels and calculated their medication requirements. The results were astounding. Remember in type 1 diabetes no insulin is produced so it seems unlikely that a change in diet would help. However, Anderson's patients required 40 per cent less insulin medication than they had needed before the trial. In addition to this, their cholesterol levels dropped by an average of 30 per cent too. This is just as important in lowering the risk factors for secondary outcomes of diabetes such as heart disease and stroke. Type 2 diabetes is generally more treatable and the results among the type 2 patients were even more impressive: 24 out of the 25 participants consuming the high-fibre, low-fat diet were able to stop taking their insulin medication completely! These benefits were not of a temporary nature, indeed they were sustained over time in a group of 14 diabetic men continuing on the high-carbohydrate, high-fibre diet for four years (Story *et al.*, 1985). The evidence is overwhelming: a high-carbohydrate, high-fibre diet provides effective, positive and safe treatment for diabetes and lowers the associated risk for coronary artery disease (Anderson *et al.*, 1990). Of course it should be noted that this is not a special diet for diabetics; most people would benefit from increasing their fibre intake while reducing the amount of fat they consume.

In 2000 an extensive study of children from 40 different countries confirmed a link between diet and incidence of type 1 diabetes (Muntoni *et al.*, 2000). The study set out to examine the relationship between dietary energy from major food groups and incidence of type 1 diabetes. The total energy intake was not associated with type 1 diabetes incidence. However, energy from animal sources (meat and dairy foods) was associated and energy from plant sources was inversely associated with diabetes. This means that the more meat and milk in the diet, the higher the incidence of diabetes and the more plant-based food in the diet, the lower the incidence.

Type 1 diabetes is an autoimmune disease where the immune system's 'soldiers', known as T-cells, destroy the body's own insulin-producing beta cells in the pancreas. This type of response is thought to involve a genetic predisposition (diabetes in the family) coupled to an environmental trigger. The trigger may be a virus or some component of food. In the early 1990s a Canadian research group suggested that cow's milk proteins might be an important environmental trigger providing specific peptides that share antigenic epitopes with host cell proteins (Martin *et al.*, 1991). This means that the proteins in cow's milk look the same as proteins in our own bodies; these similarities can confuse our immune system and initiate an inappropriate (autoimmune) response that can lead to diabetes.

The milk protein casein is similar in shape to the insulin-producing cells in the pancreas. Because the body may perceive casein as a foreign invader and attack it, it may also start to attack the pancreas cells having confused them for casein, again leading to diabetes (Cavallo *et al.*, 1996). Some studies have suggested that bovine serum albumin (BSA) is the milk protein responsible. In a study of 142 children with type 1 diabetes, all the diabetic patients had higher serum concentrations of anti-BSA antibodies compared to 79 healthy children (Karjalainen *et al.*, 1992). These antibodies may react with proteins on the surface of the beta cells of the pancreas and so interfere with insulin production.

Other studies suggest it is the cow's insulin present in formula milk that increases the risk of type 1 diabetes in infants (Vaarala *et al.*, 1999). Research shows that some infants may be more vulnerable to type 1 diabetes later in life if exposed to cow's milk formula while very young. A Finnish study of children (with at least one close relative with type 1 diabetes) examined whether early exposure to insulin in cow's milk formula increased the risk of type 1 diabetes. Results showed that infants given cow's milk formula at three-months-old had immune systems which reacted far more strongly to cow's insulin (Paronen *et al.*, 2000). This raises concerns that exposure to cow's insulin plays a role in the autoimmune process leading to type 1 diabetes.

A review of the clinical evidence suggests that the incidence of type 1 diabetes is related to the early consumption of cow's milk; children with type 1 diabetes are more likely to have been breast fed for less than three months and to have been exposed to cow's milk protein before four months of age (Gerstein *et al.*, 1994). The avoidance of cow's milk during the first few months of life may reduce the risk of type 1 diabetes. Infants who cannot breast feed from their mothers may benefit more from taking a plant-based formula such as soya-based formula rather than one based on cow's milk. Other studies support the finding that both early and adolescent exposure to cow's milk may be a trigger for type 1 diabetes (Kimpimaki *et al.*, 2001; Thorsdottir and Ramel, 2003).

Taken together, the evidence suggests that avoiding milk and milk products may offer protection from diabetes (types 1 and 2).

Dementia

Obesity is epidemic in Western societies and constitutes a major public health concern. A recent study published in the *British Journal of Medicine* reports that being obese during middle-age can increase the risk of developing dementia later in life (Whitmer *et al.*, 2005). The research is based on data collected from detailed health checks made on 10,276 men and women between 1964 and 1973 (when they were aged 40 to 45). Dementia was diagnosed in seven per cent of participants between 1994 and 2003. Results showed that being obese increased the risk of dementia by 74 per cent while being overweight increased it by 35 per cent. The link between obesity and dementia in women was stronger than that in men. This is in agreement with a Swedish study which found that the higher a woman's body mass index (BMI), the greater the risk of dementia (Gustafson *et al.*, 2003). In this study the relationship between BMI and dementia risk was investigated in 392 Swedish adults who were assessed between the ages of 70 and 88. During the 18-year study, 93 participants were diagnosed as having dementia. Women who developed dementia had a higher average BMI compared to women without dementia. For every one unit increase in BMI at age 70 years, the risk of dementia increased by 36 per cent. This raises concerns that the current obesity epidemic could lead to a steep rise in the numbers of people suffering from dementia in the future. The evidence suggests that leading a healthy lifestyle could help to reduce the risk of dementia (See Overweight and obesity, page 55).

Ear infection

The most common type of ear infection (*otitis media*) affects the middle ear, the space between the eardrum and the inner ear. The middle ear is usually filled with air but it can fill up with fluid (during a cold for example) and ear infections happen when bacteria, viruses or fungi infect the fluid and cause swelling in the ear. Ear infections are common in childhood and can be extremely painful, causing a considerable amount of distress. Chronic *otitis media* is when ear infections keep recurring, for example Glue ear is a type of chronic *otitis media*. Ear infection is the most common health problem doctors see in young children with around one in 10 children having an ear infection by the time they are three months old (NHS Direct, 2005). It can be a serious problem; *otitis media* is the most common cause of hearing loss in children today (Bernstein, 1993).

Ear infections are often linked to colds or other problems of the respiratory system. However, recent reports link ear infections to food allergies (Hurst, 1998; Aydogan *et al*., 2004; Doner *et al*., 2004). Researchers from Georgetown University in the US examined the role of food allergy in ear infection in 104 children with recurrent ear problems (Nsouli *et al*., 1994). The children were tested for food allergies and those who tested positive excluded that particular food for 16 weeks, then reintroduced it. Results showed that 78 per cent of the children with ear problems also had food allergies, the most common allergenic foods were cow's milk (38 per cent), wheat (33 per cent), egg white (25 per cent), peanut (20 per cent) and soya (17 per cent). 86 per cent of these children responded well to eliminating the offending food, and of these, 94 per cent suffered a recurrence of ear problems on reintroducing the offending food.

A different approach was taken in a Finnish study of 56 children with cow's milk allergy and 204 children without cow's milk allergy. These researchers examined the occurrence of ear infection in children known to have cow's milk allergy. Results showed that 27 per cent of those with the allergy suffered from recurrent ear infections compared to just 12 per cent of those who did not have the allergy (Juntti *et al*., 1999). It was concluded that children with cow's milk allergy experience significantly more ear infections.

Dr John James of the Colorado Allergy and Asthma Centres in the US suggests that food allergies can cause inflammation in the nasal passages and lead to the build up of fluid in the middle ear, but he acknowledges that the link between food allergy and ear infection may be hard to prove (James, 2004). The possibility of cow's milk allergy should be considered in all cases of ear infection, particularly in children.

Food poisoning

Food poisoning is a common, often mild, but sometimes deadly illness (NHS, 2006). It is caused by the consumption of food or drink that is contaminated with bacteria, parasites or viruses. Most cases result from bacterial contamination. Food poisoning happens in one of two ways: either in the food (for example in undercooked meat or unpasteurised milk), or on the food (if it is prepared by someone who has not washed their hands). The length of the incubation period (the time between swallowing the bacteria and symptoms appearing) varies from hours to days, depending on the type of bacteria and how many were swallowed. The most common symptoms of food poisoning are sickness, vomiting, abdominal pain and diarrhoea. According to the Food Standards Agency, it is estimated that over five million people in the UK are affected by food poisoning each year (NHS Direct, 2006). It usually lasts for less than three days, but can continue for up to a week. The greatest danger lies in the loss of fluids and salts from prolonged diarrhoea. The results can be deadly in infants and over 60s. Also, in these patients, the bacteria may enter the bloodstream infecting other parts of the body and may cause death unless the person is treated promptly with antibiotics.

Most cases of food poisoning are related to the consumption of animal products (meat, poultry, eggs, fish and dairy) as plants tend not to harbour the types of bacteria capable of causing food poisoning in humans. Intensive animal husbandry technologies, introduced to minimise production costs, have led to the emergence of new zoonotic diseases – animal diseases that can be transmitted to humans (WHO, 2006b). *Escherichia coli* (*E. coli*) O157 was identified for the first time in 1979 and has since caused illness and deaths (especially among children) owing to its presence (in several countries) in minced beef, unpasteurised cider, cow's milk, manure-contaminated lettuce and alfalfa and manure-contaminated drinking-water (WHO, 2006b). In a joint report between the FSA Scotland and the Scottish Executive it was noted that the main source of *E. coli* O157 is from cattle and sheep, but that more cases of *E. coli* O157 are now associated with environmental contamination, including contact with animal faeces or contamination by faeces of water supplies, than with food (FSA/SE, 2001). If plants do cause food poisoning it is generally because they have been contaminated with animal excreta, human sewerage or handled with dirty hands during preparation. Safe disposal of manure from large-scale animal and poultry production facilities is a growing food safety problem in much of the world (WHO, 2006b).

The most common cause of food poisoning in the UK is the bacterium *Campylobacter*, which has been found in poultry, unpasteurised milk, red meat and untreated water. The next most common cause is *Salmonella*, which has been found in unpasteurised milk, eggs, meat and poultry (NHS Direct, 2005). *Salmonella* causes the greatest number of deaths: 119 deaths England and Wales in 2000 (POST, 2003). In a small number of cases, people infected with *Salmonella* will go on to develop pains in their joints, irritation of the eyes and painful urination; this is called Reiter's syndrome and can last for months or years and may lead to chronic arthritis (Centers for Disease Control and Prevention, 2006). *Listeria*, sometimes found in soft cheeses and pates, can cause severe illness (listeriosis) in vulnerable groups such as pregnant women, babies, the elderly and people with reduced immunity. The Government advises pregnant women to avoid soft mould-ripened cheese, such as Camembert and Brie, blue cheese and all types of meat pâté. Other bacteria that can cause food poisoning include species of *Staphylococcus* and *Clostridium*. Certain strains of otherwise normal intestinal bacteria can cause food poisoning. For example, *E. coli* is usually harmless but the strain *E. coli* O157 can cause kidney failure and death.

The majority of food poisoning cases in the UK are caused by consuming contaminated meat or dairy products. For example, of the *Staphylococcal* food poisonings reported in the UK between 1969 and 1990, 53 per cent were due to meat products (especially ham), 22 per cent were due to poultry, eight per cent were due to milk products, seven per cent to fish and shellfish and 3.5 per cent to eggs (Wieneke *et al.*, 1993).

While most cases of food poisoning are associated with meat and poultry, the link between milk products and food poisoning should not be discounted: 20 separate outbreaks of food poisoning in England and Wales associated with the consumption of milk and dairy products were reported to the Public Health Laboratory Service Communicable Disease

Surveillance Centre between 1992 and 1996 (Djuretic *et al*., 1997). 600 people were affected and over 45 were admitted to hospital. *Salmonella* species were responsible for 11 of the outbreaks, *Campylobacter* species for five, *E. coli* O157 for three and *Cryptosporidium parvum* for one. Outbreaks were associated with hotels, a psychogeriatric hospital, schools, a Royal Air Force base, a farm visit, an outdoor festival and milk supplied directly from farms. Milk was implicated in 16 of the outbreaks, 10 of which were associated with unpasteurised milk. Two outbreaks were associated with eating contaminated ice-cream and two with eating contaminated cheese.

Food poisoning may result from milk and milk products if they have not been properly heated (pasteurised) or if they have become contaminated following pasteurisation. A report published in the *New England Journal of Medicine* reported how 142 cases of listeriosis in Los Angeles in 1985 led to 48 deaths (Linnan, 1988). An extensive investigation traced the source to a cheese factory where it was found that a Mexican-style soft cheese had been contaminated with unpasteurised milk.

Bacteria are too small to see and they do not taste or smell of anything so it is difficult to detect their presence. The risk of food poisoning can be minimised by following some basic hygiene rules. This means washing hands before handling food, washing salads thoroughly (to remove contaminating bacteria from manure for example), making sure all food is covered and chilled. If meat is to be consumed it must be thawed and cooked properly to kill harmful bacteria. It is important to keep raw meat (and its juices) away from other foods. Avoiding unpasteurised milk, raw eggs and undercooked meat further reduces the risk of food poisoning. Of course the safest option is to follow a plant-based diet free of red meat, poultry, fish, milk and eggs. Excluding animal foods from the diet will dramatically decrease the risk of food poisoning.

Gallstones

Gallstones are solid pieces of stone-like material that form in the gall bladder, which is a small organ on the right hand side of the body, below the liver. It stores a green liquid called bile, which is produced by the liver to help the body digest fats. As we eat, bile is released from the gall bladder into the intestines through a thin tube called the bile duct.

Gallstones are formed when some of the chemicals stored in the gall bladder harden into a solid mass. They may be as small as a grain of sand or as large as a golf ball. Some people may have one large stone while others may have many small ones. About one in 10 people over 50 in the UK have gallstones.

Gallstones are made up from a mixture of water, cholesterol and other fats, bile salts and the pigment bilirubin. They occur when the composition of the bile is abnormal, the outlet from the gall bladder is blocked (perhaps by infection), or if there is a family history of gallstones. Gallstones can cause inflammation of the gall bladder (cholecystitis), which may then block the bile duct leading to obstructive jaundice. The passage of a gallstone along the bile duct to the duodenum can be extremely painful.

Obesity is a major risk factor for gallstones, especially in women, who are twice as likely as men to develop gallstones. Risk increases with age; people over 60 are at a higher risk. Diet is also a causal factor. A study published in the *British Medical Journal* in 1985 reported that meat-eaters are twice as likely to develop gallstones as vegetarians (Pixley *et al*., 1985). Since then the low incidence of gallstones in vegetarians compared to meat-eaters has been well documented (Key *et al*., 1999). Indeed vegetarian diets have been shown to be beneficial for both the prevention and treatment of gallstones (Leitzmann, 2005). The main risk factors appear to be low fibre intake, high saturated fat and cholesterol intake and obesity. A recent Australian study reported an inverse association between dietary fibre and gallstones (Segasothy and Phillips, 2000). In other words, the more fibre in the diet, the lower the risk of gallstones. Polish researchers examined the diets of patients suffering from gallstones and found that they were characterised by their low fibre diet (Ostrowska *et al.*, 2005). Patients with gallstones ate less wholemeal products, fruit and vegetables and pulses. Furthermore, obese women with gallstones ate significantly more milk, yogurt, meat and meat products.

It is important is to eat as healthily as possible. If you are overweight, losing some weight may help. A well-balanced diet, which includes vegetables, fruit, and whole wheat cereals including bread and is low in animal fat, is considered the best for most people (British Liver Trust, 2005).

Insulin-like growth factor 1 (IGF-1)

Insulin-like growth factor 1 (IGF-1) is a hormone produced in the liver and body tissues of mammals. One important role for IGF-1 is to promote cell growth and division, this is important for normal growth and development. IGF-1 from cows is identical to human IGF-1 in that the amino acid sequence of both molecules is the same (Honegger and Humbel, 1986). Amino acids are the building blocks of proteins and there are 20 different amino acids. All proteins consist of amino acids joined together like beads on a string and the nature of the protein (how it behaves) is determined by the order in which the amino acids occur along the string. In both human and bovine IGF-1 the same 70 amino acids occur in exactly the same order, which would suggest that bovine IGF-1 behaves the same way in humans as it does in cows. As previously stated, the use of recombinant bovine somatotrophin (rBST) in cows increases levels of IGF-1 in their milk, however, it should be noted that cow's milk from cows that are not treated with rBST also contains IGF-1.

It has been suggested that IGF-1 is not destroyed during pasteurisation. Furthermore it has also been suggested that it is not completely broken down in the gut and that it may cross the intestinal wall in the same way that another hormone, epidermal growth factor (EGF), has been shown to do. EGF is protected from being broken down when food proteins (such as the milk protein casein) block the active sites of the digestive enzymes (Playford *et al.*, 1993). This allows the molecule to stay intact and cross the intestinal wall and enter the blood. This raises concerns that IGF-1 from cow's milk could increase normal blood IGF-1 levels and so increase the risk of certain cancers linked to IGF-1.

As stated, IGF-1 regulates cell growth, development and division; it can stimulate growth in both normal and cancerous cells. Even small increases in serum levels of IGF-1 in humans are associated with increased risk for several common cancers including cancers of the breast, prostate, lung and colon (Wu *et al.*, 2002). The link between IGF-1 and cancer is becoming increasingly apparent in the scientific literature.

In the first prospective study to investigate the relationship between the risk of breast cancer and circulating IGF-1 levels, researchers at Harvard Medical School analysed blood samples originally collected from 32,826 women aged between 43 and 69 years during 1989 and 1990. From this group, 397 women were later diagnosed with breast cancer. Analysis of IGF-1 levels in samples collected from these women compared to samples from 620 controls (without breast cancer) revealed a positive relationship between circulating IGF-1 levels and the risk of breast cancer among premenopausal (but not postmenopausal) women. It was concluded that plasma IGF-1 concentrations may be useful in the identification of women at high risk of breast cancer (Hankinson *et al.*, 1998a).

To investigate the link between prostate cancer risk and plasma IGF-1 levels, a study was conducted on 152 men with prostate cancer and 152 men without the disease. Analysis revealed a strong positive association between IGF-1 levels and prostate cancer risk (Chan *et al*., 1998). In agreement, a Swedish study compared IGF-1 levels in 210 prostate cancer patients with those in 224 men without the disease and found that there was a strong positive correlation between the risk of prostate cancer and raised serum levels of IGF-1. It was concluded that high levels of IGF-1 may be an important predictor for risk of prostate cancer (Wolk *et al*., 1998).

In a study into the link between the risk of lung cancer and IGF-1, serum IGF-1 levels were measured in 204 lung cancer patients registered at the University of Texas M.D. Anderson Cancer Centre and compared to those in 218 people without lung cancer. Results showed that high levels of IGF-1 were associated with an increased risk of lung cancer (Yu *et al*., 1999).

In order to assess colorectal cancer risk in relation to IGF-1, a research group at Harvard Medical School analysed blood plasma samples originally collected from a pool of 14,916 men. In a 14-year follow-up of these men, 193 had been diagnosed with colorectal cancer. Analysis of IGF-1 levels in samples taken from these men and 318 controls revealed an increased risk for colorectal cancer among the men who had the highest levels of circulating IGF-1 and it was concluded that circulating IGF-1 is related to future risk of colorectal cancer (Ma *et al*., 1999).

In summary, the literature strongly supports a link between high circulating IGF-1 levels and cancer, but what has this to do with the consumption of cow's milk and dairy products? The answer is a lot: circulating IGF-1 levels are higher in people who consume milk and dairy products. Researchers at Bristol University investigating the association of diet with IGF-1 in 344 disease-free men found that raised levels of IGF-1 were associated with higher intakes of milk, dairy products and calcium while lower levels of IGF-1 were associated with high vegetable consumption, particularly tomatoes. In their study, published in the *British Journal of Cancer*, it was concluded that IGF-1 may mediate some diet-cancer associations (Gunnell *et al*., 2003).

US researchers from Harvard Medical School and Bringham and Women's Hospital in Boston also investigated the link between IGF-1 levels and diet. They examined circulating IGF-1 levels in 1,037 healthy women. The most consistent finding was a positive association between circulating IGF-1 and protein intake; this was largely attributable to cow's milk intake (Holmes *et al*., 2002). In another study, researchers at the Fred Hutchinson Cancer Research Centre in Washington investigated the link between plasma levels of IGF-1 and lifestyle factors in 333 people thought to be representative of the general population. They too found that milk consumption was linked to IGF-1 levels (Morimoto *et al*., 2005). One study actually quantified the effect of cow's milk on circulating IGF-1 levels in 54 Danish boys aged 2.5 years. In this study an increase in cow's milk intake from 200 to 600ml per day corresponded to a massive 30 per cent increase in circulating IGF-1. It was concluded that milk contains certain compounds that stimulate IGF-1 concentrations (Hoppe *et al*., 2004). Cow's milk contains many other bioactive compounds such as hormones and cytokines, growth factors, and many bioactive peptides (Playford *et al*, 2000), which may also affect IGF-1 levels.

In conclusion, the research shows that nutrition has an important role in determining serum IGF-1 levels (Yaker *et al*., 2005). Whether the increase in IGF-1 caused by cow's milk occurs directly (by IGF-1 crossing the gut wall), or indirectly (as a result of the action of other factors), the research is clear. The consumption of cow's milk and milk products is linked to increased levels of IGF-1, which in turn are linked to various cancers.

Kidney disease

The kidneys are two bean-shaped organs located in the lower back. Kidneys filter the blood to remove unwanted waste products broken down from our food and drink. They also remove excess liquid to help maintain correct fluid balance in the body.

There are many diseases and conditions that can affect the kidney function: kidney inflammation (glomerulonephritis); kidney infection (such as pyelonephritis); genetic disorders (such as polycystic kidney disease); hardening of the kidney due to a disease of the arteries (nephrosclerosis); kidney failure due to atherosclerosis (plaques forming in the arteries supplying the kidneys); autoimmune diseases (such as systemic lupus erythematosus); malaria; yellow fever; certain medicines; mechanical blockages (kidney stones) and physical injury.

Surveys have revealed that mild forms of kidney disease are surprisingly common among the general population. The global epidemic of type 2 diabetes has led to an alarming increase in the number of people with chronic kidney disease. Global estimates of people suffering with chronic kidney disease lie at over 50 million, of which one million experience kidney failure every year (Dirks *et al*., 2005). There may be no apparent symptoms, although small amounts of blood or protein may pass through the damaged filters in the kidneys into the urine. Such small amounts of blood and protein in the urine are not visible but can be detected by certain medical tests.

Normally protein is filtered out by the kidneys and no protein is excreted into the urine. However, when the kidneys are damaged, protein may pass into the urine. Other symptoms include retention of water in the body, called nephrotic syndrome. In some cases the damage to the kidney can be so severe that it leads to a build up of waste in the body and ultimately kidney failure. The symptoms of kidney failure include tiredness, sickness and vomiting.

Certain kidney disorders can lead to the formation of a kidney stone (renal calculi), a small hard mass in the kidney that forms from mineral deposits in the urine. Stones may form when there is a high level of calcium, oxalate or uric acid in the urine; a lack of citrate in the urine; or insufficient water in the kidneys to dissolve waste products.

Traditionally, a low-calcium diet has been recommended to reduce the strain on the kidneys in kidney stone patients. However, over time a low-calcium diet can cause problems in terms of bone health. In the last decade, attention has switched to the effects of animal protein on kidney stone formation. Several studies now suggest that a diet characterised by normal-calcium, low-animal protein and low-salt levels is more effective than the traditional low-calcium diet for the prevention of kidney stones in some people.

The relationship between an animal protein-rich diet and kidney stone formation was investigated by researchers at the Centre in Mineral Metabolism and Clinical Research at the Department of Internal Medicine in Dallas, Texas (Breslau, 1988). In this study, 15 young healthy participants were studied for three 12-day dietary periods during which their diet contained vegetable protein, vegetable and egg protein, or animal protein. While all three diets were constant with respect to sodium, potassium, calcium, phosphorus, magnesium and the total quantity of protein, they had progressively higher sulphur contents (due to the increased sulphur content of animal proteins compared to that of plant proteins). As the sulphur content of the diet increased, urinary calcium excretion increased from 103mg per day on the vegetarian diet to 150mg per day on the animal protein diet. The animal protein-rich diet was associated with the highest excretion of uric acid and therefore conferred an increased risk for uric acid stones (but not for calcium oxalate stones). The link between animal protein and kidney stone formation has since been demonstrated in both men (Curhan *et al.*, 1993; Taylor *et al.*, 2004) and women (Curhan *et al.*, 1997).

Dr Neil Barnard, president of the PCRM, states that animal protein is the worst kind of enemy of people with a tendency towards kidney stones or any kidney disease (Barnard, 1998). The animal protein in red meat, poultry, fish, eggs and milk tend to overwork the kidneys causing their filtering abilities to decline. This may make matters worse in a person who already has kidney disease. Additionally, animal protein causes calcium to be leached from the bones and excreted in the urine, adding further to the burden on the overworked kidney.

A report published in the *Lancet* in 1992 suggested that soya products may be beneficial in kidney disease. Kidney disease patients with protein in the urine and high cholesterol levels were placed on a cholesterol-free, low-protein, low-fat, high-fibre vegetarian (vegan) diet containing soya products. The amount of protein excreted in the urine dropped considerably as did their blood cholesterol levels (D'Amico *et al.*, 1992). It was uncertain whether these results reflected the reduction in dietary protein and fat or if the favourable results arose from a change in the nature of the food consumed. Either way, switching from a diet containing meat and dairy products to a plant-based diet containing less fat and protein and more fibre was beneficial to patients with kidney disease.

In addition to avoiding animal protein in the diet, increasing the potassium intake has been shown to yield benefits as potassium reduces calcium excretion, which can decrease the risk of stone formation. Additionally, the beneficial effect of increasing the fluid intake and the subsequent dilution of urine is well known (Curhan *et al.*, 1993).

Lactose intolerance

Most people in the world are unable to consume cow's milk and milk products after weaning because they are unable to digest the sugar in milk called lactose. This sugar only exists in mammals' milk, including human breast milk. In order for lactose to be digested it must be broken down (to glucose and galactose) in the small intestine by the enzyme lactase. Most infants possess the enzyme lactase and can therefore digest lactose, but this ability is lost in many people after weaning, commonly after the age of two. This makes sense as no other mammal consumes milk after weaning. In the absence of lactase, lactose is fermented by bacteria in the large intestine, which leads to a build up of gas. Symptoms of lactose intolerance include nausea, cramps, bloating, wind and diarrhoea and usually appear within two hours of consuming food containing lactose. The symptoms of lactose intolerance and irritable bowel syndrome (IBS) are very similar, so misdiagnosis between the two conditions can occur.

Most infants are born with the ability to digest lactose but over time this ability decreases. There are other, more uncommon, causes of lactose intolerance including injury to the mucus membrane of the small intestine and digestive diseases of the small intestine such as ulcerative colitis and Crohn's disease.

Lactose intolerance varies widely between different ethnic groups:

95 per cent of Asian people
75 per cent of Afro-Caribbean people
50 per cent of Mediterranean people

10 per cent of northern European people
Source NHS Direct, 2005.

Lactose intolerance occurs in as few as just two per cent of some northern European populations and as many as 100 per cent of adult Asian populations (Swagerty *et al.*, 2002). This widespread variation suggests that lactase deficiency is the normal or natural state and that the ability to digest lactose originates from a genetic mutation that provided a selective advantage to populations using dairy products (Swagerty *et al.*, 2002). This idea is supported by William Durham in his book *Coevolution* (Durham, 1991). Durham describes milk as baby food not 'intended' for adult consumption. He describes how the ability to digest lactose is the exception to the norm and can originally be traced back to a minority of pastoral tribes: the Tutsi and Hutu of Rwanda; the Fulani of West Africa; the Sindhi of North India; the Tuareg of West Africa and some European tribes. People who have retained the normal intolerance of lactose include: Chinese, Japanese, Inuit, native Americans, Australian Aborigines, Iranians, Lebanese and many African tribes including the Zulus, Xhosas and Swazis. These people, generally, do not have a history of pastoralism.

In conclusion, drinking cow's milk is neither normal nor natural. The health implications of being the only mammal to consume milk as adults (and not just that, milk from another species too) are becoming clearer in the scientific literature as levels of the so-called diseases of affluence soar.

The treatment for lactose intolerance is straightforward: avoid lactose. This means cutting out all dairy foods and checking labels for lactose in bread, chocolate and other processed foods.

Migraine

A migraine is much more than a bad headache; unless you suffer from them it is difficult to appreciate just how debilitating a migraine can be. Often people with a migraine can do nothing but lie quietly in a darkened room waiting for the pain to pass. The pain is excruciating, often accompanied by nausea, vomiting and an increased sensitivity to light and sound. A migraine can last for a few hours or a few days. Migraines occur more commonly in women than men and usually affect people in their teenage years up to around 40 years of age, although they do sometimes occur in children. It is estimated that almost six million people in the UK are affected by migraine.

A range of common factors that can cause migraines in some people have been identified. Foods are frequently identified as triggers and the most common culprits include dairy products (particularly cheese), chocolate, alcohol (particularly red wine), caffeine, citrus fruits, nuts, fried foods and foods containing monosodium glutamate (MSG) such as Chinese food, processed meats and frozen pizzas (NHS Direct, 2005). Other triggers include cigarette smoke, bright lights, hunger, certain drugs (such as sleeping tablets and the combined oral contraceptive pill), loud noises, strong smells, neck and back pain, stress and tiredness (NHS Direct, 2005). All these and others can lead to a migraine, and some people may experience a migraine following any one or a combination of these factors.

The national medical charity Allergy UK lists cheese (particularly Stilton, Brie, Camembert and Emmenthal) as the third commonest cause of food-induced migraine after alcohol and chocolate. They suggest that 29 per cent of food-induced migraines are caused by alcohol, 19 per cent by chocolate, 18 per cent by cheese and 11 per cent by citrus foods. Other foods thought to trigger migraine include fried and fatty foods, onions, pork, pickled herring and yeast extract (Allergy UK, 2005).

In a study at Great Ormond Street Children's Hospital in London, 88 children with severe and frequent migraines were treated with a diet that eliminated many foods linked to migraine, 93 per cent of the children responded well to the diet and were free of headaches (Egger *et al.*, 1983). Foods were gradually reintroduced to identify those most likely to provoke a migraine. Top of the list was cow's milk, followed by chocolate (containing cow's milk), the food preservative benzoic acid, eggs, the synthetic yellow food colouring agent tartrazine, wheat, cheese, citrus, coffee and fish. Interestingly, children who had initially developed a migraine in response to factors other than food (for example flashing lights or exercise) no longer responded to these triggers while on the special elimination diet.

The relationship between food allergy or intolerance and migraine is difficult to prove and, despite the evidence, remains a controversial subject. However, the possibility of cow's milk allergy or intolerance should be considered in all cases of migraine.

Multiple sclerosis and autoimmunity

Multiple sclerosis (MS) is the most common disease of the central nervous system (the brain and spinal cord) affecting young adults in the UK. MS currently affects around 85,000 people in the UK and twice as many women as men have MS. Although it usually occurs in young adults in their twenties and thirties, MS can occur in older people. It is rarely diagnosed in children and teenagers.

Sclerosis means scarring and multiple refers to the different sites at which the scarring can occur throughout the brain and spinal cord. In MS the protective sheath (myelin) that surrounds the nerve fibres of the central nervous system becomes damaged. When myelin is damaged (demyelination) the messages between the brain and other parts of the body become disrupted. Myelin protects the nerve fibres in much the same way that household electrical wires are protected by an insulating cover. If this cover becomes damaged the normal signalling route becomes disrupted and may result in a short-circuit. The severity of the symptoms depends on how much damage has occurred to the central nervous system. For some people there may be periods of relapse where there are few symptoms, then times when the symptoms become more severe including blurred vision, paralysis, slurred speech, lack of coordination and incontinence.

The cause of MS is not yet fully understood but is thought to be an autoimmune disease whereby the body's immune system attacks its own tissues. As with other autoimmune diseases, it is thought that a combination of genetic factors and environmental triggers cause the disease. Environmental triggers may include viruses, components of the diet or stress. Interestingly, the incidence of MS increases the further you get from the equator, whether going north or south. For example, MS is five times more common in temperate zones than in the tropics (NHS Direct, 2005). Campbell suggests that MS is over 100 times more prevalent in the far north than at the equator (Campbell and Campbell, 2005). In Australia the incidence of MS decreases seven-fold as you move towards the equator from the south to the north (Campbell and Campbell, 2005). This geographical distribution pattern applies to other autoimmune diseases including type 1 diabetes and rheumatoid arthritis (Campbell and Campbell, 2005).

Indeed, this phenomenon has been noted since 1922 (Davenport, 1922). Campbell suggests in his book *The China Study* that autoimmune diseases should be considered as a group rather than as individual diseases as they share similar clinical backgrounds and sometimes occur in the same person or among the same populations (Campbell and Campbell, 2005).

The research investigating the links between diet and MS date back over 50 years to Dr Roy Swank's work first at the Montreal Neurological Institute in Norway, then at the Division of Neurology at the University of Oregon Medical School in the US. Swank was intrigued by the geographical distribution of MS and thought it may be due to dietary practices. Swank suspected animal foods high in saturated fats may be responsible as MS seemed to occur most among inland dairy-consuming populations and less among coastal fish-eating populations. Perhaps his best known trial was that published in the *Lancet* in 1990. In this study Swank followed 144 MS patients for a total of 34 years. Swank prescribed a low-saturated fat diet to all the participants but the degree of adherence to the diet varied widely. He observed how their conditions progressed. Results showed that for the group of patients who began the low-saturated fat diet during the earlier stages of MS, 95 per cent survived and remained physically active for approximately 30 years. In contrast, 80 per cent of the patients with early-stage MS who did not adhere to the diet died of MS (Swank and Dugan, 1990). It was concluded that saturated animal fats increase the risk of MS.

More recent studies have extended Swank's findings and revealed a positive correlation between the consumption of cow's milk and the incidence of MS. This later research suggests that there could be a combination of predisposing or precipitating factors involved in the aetiology of MS, and that environmental factors, such as the consumption of cow's milk, play a part (Agranoff *et al.*, 1974; Butcher, 1976). These and more recent studies suggest that cow's milk may contain some component other than saturated fat that influences the incidence of MS. For example, it has been suggested that this factor or environmental trigger may be a virus (Malosse *et al.*, 1992).

You are more likely to get MS if other people in your family have it (especially a brother or sister). This shows that there is an element of genetic predisposition in this disease. However, twin studies have shown that only about a quarter of identical twins with MS have a twin with the disease (Willer *et al.*, 2003). In other words for every four genetically identical sets of twins (one of whom has MS) one other twin will have the disease and three will not. If genes were solely responsible for MS, the genes that cause MS in one twin would also cause it in the other. When considering the role of genetics in a disease, it is useful to look at what happens to the risk of that disease in migrating populations. As for cancer, heart disease and type 2 diabetes, people tend to acquire the MS risk of the population to which they move, especially if they move early in life. This shows that MS is more strongly related to environmental factors and diet than genes.

While the benefits of excluding milk from the diet may not have been directly proven for MS sufferers, there is evidence that a high intake of saturated fat increases the incidence of this disease. Others studies suggest that increasing the intake of unsaturated fatty acids (such as linoleic acid), vitamin D and antioxidants may be helpful (Schwartz *et al.*, 2005). The overall message is clear: a plant-based diet low in fat, salt and sugar (and processed foods) and high in fresh fruits, vegetables, whole grains, pulses, nuts and seeds can provide all the nutrients required for good health and reduce some of the risk factors for MS or prevent making an already existing condition worse.

As the incidence of most autoimmune diseases correlates directly to the consumption of animal foods, this approach could help prevent other autoimmune conditions that occur increasingly among populations that consume high levels of dairy and meat products.

Overweight and obesity

Most people know what the term obesity means: an increased body weight caused by the excessive accumulation of fat.

Overweight and obesity occur when more calories are taken into the body than are burnt up over time. In other words, if you don't burn up the energy you consume it will be stored as fat, and over time this may lead to excessive weight gain and obesity. So someone who works in a very physically demanding job, such as a building-site labourer, may need between 4,000 and 5,000 calories per day to maintain their normal weight. Whereas an office worker who drives to work and does not take any exercise may only need 1,500 calories per day (NHS Direct, 2005).

Another way of defining obesity is to measure your body mass index (BMI). This is your weight in kilograms divided by the square of your height in metres. There are many websites that can do conversions and calculations for you (see Appendix II, page 68). In England, people with a body mass index between 25 and 30 are categorised as overweight, and those with an index above 30 are categorised as obese. The Food Standards Agency's BMI calculator describes 18.5 to 25 as healthy and suggests that a BMI of less than 18.5 is underweight (FSA, 2006). The average BMI of an adult in Africa and Asia falls between 22 and 23, whereas in North America and Europe the average BMI is much higher ranging from 25 to 27 (WHO, 2006d). In 2004 the FSA reported that the number of obese adults in the UK has risen considerably since the last survey in 1987; numbers of obese men have risen from eight per cent to 25 per cent and women from 12 per cent to 20 per cent (FSA, 2004). This survey showed that the level of obesity in men has risen faster than those of women. In addition, the FSA survey reported that 41 per cent of men and 33 per cent of women were found to be overweight.

The main causes of obesity include an excessive intake of food coupled to a lack of exercise and a sedentary lifestyle. Other much less frequent causes include a genetic predisposition or an underlying illness (such as hypothyroidism). The British Medical Association (BMA) warns that childhood obesity levels have soared in the UK over recent years. In 2002 in the UK, 22 per cent of boys and 28 per cent of girls aged between two and 15 were either overweight or obese (BMA, 2005). The BMA attribute this rise to the fact that children are eating too much for the amount of physical activity they undertake. This is very worrying as early childhood obesity tends to indicate adult obesity which can lead to serious health risks later in life. Obesity is a known risk factor for many illnesses including type 2 diabetes, heart disease, hypertension, stroke, gall bladder disease and certain forms of cancer especially the hormonally related and large-bowel cancers.

The WHO suggests that as the degree of affluence increases, diets high in complex carbohydrates give way to diets high in saturated fats and sugars (WHO, 2006d). This combined with a shift towards less physically demanding work, an increasing use of automated transport, technology in the home and more passive leisure pursuits means that we are less active than our parents and our grandparents.

The WHO suggests several ways to lose weight including eating more fruit, vegetables, nuts and whole grains; engaging in daily moderate physical activity for at least 30 minutes; cutting the amount of fatty, sugary foods in the diet and moving from saturated animal-based fats to unsaturated vegetable-oil based fats (WHO, 2006d). Whole milk, cheese, cream, butter, ice-cream and most other dairy products, apart from skimmed and non-fat products, contain significant amounts of saturated fat and cholesterol. While we do need a certain amount of fat in the diet there is no nutritional requirement for saturated fat. Cow's milk is high in the unhealthy saturated fats and low in the healthy polyunsaturated essential fatty acids, which are required in the diet for good health. Most people eat much more fat than they need, and making minor changes to the diet (cutting down on fat) can make a big difference over time.

A number of small-scale studies (of less than 35 obese adults) have suggested that the consumption of dairy products may actually help people lose weight (Zemel *et al.*, 2004; Zemel *et al.*, 2005). In these studies Professor Zemel, who has received a considerable amount of funding from the National Dairy Council (COS, 2005), suggests that diets containing calcium from dairy foods might affect fat cell metabolism in such a way that greater weight loss can occur despite an identical calorie intake with a control group not consuming so much dairy. Interestingly, a subsequent study (by a research group including Zemel but not as the first named author) found no evidence that a diet high in dairy products enhances weight loss (Thompson *et al.*, 2005).

Dr Amy Joy Lanou, the nutrition director of the PCRM, warns that care should be taken when interpreting the findings from Zemel's trials. Furthermore, Lanou suggested that the US National Dairy Council's claims promoting dairy consumption for weight loss went well beyond Zemel's findings. Lanou suggests that it was likely that calorie restriction, not dairy consumption, caused the weight loss reported in these studies (Lanou, 2005).

In June 2005 the PCRM decided enough was enough and filed two separate lawsuits to stop the multimillion-dollar advertising campaign claiming that milk facilitates weight loss. The PCRM filed one lawsuit to the US Food and Drugs Administration and the other to the US Federal Trade Commission. In the lawsuit the PCRM charged the National Dairy Council, the International Dairy Foods Association, Dairy Management Incorporated, Dannon Company, Kraft Foods and other dairy manufacturers with purposefully misleading customers (PCRM, 2005).

Despite the dairy industry's claims, scientific studies show that adding dairy products to the diet does not help control weight; in fact the research confirms that in many cases the reverse is true, consuming milk and dairy foods can lead to weight gain. Some studies designed to test the effects of dairy consumption on weight found no difference in weight between groups consuming relatively large amounts of dairy foods compared to groups consuming little (Lappe *et al.*, 2004; Gunther *et al.*, 2005). Another study, this time of the effects of just calcium supplementation on weight loss in women who had recently given birth, found no relationship between calcium supplementation and weight loss (Wosje, 2004). Researchers at the University of British Columbia in Vancouver, Canada, who reviewed the scientific literature on the effects of dairy products or calcium supplements on body weight found that out of nine studies on dairy products, seven showed no significant difference while two studies linked weight gain to dairy consumption (Barr *et al.*, 2003). Furthermore, out of 17 studies on calcium supplementation, just one reported weight loss.

A recent large scale study that followed over 12,000 children for three years concluded that the children who drank the most milk gained the most weight (Berkey *et al.*, 2005). The analyses showed that out of milk, calcium, dairy fat and total energy intake, it was energy intake that was the most important predictor of weight gain. The authors attribute this weight to… you've guessed it, the added calories! To most people it is just common sense, a calorie is a calorie and weight gain or weight loss is a case of mathematics. If you take in more energy (calories) than you use, you will gain weight. If you use up more energy than you consume, you will lose weight. There is no magic bullet, and if there were it seems very unlikely that it would be cow's milk.

Osteoporosis

Bones consist of a thick outer shell and a strong inner mesh filled with a protein called collagen, calcium salts and other minerals. Osteoporosis (meaning porous bones) occurs when calcium is lost from the bones and they become more fragile and prone to fracture. This debilitating condition tends to occur mostly in postmenopausal women due to a lack of the hormone oestrogen, which helps to regulate the incorporation of calcium into the bones. Osteoporosis tends to occur mostly among postmenopausal women aged between 51 and 75. It can occur earlier or later and not all women are at equal risk of developing osteoporosis.

Osteoporosis is sometimes called the silent disease as there are often no symptoms until a fracture occurs. Although the whole skeleton is usually affected, fractures mostly occur in the wrist, spine and hip. One in two women and one in five men in the UK will suffer a fracture after the age of 50; in fact every three minutes someone has a fracture due to osteoporosis (National Osteoporosis Society, 2005). However, osteoporosis has been diagnosed in people as young as 20. The dairy industry has responded to this health scare by promoting the consumption of milk, cheese and yogurt directly to teenage girls in a campaign run by the Milk Development Council (MDC, 2005a).

It is deeply entrenched in the British psyche that calcium from dairy sources is essential for good bone health. However, a recent review on dairy products and bone health published in the official journal of the American Academy of Pediatrics challenged this misleading notion by concluding that there is very little evidence to support increasing the consumption of dairy products in children and young adults in order to promote bone health (Lanou *et al.*, 2005). This review examined the effects of dairy products and total dietary calcium on bone integrity in children and young adults and found that out of 37 studies, 27 showed no relationship between dairy or dietary calcium intake and measures of bone health. In the remaining studies the effects on bone health were either small or results were confounded by the fortification of milk with vitamin D.

American women are among the biggest consumers of calcium in the world, yet they have one of the highest levels of osteoporosis (Frassetto *et al.*, 2000). African Bantu women, on the other hand, eat almost no dairy products at all; they have a relatively low calcium intake, mainly from vegetable sources, and typically have up to 10 children each. Yet osteoporosis is virtually unknown among Bantu women (Walker *et al.*, 1972).

It seems that the more dairy produce we consume, the higher our risk of fracture. The Harvard Nurses Health study examined whether higher intakes of milk can reduce the risk of osteoporotic fractures. The study observed over 75,000 women for 12 years and concluded that increasing milk consumption did not confer a protective effect against hip or forearm fracture (Feskanich *et al.*, 1997). In fact the report suggested that an increased calcium intake from dairy foods was associated with a higher risk of fracture.

It has been suggested that calcium loss from the bone is promoted by a high intake of animal protein. One study of 1,600 older women examined the level of bone loss and found vegetarians had only 18 per cent less bone mineral compared to omnivores who had lost 35 per cent bone mineral by the age of 80 (Marsh *et al.*, 1988). Another study of 1,035 elderly women found that women with a high ratio of animal to vegetable protein intake had a greater risk of hip fracture than those with a low ratio (Sellmeyer *et al.*, 2001). In a similar study that analysed the incidence of hip fracture in relation to the consumption of animal and vegetable protein in 33 countries, it was concluded that moderating the consumption of animal food might protect against hip fracture (Frassetto *et al.*, 2000). Cross-cultural studies summarising data on protein intake and fracture rates from 16 countries compared industrialised and non-industrialised lifestyles and revealed strong links between a high animal protein diet, bone degeneration and the occurrence of hip fractures (Abelow *et al.*, 1992). In the book *The China Study*, Campbell observed that in rural communities where animal protein made up just 10 per cent of the total protein intake (the other 90 per cent coming from plant-based sources) the bone fracture rate was one-fifth of that in the US where 50 per cent or more of total protein is made up of animal protein (Campbell and Campbell, 2005), again indicating a link between animal protein and bone degeneration.

But what is the mechanism for this process? As food is digested acids are released into the blood, and the body attempts to neutralise the acid by drawing calcium from the bones. This calcium is then excreted in the urine (the calciuric response). Animal protein from cow's milk and dairy products as well as meat, fish and eggs has a particularly bad effect because of the greater amount of sulphur-containing amino acids it contains compared to plant protein. As the sulphur content of the diet increases so does the level of calcium in the urine. Studies reveal that an animal protein diet (with the same total quantity of protein as a vegetarian diet) confers an increased risk for uric acid stones (Breslau *et al.*, 1988). Furthermore the animal-protein induced calciuric response may be a risk factor for the development of osteoporosis. The traditional Inuit (or Eskimo) diet is made up almost entirely of animal protein. Inuits potentially have one of the highest calcium intakes in the world (up to 2,500 milligrams per day) depending on whether they eat whole fish, including the bones, or not. They also have a high rate of osteoporosis, even higher than white Americans (Mazess *et al.*, 1974; Mazess *et al.*, 1975; Pratt *et al.*, 2001).

There are many factors linked to bone health that may even be more important than calcium. For example, when the bone density of 80 young women was monitored over a 10-year period, it showed that exercise was more important than calcium intake (Lloyd *et al.*, 2004). In older people, a 15-year investigation into whether low calcium intake was a risk factor for hip fractures concluded that cutting back on dairy did not increase the risk and that physical activity provided better protection (Wickham *et al.*, 1989). The discovery of 18th-century human bones under a London church revealed that today's women lose far more calcium than our ancestors (Lees *et al.*, 1993). This may be attributed to a lower degree of physical activity. This research supports an increasing amount of evidence that physical activity is a key factor in reducing osteoporosis risk.

An increasing amount of evidence now shows that milk is not the best source of calcium at all and suggests that our bone health would benefit enormously if we switched to plant-based sources. Interestingly, a large share of the calcium in our diets (over 50 per cent) comes from sources other than dairy foods (FSA, 2003b). This is not surprising as most people in the world (over 70 per cent) obtain their calcium from plant-based sources rather than dairy products. Good plant-based sources of calcium include non-oxalate (eg spinach) dark green leafy vegetables such as broccoli, kale, spring greens, cabbage, bok choy and watercress. Also rich in calcium are dried fruits, such as figs and dates, nuts, particularly almonds and brazil nuts, and seeds including sesame seeds and tahini (sesame seed paste) which contains a massive 680mg of calcium per 100g. Pulses including soya beans, kidney beans, chick peas, baked beans, broad beans, lentils, peas and calcium-set tofu (soya bean curd) provide a good source of calcium. A good additional source is calcium-enriched soya milk. Interestingly, the calcium in dairy products is not as well absorbed as that in many dark green leafy vegetables, for example, in one study calcium absorbability from kale was demonstrated to be considerably higher than that from cow's milk (Heaney and Weaver, 1990).

In summary, research suggests that physical (especially weight-bearing) exercise is the most critical factor for maintaining healthy bones, followed by improving the diet and lifestyle; this means eating plenty of fresh fruit and vegetables, and cutting down on caffeine and avoiding alcohol and smoking.

CONCLUSION

The realisation is growing that changing our diet can have an enormous impact on health – for better or worse. But what constitutes healthy food – and unhealthy – is not universally agreed. Cow's milk is vigorously defended by the dairy industry and they have managed to turn it into a national icon. Woe-betide anyone who challenges their sacred cow. Not surprisingly, the resulting controversy is confusing. On one hand consumers are told that milk is essential for good bone health while on the other, that it causes allergies, illness and disease.

Of course we need calcium for bones and teeth as well as blood clotting, muscle function and regulating the heart's rhythm. But no matter how loudly the dairy industry shouts, an increasing body of evidence begs the question: is cow's milk really the best source of calcium? It certainly is not for most of the world's people. Claims that dairy is best carry strong overtones of cultural imperialism and simply ignore the 70 per cent of the global population who obtain their calcium from other sources – people such as the Japanese who traditionally have consumed no dairy yet have far better health than British people and live considerably longer.

Milk has been part of the human diet for less than 6,000 years – recent in evolutionary terms. It is not just that most people don't drink it – they cannot because their bodies will not tolerate it. Up to 100 per cent of some ethnic groups are lactose intolerant. It is obvious that the claims made for milk ignore the research and owe more to marketing hype than science.

The dairy industry has spent many years and many millions promoting the notion that cow's milk is good for us through expensive advertising campaigns such as the 'White Stuff'– fronted by the milk-moustachioed celebrity, Nell McAndrew. Now, because of an increasing body of evidence, there are signs of a growing realisation that milk is neither natural nor healthy.

The very people who are most aggressively targeted by the dairy industry – the young – are those most at risk of being damaged by milk. It is not just the two per cent under the age of one who will develop allergies but those likely to develop type 1 diabetes from cow's milk infant formula. The evidence is convincing even though the mechanism is not yet fully understood.

Author of the world-famous book, *Baby and Child Care*, Dr Benjamin Spock, withdrew his support for cow's milk in 1998. In 1999, a study published in the *Journal of Pediatric Surgery* reported that gastrointestinal bleeding caused by an allergic response to milk was a major cause of rectal bleeding in infancy, leading to iron-deficiency anaemia. This is now universally accepted. The World Health Organisation recommends that infants should be exclusively breast fed for the first six months of life in preference to being given cow's milk or soya formulas.

But it's not all about infants; in 2005, cow's milk was linked to teenage acne in a study published in the *Journal of the American Academy of Dermatology*. In the same year, the journal *Pediatrics* published a review article concluding that there is scant evidence that consuming more milk and dairy products promotes better bone health in either children or adolescents.

T. Colin Campbell, professor emeritus of nutritional biochemistry at Cornell University, culminated a lifetime of research with *The China Study*, one of the most comprehensive nutritional studies ever undertaken. Campbell agrees there is little evidence to show that increasing calcium intake will prevent fractures. In fact, research is moving in the opposite direction, showing that the more dairy and animal protein that is consumed, the higher the incidence of osteoporosis.

Cow's milk is clearly implicated in disease in both the young and old. Both UK arthritis charities, Arthritis Care and the Arthritis Research Campaign, agree that moving away from fatty foods such as meat and dairy and towards a diet rich in fruit, vegetables, and whole grains can help people with arthritis.

The rate at which some cancers are increasing is also a matter of concern. When Professor Jane Plant wrote *Your Life in Your Hands*, an account of how she overcame breast cancer by eliminating dairy, one in 10 UK women were affected by the disease. That was in 2000 and now, in 2006, one in nine women will develop breast cancer at some point in their lives!

In fact, since 1971, the incidence of breast cancer in the UK has increased by 80 per cent. In rural China, on the other hand, where very little if any dairy is consumed, just one in 10,000 women gets breast cancer. These figures should be shouted from the rooftops as a basis for action. Plant and Campbell – and many others for that matter – are in no doubt that cow's milk and dairy foods are responsible.

A point that is consistently overlooked is that two-thirds of the UK's milk comes from pregnant cows and as every mum knows, hormone levels during pregnancy can rise dramatically. This is no laughing matter as prostate, ovarian and colorectal cancer are all implicated. These cancers and the so-called diseases of affluence, such as diabetes, obesity, heart disease and even osteoporosis, occur increasingly in the countries that consume the most dairy products. It is not rocket science… **cow's milk and dairy products cause disease**.

The conclusions of this report are drawn from a huge body of research from academic institutions all around the world. While the majority was done in an academic environment involving clinical trials or statistical analysis, some is of a more personal nature. Professor Jane Plant's spirit and courage in overcoming breast cancer through the elimination of all dairy could not fail to inspire the increasing number of women who are affected by this type of cancer.

Plant did not set out to promote one type of diet above another but as a scientist (geochemist) she took an analytical approach to the problem of cancer and ultimately found the solution: a dairy-free diet. Similarly, what initiated Campbell's extensive China study was not an attempt to justify or promote vegetarianism. In fact, Campbell grew up on a farm in northern Virginia and for much of his life ate the typical North American diet high in meat, eggs, whole milk and butter. He began his academic life trying to increase animal protein production. It was evidence from his own laboratory research that pointed an accusing finger at animal protein as a trigger for many diseases and he set out to confirm it through epidemiological research. For health reasons, he and his family now eat a plant-based diet.

The World Health Organisation believes that the only way people can improve their health is through informed opinion and their own, active co-operation. We agree! As a science-based health charity, the VVF provides unbiased information on which people can make informed choices. We monitor and interpret scientific research on diet and health and communicate those findings to the public, health professionals, schools and food manufacturers. Importantly, we have no commercial or vested interests and offer a vital – and what sometimes feels like a solitary – source of accurate and unbiased information.

This report combines the findings of over 250 scientific papers from reputable peer-reviewed journals such as the *British Medical Journal* and the *Lancet*. The research is clear – the consumption of cow's milk and dairy products is linked to the development of teenage acne, allergies, arthritis, some cancers, colic, constipation, coronary heart disease, Crohn's disease, diabetes, dementia, ear infection, food poisoning, gallstones, kidney disease, migraine, autoimmune conditions, including multiple sclerosis, overweight, obesity and osteoporosis.

As a species, we do not need saturated animal fat, animal protein or cholesterol. We do not need the trans fatty acids in processed foods. We do not need salt and sugar in their current quantities. We do need to move towards a plant-based, whole grain diet containing a wide range of fruits, vegetables, grains, pulses, nuts and seeds for the nutrients that will promote a long and healthy life.

These, of course, are the same foods which contain protection against disease in the form of antioxidants and fibre. What is killing the Western world are the degenerative diseases associated with affluence. It is clear that the same diet that is good for preventing cancer is also good for preventing heart disease, obesity, diabetes and so on.

The official approach to the causes of all these diseases remains extremely equivocal and dietary advice seems to be based far more on not upsetting particular vested interests than improving the public's health. As a consequence, no matter how much money is thrown at the NHS, the incidence of all these diseases goes on increasing remorselessly because public health policy is geared almost exclusively towards cure rather than prevention.

Only when prevention assumes the pre-eminence it should have will the avoidance of dairy and other animal products be seen as central to improving the public's health. Meanwhile, it is left to individuals to discover what they can about diet and heath while Government health policy continues to kill us and sows the seeds for the destruction of our own children's health, most of which will germinate in early adulthood. It is a national disgrace and an evolutionary disaster.

APPENDIX I

THE SAFETY OF SOYA

Soya milk, made from soya beans, contains the same amount of protein as dairy milk. It also provides all eight of the essential amino acids which the human body requires. Soya milk is rich in polyunsaturated fatty acids including omega-3, and is free of cholesterol. Compared to cow's milk, soya milk contains lower levels of saturated fat and higher levels of unsaturated essential fatty acids which can lower cholesterol levels in the body. Soya products provide an excellent source of B vitamins, calcium, iron and zinc. Soya also contains fibre which is important for good bowel health and can also lower cholesterol.

In recent years, soya milk and soya-based products have received much attention because of the phytoestrogens that they contain. Phytoestrogens are plant-made substances that can act in a similar way to the hormone oestrogen, although they are far less potent (Coldham *et al.*, 1997). They are found in many fruits, vegetables, dried beans, peas, and whole grains. Isoflavones are a type of phytoestrogen found in soya beans and include genistein and daidzein. In general, much of the data indicates that isoflavones are beneficial to health. For example, isoflavones may have a protective role against heart disease. The UK's Joint Health Claims Initiative (JHCI) offers pre-market advice and a code of practice for the food industry, enforcers and consumers, to ensure that health claims on foods are both scientifically truthful and legally acceptable. In 2002 the JHCI concluded its deliberations on a generic health claim for soya protein and blood cholesterol. The claim approved states that "**the inclusion of at least 25 grams soya protein per day as part of a diet low in saturated fat can help reduce blood cholesterol**" (JHCI, 2005). In addition to the benefits to heart health, isoflavones have been shown to offer other health benefits. For example, they may have a role in reducing menopausal symptoms; dietary soya supplementation has been shown to substantially reduce the frequency of hot flushes in some postmenopausal women (Albertazzi *et al*, 1998). While only a few clinical studies have examined the influence of phytoestrogens on bone health, a review of the current research states that the collective data suggests that diets rich in phytoestrogens have bone-sparing effects in the long term, in other words the data indicates that phytoestrogens may be beneficial to bone health (Setchell and Lydeking-Olsen, 2003).

Conversely, research focusing on the hormonal content of cow's milk has not been widely discussed and surprisingly very little research has been published on this topic. Cow's milk contains the hormones oestrogen, progesterone and a range of hormone precursors (androstenedione, dehydroepiandrosterone-sulphate, and 5^{a}-reduced steroids like 5^{a}-androstanedione, 5^{a}-pregnanedione, and dihydrotestosterone). Some researchers are particularly concerned about the oestrogen content of cow's milk (Ganmaa and Sato, 2005), suggesting that cow's milk is one of the important routes of human exposure to oestrogens. What concerns them is that the nature of cow's milk has changed drastically over the last hundred years, in that for most of the time that a cow is milked, she is also pregnant and therefore secreting hormones into the milk. The levels of these hormones in cow's milk increases markedly during pregnancy and has been linked to a wide range of illnesses and diseases including certain hormone-dependent cancers such as ovarian and breast cancer.

Consistent levels of soya isoflavones have been a component of the diet of many populations for centuries and the consumption of soya is generally regarded as beneficial for health with a potentially protective effect against a number of chronic diseases because of their oestrogenic activity. A recent review of the current literature concluded that when viewed in its entirety, the current literature supports the safety of isoflavones as typically consumed in diets based on soya or containing soya products (Munro *et al.*, 2003).

Soya-based infant formula

Because soya-based infant formula is such a popular alternative to cow's milk formula, it was decided to include a separate section on it here. Soya protein-based nutrition during infancy has a long history of safe use around the world dating back centuries. The first report of soya-based infant formula in the West was recorded in 1909 (Ruhrah, 1909) and soya-based infant formula was used in cases of infantile eczema as early as in the 1920s (Hill and Stuart, 1929). Since these early days soya-based infant formula has come a long way; it now contains all the nutrients needed by an infant and can be used as a safe alternative or supplement to breast milk if necessary.

Soya-based infant formulas have been more widely used in the UK since the 1960s and are currently fed to approximately one per cent of non-breast fed infants aged four to 10 weeks rising to approximately two per cent of infants aged 10-14 weeks (Hamlyn *et al.*, 2002). However, the UK Foods Standards Agency advises that you should only give your baby soya-based infant formula if your GP or health visitor advises you to (FSA, 2005). They also state that in almost all cases, breast feeding or another type of formula will be a better choice, and suggest that if you are giving your baby soya-based infant formula at the moment, you should talk to your GP or health visitor about changing to a different formula (FSA, 2005). This reflects concerns about the use of soya-based infant formulas. Based largely on anecdotal and animal-based experimental evidence, these concerns have focused on the nutritional adequacy of soya-based infant formula, the effect of phytoestrogens, genetically modified soya and the effects of glucose syrup (which is used in place of lactose). These concerns are addressed below.

Nutritional adequacy

Soya-based infant formulas are formulated to meet all of the nutrient requirements of the growing infant. A number of studies have documented normal growth and development in infants fed soya-based infant formulas. One study compared weight, length and head circumference of healthy term infants to one year of age, fed either soya-based formula, or exclusively breast fed for at least two months then weaned on to cow's milk formula. Results demonstrated similar growth in the first year of life between groups (Lasekan *et al.*, 1999). Another, more recent study compared the nutritional status and growth of 168 infants who were allergic to cow's milk and were fed either soya-based infant formula or extensively hydrolysed whey formula. Results showed that in both groups, nutrient intake and growth were within reference values confirming the safety and effectiveness of the soya-based formula (Seppo *et al.*, 2005).

There is currently only one vegan infant soya formula on the market: Farley's Soya Formula, produced by Heinz. This dairy-free infant formula is nutritionally complete and can be used from birth. It contains no animal products, so it is suitable for both vegetarians and vegans. It is also suitable for infants who require a diet free from lactose.

Phytoestrogens

The role of phytoestrogens in the diet has become a somewhat controversial area with warnings focusing particularly on the safety of soya-based infant formulas. Various animal experiments (primarily using rodents and primates) have suggested that phytoestrogens can elicit oestrogenic effects with respect to sexual development and reproductive function. However, it is widely acknowledged that the results of animal experiments should not form the basis of a public health policy as significant differences in biological function between rodents, primates and humans make the interpretation of these types of experimental studies extremely difficult. Just one single human study has specifically examined the effect of soya formula feeding on sexual development and fertility (Strom *et al.*, 2001). This study examined the association between exposure to soya formula in infancy and reproductive health in adulthood. The results provided no evidence of adverse clinical effects on sexual development or reproductive health of males and females. Indeed the authors of this study stated that their findings were reassuring about the safety of infant soya formula.

In 1998 a review on isoflavones, soya-based infant formulas and hormone function reported that growth was normal and no changes in timing of puberty or in infertility rates were reported in humans who consumed soya formulas as infants (Klein, 1998). The author concluded that soya-based infant formulas continue to be a safe, nutritionally complete feeding option for most infants.

However in 2003, in response to concerns about the oestrogenic properties of phytoestrogens the UK Department of Health's committee of independent experts, the Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) reviewed the health aspects of phytoestrogens as part of an ongoing programme of reviews on naturally-occurring chemicals (COT, 2003). This report attempted to assess, on the basis of current evidence, if ingestion of soya-based infant formulas poses any risk for human infants.

The report compared estimated dietary isoflavone intakes in Western and Eastern populations and found that Eastern populations have a significantly higher intake of phytoestrogens. While in the UK, the US, Australia and New Zealand isoflavone intakes tend to range from around 0.8 milligrams per day to 17.0 milligrams per day, intakes in Japan, China and Korea range from 18.0 milligrams per day to 200 milligrams per day. These figures do not include data collected from one group of vegans in New Zealand whose intake was found to be 140.0 milligrams per day (COT, 2003). The COT estimated that the daily isoflavone intake of a soya formula fed infant is approximately 40 milligrams per day (COT, 2003), above the average Western intake but well within the range of intakes seen in Eastern countries.

In a cautionary statement the COT warned that isoflavones *may* lower free thyroxine concentrations and advised that physicians and other health care workers be aware of possible interactions between isoflavones in soya-based infant formulas and thyroid function, particularly in infants with congenital hypothyroidism. That said, the report concluded that the findings from a wide range of studies did not provide direct evidence that phytoestrogens present in soya-based infant formulas can adversely affect the health of infants. However, they said that the findings did provide evidence of *potential* risks. For this reason, the Scientific Advisory Committee on Nutrition (SACN) considered there to be no substantive medical need for, nor health benefit arising from, the use of soya-based infant formulas and together with the COT recommended that the Department of Health reviewed current advice on the use of soya-based infant formulas.

The report did acknowledge that there is no evidence that populations which habitually ingest high quantities of soya (such as the Chinese or Japanese) have impaired fertility or altered sexual development. Despite this, they recommended that research should be undertaken as a matter of high priority to determine whether ingestion of soya-based formulas can affect infant reproductive development in any way. Interestingly, the United Kingdom and New Zealand are the only countries to have issued such advice with specific reference to phytoestrogens and soya-based infant formulas.

This is a controversial issue which has yet to be resolved. The FSA advise that, until a full review of the evidence both supporting and opposing soya formula has been completed, there is no reason to stop your baby having a soya formula if it has been suggested by a health professional. This it would seem is erring of the side of extreme caution given that thousands of babies have been raised on soya-based infant formula.

Genetically modified soya

It is relatively recently that the genetic modification (GM) of organisms (plants and animals) has developed as a technology. However, GM technology has not been welcomed by the British public; many people are deeply suspicious and mistrustful of the science. We have been reassured in the past that certain foods are quite safe to eat only to find that they are not. Many of us will remember in 1990, just before the bovine spongiform encephalopathy (BSE) crisis, John Gummer feeding his daughter a beef burger and saying that beef was perfectly safe, it was not.

The mistrust remains and many questions have gone unanswered. For example, have the transgenic plants grown so far met expectations? Evidence suggests that in many cases they have not met the high yields expected. What is the real risk of transgenic contamination between genetically modified (GM) and unmodified plants? This question refers to the contamination of an unmodified crop with pollen from a GM plant. The pollen of the GM plant will carry copies of the foreign genes that were used confer some additional characteristic to the plant. These may encode pesticide resistance for example along with antibiotic resistance marker genes that were used to identify the successfully modified plants when they were first produced. The question of contamination is difficult to answer as it may be years or even decades before we can assess the full extent of transgenic contamination, but so far evidence suggests widespread contamination has occurred in some parts of the world.

Another concern is that the genetic material (DNA or genes) may be transferred from GM foods to bacteria in the human gut and from there into human tissue. There is experimental evidence that DNA from GM soya has been taken up by bacteria in the small intestines of human volunteers (Netherwood *et al.*, 2004). This raises concerns that bacteria in the gut (for example *Lactobacillus*) might then transfer that DNA into our intestinal epithelial cells. What effect this may have on human health will largely depend on what the gene does; it may do nothing but is that a risk worth taking? Finally, as a result of a lack of funding, scientists are sometimes forced to adopt the corporate agenda, which is not necessarily the same as the public good. For example, Monsanto has used genetic engineering to produce herbicide resistance crops thus increasing sales of its herbicide Roundup.

GM products, especially soya and maize, are now in so many foods, including baby milks, that it can be difficult to avoid them. We do not yet know enough about this technology to confidently say what the long term effects of it will be but consumers appear to be voting with their shopping baskets by avoiding GM foods as far as possible. The good news for vegan babies is that Heinz state that no GM ingredients at all are used in Farley's Soya Formula (Heinz, 2005). In addition, SMA Nutrition and Cow and Gate also state that no GM soya is used in their soya-based infant formulas (SMA Nutrition, 2006; Cow and Gate, 2006).

Glucose syrup and tooth decay

Another concern with infant soya formula is that the glucose syrup content may harm teeth. All infant formulas must comply with standards laid down by UK regulations which specify minimum and maximum amounts of carbohydrate (the body's main form of energy). The carbohydrate in cow's milk is the sugar lactose, in soya-based infant formula an alternative carbohydrate is used: glucose syrup. Glucose syrup is often confused with sugars but in fact is derived from corn starch and is not the same as glucose or syrup. It is mainly made up of beneficial complex carbohydrates (starches) rather than simple carbohydrates (sugars) which are known to be harmful to teeth. Research has shown that soya infant formulas are no more likely to cause tooth decay than other infant formulas (Moynihan, 1996).

Tooth decay can be the result of many factors, not only the presence of sugars in a food and drink but *how* they are consumed. It has been shown that prolonged contact of sugary foods and drinks with teeth increases the risk of tooth decay significantly. Children should be encouraged to drink water if they are thirsty as it quenches the thirst, maintains body fluid levels, does not spoil the appetite and is safe for teeth. Fresh fruit juice provides a good source of vitamin C and can be given with meals to help the absorption of iron. However, fresh fruit juices are acidic so may be harmful to teeth and should be diluted with water. Furthermore, juice should be served in a cup rather than a bottle to minimise the risk of tooth decay. Children should be discouraged from consuming sugary carbonated drinks and squashes as these contribute to dental problems, are a poor source of nutrients and tend to displace other more nutritious foods. If normal weaning practices are adopted, soya infant formulas should not cause harm to teeth (Moynihan, 1996).

In summary, soya-based infant formulas continue to provide a safe feeding option for most infants. They meet all the nutritional requirements of the infant with none of the detrimental effects associated with the consumption of cow's milk formulas.

APPENDIX II

BODY MASS INDEX

Table 1. Body mass index (BMI) table in imperial units. Find the nearest height in feet and inches on the top row. Read down that column to find the nearest weight in stones and pounds. Then find your BMI in the left hand column. See page 56 for information on BMI.

BMI	4FT10IN	4FT11IN	5FT0IN	5FT1IN	5FT2IN	5FT3IN	5FT4IN
17.0	5st11lb	6st0lb	6st3lb	6st5lb	6st8lb	6st11lb	7st1lb
18.5	6st4lb	6st7lb	6st10lb	6st13lb	7st3lb	7st6lb	7st9lb
20.0	6st11lb	7st1lb	7st4lb	7st7lb	7st11lb	8st0lb	8st4lb
22.5	7st9lb	7st13b	8st3lb	8st7lb	8st11lb	9st1lb	9st5lb
25.0	8st7lb	8st11lb	9st2lb	9st6lb	9st10lb	10st1lb	10st5lb
27.5	9st5lb	9st10lb	10st0lb	10st5lb	10lb10lb	11st1lb	11st6lb
30.0	10st3lb	10st8lb	10st13lb	11st4lb	11st10lb	12st1lb	12st6lb
32.5	11st1lb	11st6lb	11st12lb	12st4lb	12st9lb	13st1lb	13st7lb
35.0	11st13lb	12st5lb	12st11lb	13st3lb	13st9lb	14st1lb	14st7lb

BMI	5FT5IN	5FT6IN	5FT7IN	5FT8IN	5FT9IN	5FT10IN	5FT11IN
17.0	7st4lb	7st7lb	7st10lb	7st13lb	8st3lb	8st6lb	8st9lb
18.5	7st13lb	8st2lb	8st6lb	8st9lb	8st13lb	9st2lb	9st6lb
20.0	8st8lb	8st11lb	9st1lb	9st5lb	9st9lb	9st13lb	10st3lb
22.5	9st9lb	9st13lb	10st3lb	10st7lb	10st12lb	11st2lb	11st7lb
25.0	10st10lb	11st0lb	11st5lb	11st10lb	12st1lb	12st6lb	12st11lb
27.5	11st11lb	12st2lb	12st7lb	12st12lb	13st4lb	13st0lb	14st1lb
30.0	12st12lb	13st3lb	13st9lb	14st1lb	14st7lb	14st13lb	15st5lb
32.5	13st13lb	14st5lb	14st11lb	15st3lb	15st10lb	16st2lb	16st9lb
35.0	15st0lb	15st6lb	15st13lb	16st6lb	16st13lb	17st5lb	17st12lb

BMI	6FT0IN	6FT1IN	6FT2IN	6FT3IN	6FT4IN	6FT5IN
17.0	8st13lb	9st2lb	9st6lb	9st10lb	9st13lb	10st3lb
18.5	9st10lb	10st0lb	10st4lb	10st8lb	10st11lb	11st2lb
20.0	10st7lb	10st11lb	11st1lb	11st6lb	11st10lb	12st0lb
22.5	11st11lb	12st2lb	12st7lb	12st12lb	13st2lb	13st7lb
25.0	13st2lb	13st7lb	13st12lb	14st4lb	14st9lb	15st0lb
27.5	14st6lb	14st12lb	15st4lb	15st10lb	16st1lb	16st7lb
30.0	15st11lb	16st3lb	16st9lb	17st2lb	17st8lb	18st1lb
32.5	17st1lb	17st8lb	18st1lb	18st8lb	19st1lb	19st8lb
35.0	18st6lb	18st13lb	19st6lb	20st0lb	20st7lb	21st8lb

Adapted from Walsh, 2003.

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