Vegetarian & Vegan Foundation

white meat black mark

The health consequences of consuming chicken, turkey, duck and goose meat

A scientific report by Amanda Woodvine, BSc Nutrition
Senior Nutritionist, Vegetarian & Vegan Foundation (VVF)

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"Humans become part of chickens' lives billions of times a day in the most intimate way possible. We eat them. We consume their bodies. They become part of us, flesh of our flesh."
Hattie Ellis, author of *Planet Chicken: The Shameful Story of the Bird on Your Plate*.

CONTENTS

Executive Summary

White meat – from chickens, turkeys, ducks and geese – has become the meat of choice for many people living in the West. The average consumer will eat at least 1,226 birds in a lifetime.

Of all types of meat, chicken is especially popular, accounting for one third of all meat consumed in the UK. Recent fears over bird flu, food poisoning, dubious foreign imports and chicken meat pumped up with beef protein and water knocked sales a bit, but the birds' 'healthy' image remains largely untarnished.

White meat is perceived to be a low-fat food; something to be eaten in quantity by top athletes. However, modern farming's focus on high-energy feed, little exercise and breeding for rapid weight gain means that even organic meat is not even close to being low-fat – even after removing the skin and scraping away the subcutaneous fat. A medium-sized chicken contains almost a pint of fat! And contrary to popular opinion, animal protein is not essential for building muscle or for children's growth.

Turkey has even been called a 'superfood'. However, white meat contains no fibre, complex carbohydrates, nor vitamin C. When white meat takes the place of fruits, vegetables, wholegrains and pulses in the diet, the result is less vitamins, fibre, and unwanted dietary fat and cholesterol – increasing the risk of a number of chronic diseases, which are discussed in this report.

In the UK, 95 per cent of chickens, 95 per cent of ducks, and the overwhelming majority of turkeys are raised on large factory farms. Crowded together indoors, these animals eat, breathe and excrete in the same physical space every day. The overcrowded, unsanitary conditions mean that infectious illnesses spread rapidly through the birds. Death rates of five to 15 per cent of all birds are common on intensive units – they fail to live to even their very young slaughter age.

The amount of meat that the world eats is expected to rise by over 55 per cent in the next 20 years. Chickens, as the most intensively farmed animals, are expected to be on the front line of this change. Human health – and the environment – will be on the front line, too.

Introduction

White meat – from chickens, turkeys, ducks and geese – has become the most popular meat for people living in the West.

Apart from the muscle, other parts of the bird – collectively described as offal – are also consumed. These include the liver, kidneys, brain and pancreas (sweetbreads).

In the EU, the consumption of white meat overtook that of beef and veal in 1996, when BSE hit the headlines. Britons eat almost twice as much white meat as beef every year. The average consumer will eat at least 1,226 birds in their lifetime (Viva!, 2005a).

Recent fears over bird flu, food poisoning, dubious foreign imports and chicken meat pumped up with beef protein and water knocked sales a bit, but the birds' 'healthy' image remains largely untarnished. It is perceived to be low in fat and something to be eaten in quantity by top athletes.

The amount of meat the world eats is expected to rise by over 55 per cent in the next 20 years. Chickens, as the most intensively farmed animals, will be on the front line of this change (Ellis, 2007).

Table 1: Average Intake, per Person, per Week of Selected Meat and Meat Products

Average intake, per person, per week in grams (based on household purchase data)

	2003-04	2006	% change since 2003-04
Poultry (cooked or uncooked)	248	255	+5.7
Fish	156	170	+9.1
Bacon and ham (cooked or uncooked)	117	111	-1.0
Meat based ready meals and convenience meat products	155	146	-6.1
All other meat and meat products	316	292	-2.8

Data from Defra, 2008a

PART 1: White Meat – Nutritional Considerations

White Meat: the Low-Fat Choice?

White meat is perceived, and often promoted by producers, to be a low-fat, healthy food. The reality is that it is not even close to being so. All meats are muscles, which are made of protein and fat (PCRM, 2000).

Average raw chicken meat is 17.5 per cent fat – rising to 38.1 per cent once the meat is roasted (see Table 2). Raw turkey comes close at 13.7 per cent of calories from fat. Nearly half of the calories in roasted duck come from fat – and that is only if the skin and excess fat is discarded from the carcass. If this is not done then 80 per cent of the calories from roasted duck will be from fat! Roasted goose is not far behind, at 63 per cent of calories. This is in stark contrast to the one per cent fat in a baked potato, and four per cent found in baked beans.

Table 2: Fat/Protein Content of Various Meats

Meat	Energy (kilocalories per 100g)	Fat (per 100g)	% kilocalories from fat	Protein (per 100g)
Chicken				
Meat, average, raw	108	2.1	17.5	22.3
Meat, average, roasted	177	7.5	38.1	27.3
Turkey				
Meat, average, raw	105	1.6	13.7	22.6
Meat, average, roasted	166	4.6	24.9	31.2
Light meat, roasted	153	2.0	11.8	33.7
Dark meat, roasted	177	6.6	33.6	29.4
Duck				
Meat, average, raw	137	6.5	42.7	19.7
Crispy, Chinese style	331	24.2	65.8	27.9
Roasted, meat only	195	10.4	48.0	25.3
Meat, fat and skin	423	38.1	81.1	20.0
Goose				
Roasted, meat, fat and skin	301	21.2	63.4	27.5
Pork				
Lean, average, raw	123	4.0	29.3	21.8
Lean and fat leg roasted	215	15.2	63.6	19.0
Lamb				
Lean, average, raw	153	8.3	48.8	20.2
Lean and fat, leg roasted	187	13.0	62.6	29.7
Beef				
Lean, average, raw	129	5.1	35.6	22.5

Adapted from Meat, Poultry and Game Supplement to McCance & Widdowson's The Composition of Foods, 2002 (Chan et al., 1996).

In fact, meat and meat products, including chicken and turkey in all their guises, are the leading source of fat in the British diet (see Table 3), including equally unhealthy trans fats (The National Diet & Nutrition Survey, 2003). Not only are we eating meat in unprecedented amounts (see Figure 1) but modern farming methods have ensured that its fat content has doubled.

Professor Michael Crawford of London Metropolitan University found that chicken contains as much fat, gram for gram, as a Big Mac. His team analysed chicken thigh meat from several supermarkets – even organic suppliers – and found that they contain more than twice as much fat as they did back in 1940, a third more calories and a third less protein (Wang *et al.*, 2004). Someone eating a 100 gram portion of chicken would get 207 kilocalories from fat and only 64 from protein. And this wasn't the breadcrumbed type of chicken, which has a much higher fat content.

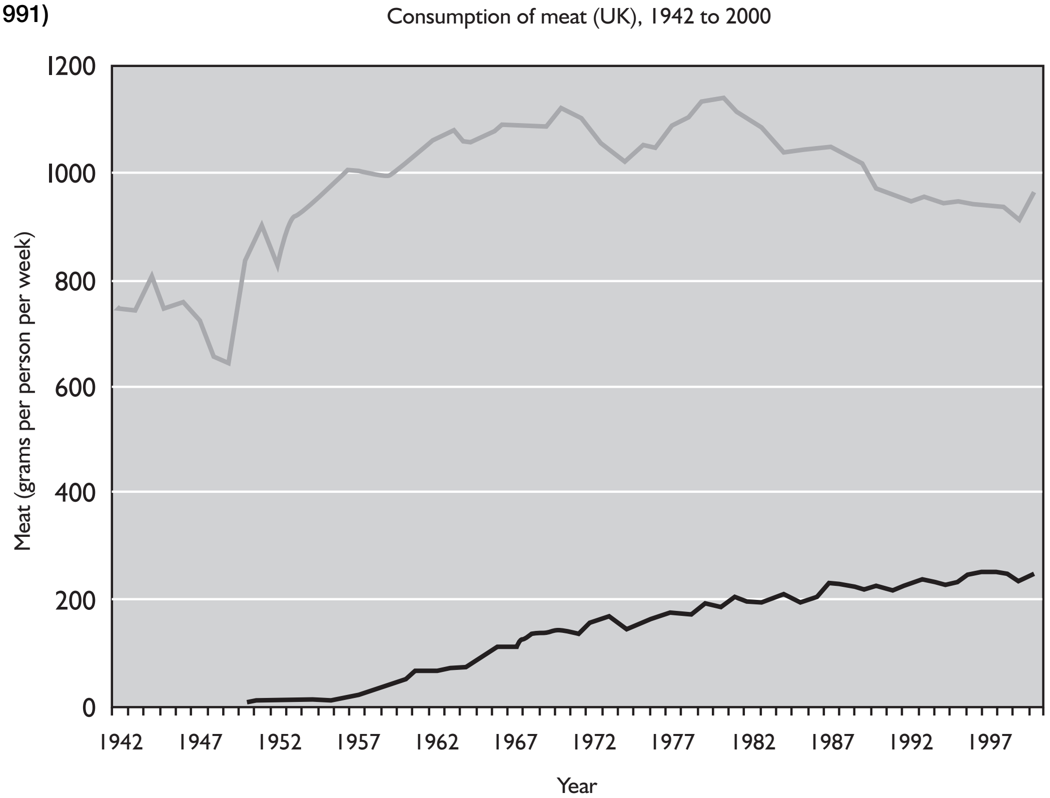
Even organic chickens didn't do much better nutritionally – 154 kilocalories from fat and 74 from protein – probably because despite having more space than factory-farmed chickens, they're on the same regime of high-energy feed, little exercise and breeding for rapid weight gain. Says Professor Crawford: "This focus on rapid growth has changed the lipid (fat) composition of the chicken meat itself, and you cannot escape that – even by removing the skin and scraping away the subcutaneous fat stuck to the meat" (*Observer*, 2005). The team also found that a medium-sized chicken contains almost a pint of fat! (Dispatches, 2005).

Table 3: Percentage Contribution of Food Types to Average Daily Total Fat Intakes in the Diet of Adults Aged 19 to 64 Years (The National Diet & Nutrition Survey, 2003)

Source of total fat	% contribution to total fat intake
Meat and meat products of which	**23**
Bacon and ham	2
Beef, veal and dishes	3
Lamb and dishes	1
Pork and dishes	1
Coated turkey and chicken	1
Chicken, turkey and dishes	4
Burgers and kebabs	2
Sausages	3
Meat pies and pastries	4
Cereals and cereal products of which	**19**
Pizza	2
White bread	2
Biscuits	3
Buns, cakes and pastries	4
Milk and milk products of which	**14**
Whole milk	3
Semi-skimmed milk	3
Cheese (including cottage cheese)	6
Fat spreads of which	**12**
Butter	4
Margarines	1
Reduced fat spreads (60-80% fat)	5
Low-fat spreads (40% fat or less)	1
Potatoes and savoury snacks of which	**10**
Chips	5
Other fried or roast potatoes	1
Savoury snacks	3
Vegetables excluding potatoes	4
Fish and fish dishes	3

It should come as no surprise then, that an association has been found between meat consumption and overweight and obesity (see ***Overweight & Obesity***, page 45) Researchers at the American Cancer Society followed more than 75,000 people for a decade to find out what it was that caused their weight loss and weight gain. High meat consumption was the food most responsible for

Figure 1: Meat Consumption, 1942 to 2000. Data from National Food Survey (Ministry of Agriculture, Fisheries and Food, 1991)



them putting on weight (Kahn *et al.*, 1997). Whether men or women, if they had more than a single serving of meat a day, they showed a 50 per cent increase in 'abdominal obesity' – they put on the pounds around their middles.

From the 1980s onwards, it became common for butchers and processors to trim from meat any visible fat as part of the demand for leaner meat. It didn't have much effect as people's fat intake from meat has dropped by a mere five per cent since 1983 (The National Diet & Nutrition Survey, 2003; Geissler and Powers, 2005).

Saturated Fat

Our bodies can't function without some fat, but it's the right kind that's important. We have no nutritional need for saturated and monounsaturated fats as the body can make them. Diets high in saturated fat and calories raise blood cholesterol levels and contribute to cardiovascular disease, diabetes and some cancers (see ***CVD***, page 29). Saturated fat has 10 times the cholesterol-raising power of dietary cholesterol (Enas *et al.*, 2003). Table 4 shows where most saturated fat comes from – animal products, including white meat!

Furthermore, foods high in saturated fat generally contain substantial amounts of dietary cholesterol (see ***White Meat: A Superfood?,*** page 11). Reducing total and saturated fat intakes could also lower the risk of breast cancer (see VVF report, *One in Nine*).

As part of a healthy diet, the Food Standards Agency encourages people to reduce the amount of hydrogenated and saturated fat that they eat and replace them with unsaturated fats (Food Standards Agency, 2005). No more than 10 per cent (and preferably less than seven per cent) of total calorie intake should come from saturated fat (Department of Health, 1991).

Not all saturated fatty acids have the same effects. Those which raise cholesterol the most are lauric acid, myristic acid, and palmitic acid, which are found in meat, dairy products, eggs and tropical oils. These three fatty acids account for 60 to 70 per cent of the saturated fat in Western diets. Palmitic acid is the most common fatty acid in the human diet. It is the main saturated fatty acid in animal fats (including poultry, red meats and eggs) and in palm oil.

Figure 2 shows the percentages of saturated fat in different kinds of fat. Around a third of the fat in both chicken and turkey is saturated fat.

Figure 2: The Percentages of Saturated Fat in Different Kinds of Fat

Animal fats:	Vegetable oils:	Tropical oils:
Beef tallow 50%	Cottonseed oil 26%	Coconut oil 87%
Pork fat (lard) 39%	Peanut oil 17%	Palm kernel oil 82%
Chicken fat 30%	Corn oil 13%	Palm oil 49%
Turkey fat 30%	Olive oil 13%	Soybean oil 15%
	Rapeseed oil 7%	Sesame oil 14%
		Sunflower oil 10%
		Safflower oil 9%

Source: Pennington J.A.T., 1994.

Table 4: Percentage Contribution of Food Types to Average Daily Total Saturated Fat Intakes in the Diet of Adults Aged 19 to 64 Years (The National Diet & Nutrition Survey, 2003)

Source of saturated fat	% contribution to saturated fat intake
Milk and milk products, of which	**24**
Whole milk	4
Semi-skimmed milk	5
Cheese (including cottage cheese)	10
Meat and meat products, of which	**22**
Bacon and ham	2
Beef, veal and dishes	4
Lamb and dishes	1
Pork and dishes	1
Coated turkey and chicken	1
Chicken, turkey and dishes	3
Burgers and kebabs	2
Sausages	3
Meat pies and pastries	4
Other	1
Cereals and cereal products, of which	**18**
Pizza	2
White bread	1
Biscuits	4
Buns, cakes and pastries	4
Fat spreads, of which	**11**
Butter	6
Margarines	1
Polyunsaturated reduced fat spreads (60-80%)	1
Other reduced fat spreads (60-80% fat)	2
Low-fat spreads (40% fat or less)	1
Potatoes and savoury snacks, of which	**7**
Chips	3
Other fried or roast potatoes	1
Savoury snacks	3
Chocolate confectionery	5

White Meat: A Superfood?

Amazingly, turkey is listed as a superfood in Dr Steven Pratt's book, *Superfoods: 14 Foods that Will Change Your Life*. Turkey makes the top 14, along with tomatoes, broccoli, beans, blueberries, tea, oats, pumpkin, yoghurt, walnuts, spinach, salmon, soya and oranges.

Dr Pratt favours turkey because it is the 'leanest meat source of protein'. However, Dr Pratt adds several provisos to this stance. Readers are advised to eat skinless breast meat only, no more than three to four servings a week, don't buy self-basting birds as they may contain damaging 'partially hydrogenated oils' and only eat ground turkey that's labelled 99 per cent fat free!

Even those who have the discipline to stick to the 3-4 ounce cautionary portion limit – about the size of a pack of cards – will be ingesting 100 milligrams of cholesterol with each portion – the same as in beef – along with a scattering of harmful trans fatty acids.

The cholesterol from white meat does just as good a job at clogging arteries and causing heart disease. The human body produces cholesterol on its own and never needs outside sources. Each added dose contributes to artery blockages, leading to heart attacks, strokes, and other serious problems (see ***CVD***, page 29). All plant foods are cholesterol-free.

While metaphorically patting turkey protein on the back with one hand, Dr Pratt assassinates it with the other, cautioning against too much animal protein. Excess can lead to a loss of calcium and an increased risk of osteoporosis, kidney damage, raised blood cholesterol levels, heart disease and increased production of the hormone insulin-like growth factor (IGF-1) – which is thought to boost the growth of cancer cells (see ***The Hazards of Protein Over-consumption***, page 15). What's enough? A meagre 45 to 55.5 grams a day (Department of Health, 1991) and you don't need to eat any meat to achieve it, there's plenty in plant foods.

Despite these hazards, Dr Pratt's support for white meat is based on it containing some vitamins and minerals, such as niacin, vitamins B6 and B12, iron, selenium and zinc. But it certainly has no monopoly on them. Mixed nuts, cereal grains, yeast extracts, vegetables and fruits are useful sources of these nutrients but without the potential for harmful side effects. It's even been shown that B12 in fortified foods such as breakfast cereals is more easily absorbed than B12 in meat, poultry and fish – particularly for the elderly. The National Academy of Sciences in the US advises adults aged 50 and over to obtain most of their B12 from fortified foods. It's pretty good advice for younger adults as well (Tucker *et al.*, 2000).

This begs the question: what is not found in white meat? White meat contains no fibre, complex carbohydrates, nor vitamin C. Fibre cleanses the digestive tract, keeping bowels healthy and regular; slows the absorption of sugar and fat; carries away excess hormones from the blood; and lowers cholesterol. Complex carbohydrates, found only in plants, are relatively low in calories and boost metabolism. Vitamin C is an antioxidant, and is involved in immunity, wound healing and the formation of collagen in skin, tendons and bones. When white meat takes the place of fruits, vegetables, wholegrains and pulses (peas, all types of beans and lentils) in your diet, you get less vitamins, less fibre, and unwanted dietary fat and cholesterol.

White Meat as a Source of Protein

Protein Quality

Protein plays an important role in the body, forming the basis of muscles, hair, nails and collagen (the connective tissue that holds the body together). It also plays regulatory roles, causing heart muscle to contract and the body to digest food, and is what makes DNA and enzymes.

To make protein, plants combine sugars (which they make from sunlight, carbon dioxide and water) with nitrogen from the air or soil. The end products are protein building blocks called amino acids – 'amino' simply means nitrogen-containing. There are 20 or so different amino acids in the body, of which the body can make about 11 just from carbohydrate, fat and nitrogen (from protein) in your diet. About nine of the amino acids are called 'essential amino acids' that must be supplied in the diet as the body cannot make them.

The essential amino acids in humans are:

- Histidine (in children)
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine

Animal, soya and quinoa (an increasingly popular food, which is a seed, used as a grain) products are sometimes called complete proteins as they contain plenty of all of the essential amino acids. Many other plant proteins have a relatively low amount of one or more of the essential amino acids – the so-called 'limiting' amino acid. Pulses (peas, beans and lentils) are a major exception to this general rule and contain good amounts of high quality protein. Nuts and seeds are rich protein sources, too.

However, the concept of a limiting amino acid has limited practical relevance – especially for people in affluent countries. Human protein requirements are relatively low compared to other species. Many dietary staples provide enough protein to meet these relatively low human needs. In addition, affluent people eat diets containing mixtures of several different proteins, rather than single proteins.

Different proteins consumed over a period of time have differing limiting amino acids. This means that any deficiency of one will be compensated for by a relative surplus of that amino acid in another. This is called mutual supplementation of proteins.

There is a persistent myth that vegetarians need to be well educated and choose protein foods that make up for the amino acid deficiencies of each another. But research shows that this is unnecessary, and that both vegetarians and omnivores get enough protein, including plenty of the amino acids they need, as long as they are getting enough calories.

Origins of the Protein Gap

In developed countries such as the UK where meat consumption is relatively high, meat provides the main source of protein. Meats are conventionally viewed as protein foods or 'complete proteins', because they contain all of the essential amino acids that the body needs. However, meats are also a major source of dietary fat (see ***White Meat: the Low-Fat Choice?***, page 7).

The myth that people should eat more protein is a hardy one, which dates back to the early twentieth century. The majority view back then was that health – and especially fitness – depended on generous amounts of protein in the diet, particularly meat (Millward, 2004). It was even reckoned that world hunger and malnutrition among children in the developing world was a result of not having enough protein, especially high-quality (ie animal) protein (Autret, 1969; Gounelle de Pontanel, 1972; Stillings, 1973; Scrimshaw and Young, 1976).

The myth reached epic heights in the 1960s. A UN report was published that identified worldwide protein deficiency. It called for a 'global strategy to avert the impending protein crisis'. International aid began to focus on projects to address the so-called protein gap. The US government, for example, subsidised the production of dried milk powder to provide 'high-quality' protein for the world's poor (Campbell and Campbell, 2005).

Then came a report by the Royal College of Physicians on diet and heart disease in 1976, which encouraged people to eat white meat in place of red, on the grounds that it contains less saturated fat and is therefore less damaging (Wang *et al*., 2004). It certainly worked, with poultry consumption in the UK almost trebling from the 1960s, with sales of pork, lamb and beef declining.

However the protein gap actually disappeared 'at the stroke of a pen' in 1969, when Miller and Payne concluded that almost all dietary staples contain sufficient protein to meet human needs. They calculated that even diets based on staples that were very low in protein were unlikely to be specifically protein deficient (Miller and Payne, 1969).

In the decades since 1969 this view has become the nutritional consensus. The maximum protein required, according to leading health bodies such as the World Health Organisation (WHO), is only around eight per cent of our calories from protein. Most foods can provide us with this eight per cent. The foods that are exceptions to this include fruits (which contain about five per cent of their energy from protein) and many sweets and junk foods. The WHO's value includes a large safety margin, so most people's real needs are even lower.

Scientists also once believed that some 'complete' protein was needed at each meal. We now know that the amino acids from protein remain in our bodies for at least four hours and for as long as 48 hours.

Despite this revolutionary change of mind, the greatly reduced emphasis on protein in human nutrition has been slow to filter through beyond the ranks of specialists.

White Meat: Essential for Growing Children?

There is a persistent myth that meat (as a protein food) is essential for growing children – perhaps more so than for adults. In reality, current protein reference nutrient intakes (RNIs) suggest that children can manage on a lower minimum concentration of protein in their diets than adults. A two-year-old child requires almost three times as many calories (energy) as an adult on a weight-for-weight basis, but only about one-and-a-half times as much protein. This means that a child's increased need for energy is far greater than their need for more protein *per se*. This applies to children of all ages: their increased calorie needs cancel out or, in most cases, greatly exceed, their increased need for protein.

The main cause of death in children in developing countries is from something called protein-energy malnutrition. It usually develops in children who get too little protein and energy, and these deficiencies tend to go hand-in-hand. Diets that contain enough energy (kilocalories) typically contain plenty of protein (see ***Origins of the Protein Gap***, page 13), so the real problem is usually quantity, rather than quality of food.

Wartime studies in the UK by Widdowson and McCance found that orphanage children grew faster than the general population when they ate a bread-based diet, with only a small fraction (14 per cent) of their protein coming from milk products. The orphanage children grew no faster when nearly half of their protein was from milk! Bread provided the children with plenty of energy to support their growth, whilst meeting more than double their protein needs (Millward, 2004).

Why were early estimates of protein requirements in children inflated? Dr Geoffrey Webb, Senior Lecturer in Nutrition and Physiology at the University of East London suggests that inappropriately extrapolating data from animal experiments to humans may have been a factor (Webb, 1995). Primates – including humans – have slower growth rates than most animals, and much lower rates than most common laboratory animals. Says Webb: "The relative protein requirements of these rapidly growing species [laboratory animals] are likely to be higher than those of human infants and children."

Don't go Against the Grain

Grains supply the vast majority of the calories that the world eats, and they provide protein, too – even though most people equate protein with animal foods such as meat, fish or dairy. In fact, almost all foods – grains, pulses (peas, all types of beans and lentils), nuts, seeds and vegetables – contain protein.

It's relatively easy to consume enough protein if you're a vegetarian, and especially so if you select from two or more of these three groups in a given day: wholegrains; pulses; nuts and seeds.

Says Dr Linda Bacon, nutrition lecturer at City College of San Francisco: "Eat a varied, nutrient-dense diet and there is no need to go out of your way to get protein or specific amino acids or amino acid combinations. It is more important to pay attention to the other nutrients the protein is packaged with than to concentrate on the protein itself. (For example, is the food high in fibre or low in saturated fat?)

"Plant products will typically do a better job of meeting your protein needs than animal products, both because they are less concentrated sources of protein (making protein over-consumption less likely) and because they are more likely to be bundled with other great nutrients, such as fibre, vitamins, minerals, phytochemicals and healthy fats," (Bacon, 2005).

The Hazards of Protein Over-consumption

The average Westerner gets well in excess of their protein needs. British men eat on average 88.2 grams per day, and women 63.7 grams (The National Diet & Nutrition Survey, 2003). This means that both sexes get more than double (just over 16 per cent) the WHO's recommendation of around eight per cent calories from protein – and suggests that protein deficiency is highly improbable in Britain and other industrialised countries.

An average portion of chicken meat (100g/3.5oz) provides 22.3g of protein, and turkey meat 22.6g – roughly half of a woman's daily requirement and almost half a man's. Duck and goose meat provide 19.7g and 27.5g of protein respectively. Too much protein has a well-documented link with many diseases, including kidney disease, osteoporosis, cancer, type 2 diabetes, and cardiovascular disease.

High protein diets usually involve eating protein from concentrated sources, such as animal products. As discussed in ***Saturated Fat***, page 9, animal products, even lean-looking meats, are often associated with large amounts of saturated fat and cholesterol. They also tend to be high in oxidants (see ***White Meat and Pro-oxidant Damage***, page 25), and low in fibre and antioxidants. But putting these nasties aside, there is strong evidence to suggest that it is excess protein *per se* which plays a part in increasing disease risk.

According to Dr Bacon, some amino acids may promote disease while others enhance health. There is compelling evidence that animal proteins – independent of other associated nutrients – increase risk for cancer (O'Keefe *et al.*, 1999; Sieri *et al.*, 2002; Holmes *et al.*, 2003; Yang *et al.*, 2002), atherosclerosis (Campbell, Parpia and Chen, 1998; Campbell and Junshi, 1994), osteoporosis (Messina and Messina, 2000; Hu *et al.*, 1993) and type 2 diabetes (Song *et al.*, 2004). This was particularly evident in the China Project (Campbell, Parpia and Chen, 1998; Campbell and Junshi, 1994; Campbell and Campbell, 2005). The Project was one of the largest and most comprehensive studies ever undertaken to examine the relationship between diet and disease. Huge differences were seen in disease rates based on the amount of plant foods participants ate compared to animal foods.

High-Protein Diets for Weight Loss

Data suggests that protein is the most filling nutrient of all (Eisenstein *et al.*, 2002; Halton and Hu, 2004) and has been credited with helping to curb hunger in people following high-protein diets. However, this has not been tested objectively. Alternative explanations such as monotony and ketosis may also contribute (Mattes *et al.*, 2005). While a few studies have observed that high-protein, carbohydrate-restricted diets can bring about modest short-term weight loss (Westman *et al.*, 2002; Foster *et al.*, 2003; Samaha *et al.*, 2003) the long-term health consequences of following such diets in order to lose weight have not yet been investigated.

Says Dr Steven Pratt, author of *Superfoods: 14 Foods that will Change Your Life*: "There's no doubt that the leaner the protein source the better, but low-fat, healthy animal protein is very hard to find," (Pratt and Matthews, 2004).

Indeed, most high-protein, low-carbohydrate diets contain less than 10 per cent carbohydrate, 25 to 35 per cent protein, and 55 to 65 per cent fat (PCRM, 2004). Because the protein is provided mainly by animal sources, these diets are high in saturated fatty acids and cholesterol, and could perhaps more aptly be renamed 'high-fat' diets (PCRM, 2004).

429 individuals following such a high-protein, high-fat, carbohydrate-restricted diet voluntarily logged their diet associated health problems using an online registry (www.atkinsdietalert.org).

Common findings included constipation, loss of energy, bad breath, difficulty concentrating, kidney problems, and heart related problems, including heart attack, bypass surgery, arrhythmias and elevated blood cholesterol levels (PCRM, 2004).

Says Dr Pratt: "Many people mistakenly believe that there's some special 'fat burning' paradise that you enter when you severely restrict your carbohydrate intake and simultaneously boost your protein intake… [however] most people who follow a high-protein diet and lose weight do so simply because their food choices are such that they automatically cut down on calories. When you restrict or severely limit one group of foods (carbohydrates), a group that ordinarily comprises over half your calorie intake, you can't help but lose weight. And once you go off the diet, all or most of the weight usually comes back."

And Dr Pratt cautions against additional dangers with an exceptionally high protein intake: "The more protein you take in, the more calcium you excrete in your urine, thus raising your risk for osteoporosis [see ***The Acidifying Effects of White Meat***, page 41]. In the Nurses' Health Study, women consuming more than 95 grams of protein a day (an extra-lean 6-ounce [170 gram] hamburger has 48.6 grams of protein) had an increased risk of fractures. While there is ongoing debate on this subject, it seems that vegetable protein causes less bone loss than animal protein."

Too much protein also puts a strain on the kidneys, forcing them to expel extra nitrogen in the urine, increasing the risk for kidney disease (also see ***Kidney Stones & Kidney Disease***, page 37).

White Meat: Desirable for Athletes?

Contrary to popular opinion, protein is not essential for building muscle. The belief that eating animal muscle (ie meat) means you automatically build human muscle simply isn't true. Muscles develop by being used, rather than eating greater amounts of another animal's flesh. Gorillas are the most muscular of all the primates. Their impressive physique comes from regular physical activity and a 99.9 per cent plant diet (0.1 per cent insects) (Fossey, 1977).

There is a widely held belief amongst athletes and coaches that training increases protein requirements. This also remains contentious. While the requirements for certain water-soluble vitamins, protein and iron may be slightly increased (Webb, 2006) these should be more than offset by an increased total food intake during training. This is the case for most athletes who are not deliberately and severely restricting their energy intake (Webb, 2006).
Athletes in training expend significantly more energy than the average person. As long as they eat

enough to satisfy their appetite and to maintain a constant body weight, they should automatically consume more calories than the average person. If their diet is similar in nutrient density to that of the rest of the population, then they should also take in more essential nutrients than the average person. This increased total food intake therefore makes protein – or any other nutrient – inadequacy unlikely in athletes.

Of course some athletes – such as gymnasts, figure skaters, jockeys, and those involved in sports where athletes are divided into weight categories – perceive the need to be lean, and thus restrict their energy intake. They have much lower energy intakes than would be predicted from their activity levels. It is therefore possible that they might have insufficient nutrient intakes.

For a discussion of the nutritional consequences of eating processed meat, see ***Processed Poultry***, page 60.

PART 2: The Health Consequences of Consuming White Meat

Food Poisoning

According to the Food Standards Agency, an estimated 5.5 million people in the UK are affected by food poisoning each year. Most cases aren't reported because people have mild symptoms and recover quickly. As a result, less than 100,000 cases a year are tested for the exact cause of food poisoning (NHS, 2009a).

Symptoms of food poisoning are generally the same, regardless of the bug – abdominal cramps, nausea, vomiting, diarrhoea, stomach pain, and sometimes fever – and may occur within 30 minutes of consuming contaminated food. Although food poisoning is particularly serious for children, adults can also be affected.

Patients become dehydrated, and for those who are already vulnerable – babies, the elderly, people with weakened immune systems and pregnant women – the resulting disturbance in their body chemistry can sometimes cause more serious illness, organ failure or even death.

Many cases of food poisoning are caused by micro-organisms, including bacteria, viruses and moulds.

Food poisoning from bacteria occurs in different ways. Some types of bacteria release toxins while they are growing in food, which cause food-poisoning symptoms soon after the food is eaten. With other types of food poisoning, the bacteria grow in the body first before causing symptoms. This leaves a gap between eating and symptoms called the incubation period. The incubation period varies in length – it can be a few hours or up to a few days.

A relatively small number of types of bacteria are responsible for almost all the serious food poisoning in the UK. BUPA (2008) lists the food sources of food poisoning bacteria as:

- meat and meat products – such as minced meat and pâtés
- poultry – such as chicken or turkey
- seafood – fish and shellfish
- eggs and raw egg products (such as mayonnaise)
- unpasteurised milk (or milk contaminated after pasteurisation)
- soft and mould-ripened cheeses
- cooked foods – such as fried rice

In fact, 95 per cent of food poisoning is caused by animal products – either directly or through their contamination of other foods (Goldman, 2001). Chicken is the main source of food poisoning in Europe. In recent years, the amount of chicken eaten in the UK has risen dramatically, so it is not surprising that food poisoning is on the increase.

The conditions in which broiler chickens are kept are rife for the spread of disease (see ***Inside the Broiler Shed***, page 51). Thousands are kept per shed, in tightly confined spaces, and the birds are not cleaned out during their six week lives. Not only do they live in their own excreta, they also live on top of the chickens that die in the factory-farming process.

Bacteria may be introduced to chicken flocks from outside the sheds, transmitted from parent to offspring (eg through eggs, in the case of *Salmonella*), or simply remain in inadequately cleaned poultry sheds. Pathogens such as *E. coli O157* and *Campylobacter* are picked up by broilers on farms and excreted in high numbers in the faeces of infected chickens.

As chickens eat faeces, pathogens spread easily in broiler chicken flocks – without necessarily causing illness in the birds themselves. *E. coli O157* may be a particular threat, as infected animals may show no symptoms of disease but still be infected, and thus excrete large numbers of the pathogen (Food Standards Agency, 2008c). Pathogens are often spread further at slaughter.

Traditionally, animal manure has been used as a fertiliser (along with certain wastes from abattoirs, such as gut contents and blood). This means that bacteria, parasites and viruses may directly contaminate fertilised crops and the livestock eating them, or, more indirectly, may contaminate water sources.

Just picking up a package of meat in a supermarket could put someone at risk of food poisoning. Researchers swabbed the outside surface of packages of raw meat – and found *Salmonella*, *Campylobacter* and multidrug-resistant *E. coli* present (Burgess, 2005). Poultry showed most contamination, followed by lamb, pork and beef.

One swab of a single Q-tip picked up over 10,000 live *E. coli* bacteria – and just 10 *E. coli 0157:H7* bacteria can lead to a potentially fatal infection (CAST, 1994). The researchers conclude: "The external packaging of raw meats is a vehicle for potential cross-contamination by *Campylobacter*, *Salmonella*, and *E. coli* in retail premises and consumers' homes," (Burgess, 2005).

Campylobacter

Like *Salmonella* and *E. coli*, *Campylobacter* are bacteria found in the intestines of many animals, non-organic and organic, although most commonly in poultry (Newell and Fearnley, 2003). Chicken is the largest single source of *Campylobacter* poisoning. Infection of an entire flock will usually take just a few days. It is more common in free-range and organic birds because *Campylobacter* is widespread in the environment (Newell and Fearnley, 2003).

The bacterium causes severe abdominal pain and, often, bloody diarrhoea. Rare but serious long-term effects can develop, such as Reiter's Syndrome, a type of arthritis. An estimated one in a thousand people infected with *Campylobacter* go on to suffer Guillain-Barré Syndrome, a neurological condition that can be fatal (Ellis, 2007).

Campylobacter is a common finding in chickens on supermarket shelves. A series of Food Standards Agency surveys between 2001 and 2004 showed that between 42 per cent and 76 per cent of retail chickens were contaminated with *Campylobacter* depending on the region. The highest rate was found in Northern Ireland and the lowest in Wales.

Salmonella

There are 2,000 different types of *Salmonella* bacteria and the intestines of chicken act like a reservoir and provide the potential for the spread of bacteria. According to a Government survey, organic laying hen farms seem to have a lower level of *Salmonella* than caged hens. The study showed that 23.4 per cent of farms with caged hens tested positive for *Salmonella* compared to 4.4 per cent in organic flocks and 6.5 per cent in free-range flocks (*The Veterinary Record*, 2007).

Salmonella poisoning can cause vomiting, diarrhoea, abdominal pain, and fever lasting for several days. When it spreads to the blood and other organs, it can be fatal.

A recent Food Standards Agency survey of retail chicken showed that about six per cent of chickens were contaminated with *Salmonella*. *Salmonella* cause between 50 and 100 deaths in the UK every year.

E. coli

As with *Campylobacter* and *Salmonella*, the presence of *E. coli* in undercooked food is a sign of faecal contamination – from the meat, dairy and egg industries (Schoenl and Doyle, 1994).

E. coli infection causes haemorrhagic colitis (bloody diarrhoea) and abdominal cramps. In extreme cases it can progress to kidney failure, seizures, coma and death. *E. coli (0157:H7)* infection – from faecal contamination – is a leading cause of acute kidney failure in children.

Additionally, millions of people develop 'extra-intestinal' *E. coli* infections – urinary tract infections (UTIs), which can invade the bloodstream and cause death. UTIs are among the most common infectious diseases in women – and may well be linked to eating meat.

The faecal flora found in animal carcasses (eg *Campylobacter, E. coli* and *Salmonella*) may show antibiotic resistance. This is because of antimicrobial agents used in food-animal production (see ***Antibiotics***, page 57). Indeed, a BBC investigation in 2005 found that about half of British chickens contained antibiotic-resistant *E. coli* bacteria – resistant to the antibiotic Trimethaprim, used to treat UTIs.

Scientists suspect that by eating chicken and other meat, women infect their lower intestinal tract with antibiotic-resistant bacteria, which can then creep up into their urethra, causing a UTI. A BBC 1 television report expressed concerns that: "these types of bacteria could make infections in humans more difficult to treat," (ElAmin, 2005).

Avoiding Food Poisoning

Most bacteria grow best and increase in number in a moist environment between a temperature 'danger' zone of between 5°C and 60°C. Bacteria cannot grow effectively at temperatures above or below this. The Food Standards Agency advises: "It's very important to cook meat properly to make sure that any harmful bacteria have been killed. Otherwise you might get food poisoning," (Food Standards Agency, 2008c).

Unfortunately, the temperature required to kill faecal bacteria (160ºF/71ºC) is the same temperature which produces carcinogenic compounds called heterocyclic amines (see ***HCAs***, page 27).

If you want to avoid food poisoning, or any potential risk from bird flu, then you're advised to cook white meat properly. But beware – thoroughly cooked chicken may increase the risk of cancer.

According to Dr Michael Greger: "Although there are cooking methods that result in lower carcinogen concentrations (marinating followed by a microwaving pre-treatment and pouring off of the 'juices', followed by relatively low temperature frying with frequent flipping), there does not seem to be a way to cook meat to an internal temperature necessary to kill off [food poisoning] bacteria without producing at least some carcinogenic compounds. And even low doses have been shown to cause human DNA mutations which could lead to cancer," (Greger, 2005).

Cancer

In 2007, around 7.6 million people worldwide died of cancer. In the UK, cancer causes 126,000 deaths per year and it kills one in four (NHS, 2009b). There are hundreds of different types of cancer. The most common cancers in Britain include cancers of the breast, prostate, lung, colon (or rectum), bladder and uterus (womb).

Cancer begins as a single abnormal cell, which begins to multiply out of control. Groups of such cells form tumours and invade healthy tissue, often spreading to other parts of the body. It takes years for a noticeable tumour to develop.

Substances which promote the development of cancerous cells are called carcinogens, and may come from foods, the air, or from within the body. Although most carcinogens are neutralised before damage can occur, they sometimes attack and alter the cell's genetic material (DNA).

While smoking is the biggest single preventable risk factor for cancer – causing one third of all cancers – a poor diet may be responsible for up to a third of all cancer deaths (Department of Health, 2000). Compounds known as inhibitors can help prevent abnormal cells from growing. These include carotenoids, the pigment that gives fruits and vegetables their colour; flavones and indoles found in vegetables such as cabbage, broccoli and Brussels sprouts; and beta-carotene, in dark green and yellow vegetables. According to the World Health Organisation, fruit and vegetables offer protection from lung, colon, bladder, rectum, oral cavity, stomach, cervix and oesophagus cancers.

Dietary fat, on the other hand, is a known promoter, helping abnormal cells to grow quickly. Research suggests that fat in foods increases a person's risk for cancer, and it may also adversely affect breast cancer survival rates for those who have cancer (Wynder *et al.*, 1986).

There is evidence that animal fat is much more harmful than vegetable fat. 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 – specifically cancers of the bowel, stomach, mouth, larynx, and oesophagus. However, a poor diet can also increase the risk of many other cancers including breast and prostate cancer (Cancer Research UK, 2005a).

As long ago as 1892, *Scientific American* stated that: "Cancer is most frequent among those branches of the human race where carnivorous habits prevail," (PCRM, 2008a).

Breast Cancer

In the UK, breast cancer is the most common type of cancer among women. In 1980 there were 25,000 cases each year. Nowadays approximately 45,000 new cases of breast cancer are diagnosed annually. It usually affects women who are over 50 years of age and who have reached the menopause. However, it is possible for women of any age to be affected by breast cancer and, in rare cases, the condition can also affect men (NHS, 2009c).

Although Asian countries have a much lower rate of breast cancer than Western countries, when Japanese girls are raised on Western diets, their rate of breast cancer increases dramatically (PCRM, 2008). A Japanese study found the risk of breast cancer was eight-and-a-half times higher in affluent women consuming meat every day than poorer women who did not eat meat daily (Hirayama, 1978).

One proposed reason is that high-fat foods – such as meat, dairy products, fried foods and vegetable oils – cause women to make more oestrogens. These encourage cancer cell growth in the breast and other organs which are sensitive to female sex hormones.

It is believed that switching to a lower fat diet throughout life decreases the risk of hormone-related cancer. Research in the *Journal of the National Cancer Institute* found that when girls aged eight to ten reduced the amount of fat in their diet – even very slightly – by increasing fruits, vegetables, grains and pulses, and cutting down on animal-derived foods – their oestrogen levels were at lower and safer levels for the next few years. The amount of oestradiol (a main oestrogen) in their blood dropped by 30 per cent, compared to a group of girls who did not change their diets (Dorgan *et al.*, 2003).

In addition, researchers at the Ontario Cancer Institute conducted a meta-analysis of all the case-control and cohort studies published up to July 2003 which looked at how dietary fat and fatty foods affect breast cancer risk. A high total fat intake was associated with increased breast cancer risk. Furthermore, a high meat intake increased cancer risk by 17 per cent, and a high saturated fat intake increased cancer risk by 19 per cent (Boyd *et al.*, 2003).

Several studies show links between meat intake and breast cancer risk, even when confounding factors, such as total energy (calorie) intake and total fat intake are controlled (De Stefani *et al.*, 1997; Matos *et al.*, 1991). Part of the reason may be that meat is a source of carcinogens such as HCAs, formed when meat is cooked at high temperatures (see ***HCAs***, page 27). Certain HCAs reach the mammary gland (Snyderwine *et al.*, 1994).

Zheng *et al.* conducted a case-control study among members of the Iowa Women's Health Study. 41,836 women were followed over the years from 1986 for mortality, cancer incidence and diet. During 1995 to 1996, Zheng and colleagues looked at all members of the original group who had been diagnosed with breast cancer (the cases) and compared them to a random sample of women from the original group who were free of cancer (the controls). They looked at the intake and preparation of meats consumed by both groups over the years. This analysis found that breast cancer risk increased with increasing intake of well done to very well done meat (Zheng *et al.*, 1998).

Colorectal Cancer (Bowel Cancer)

Colorectal cancer, or bowel cancer, refers to cancer in the colon (first part of the large intestine) and rectum (last part of the large intestine). Colon cancer affects men and women equally. However, it is the third most common type of cancer in men, and the second most common type in women.

Colon cancer usually affects people over the age of 40, with the majority of people who are diagnosed with the condition being over 60 years of age. Every year, 35,000 people are diagnosed with bowel cancer in the UK (NHS, 2009d).

The Harvard Nurse's Health Study found that women with higher animal fat intakes had a greater risk of bowel cancer (Willett *et al.*, 1990). Similar results have been found for men. One prospective study into the dietary risk factors for colorectal adenomas (precursors of cancer) found a link with saturated fat. Fibre, however, reduced risk (Giovannucci *et al.*, 1992).

Total fat and saturated fat, which tend to be considerably higher in animal products than in plant foods, and refined sugar, all increase colon cancer risk.

A review of 32 case-control and 13 cohort studies concluded that meat consumption is associated with an increase in colorectal cancer risk, especially red and processed meat (Norat and Riboli, 2001). As with breast cancer, cooking methods that promote the formation of HCAs are believed to play a significant role in bowel cancer risk (Norat and Riboli, 2001).

However, contrary to claims that white meat is healthier than red meat, earlier studies have also indicated that those consuming white meat, particularly chicken, have approximately a three-fold higher colon cancer risk, compared to vegetarians (Fraser, 1999).

A 1998 prospective study (recording subjects' diets and tracking their health over the following years) linked both red and white meat (and fish) intake to colon cancer. Researchers at Loma Linda University examined the eating habits of 32,000 men and women between 1976 and 1982 and monitored cancers over the six years. Among those who avoided red meat but ate white meat less than once a week, bowel cancer risk was 55 per cent higher than for those who avoided both kinds of meat. Those who had white meat at least once a week had more than a three-fold risk of suffering bowel cancer.

Conversely eating pulses (peas, beans or lentils) at least twice a week was associated with 50 per cent lower risk compared to never eating these foods (Singh and Fraser, 1998).

Interestingly, 'substituters' (people who used low-fat dairy products instead of high-fat ones; poultry instead of red meat; and wholegrains instead of refined grains) were at reduced risk for colon cancer but the reduction was not significant. The authors conclude that this was because many adopting these 'substituter' so-called 'healthier' diets were not increasing their vegetable consumption and this aspect of the diet is important in significantly reducing bowel cancer risk (Slattery *et al.*, 1998).

Fibre is a major constituent of a plant-based diet and it has been long thought that high-fibre diets help to protect against colon cancer. The reason for this centres around fat digestion.

In order to absorb fat, the liver makes bile, which it stores in the gallbladder. After a meal, the gallbladder sends bile acids into the intestines. Bacteria in the intestines turn these bile acids into cancer-promoting substances (mutagens) called secondary bile acids. Meats, unlike plant foods, contain a substantial amount of fat, and also nurture the growth of bacteria that cause these disease-causing acids to form. Fibre, however, changes the type of bacteria that are present in the intestine, which reduces the production of carcinogenic (cancer-causing) secondary bile acids (PCRM, 2009a). Fibre may also help both by diluting the presence of such harmful acids in the faeces and by speeding up their passage through the colon.

Prostate Cancer

Prostate cancer is the most common cancer in men, responsible for 25 per cent of newly diagnosed cases of cancer in England and Wales (NHS, 2008e) and the second most common cause of male cancer deaths after lung cancer. One in 14 men in the UK will be diagnosed with prostate cancer at some point in their lives (Cancer Research UK, 2005b).

The chances of developing prostate cancer increase with age. Most cases develop in men aged 65 or older. For reasons that are not understood, prostate cancer is more common in men who are of Afro-Caribbean or African descent and less common in men of Asian descent.

Professor Jonathan Waxman, the founder of the Prostate Cancer Charity, believes that dietary factors are strongly implicated. The rise in meat consumption since World War II is the main culprit but eating dairy products can also increase a man's chances of developing it due to the hormones in cow's milk. Vegetarians are half as likely to contract it as non-vegetarians (Browne, 2000).

Research shows that men who consume diets based on animal products tend to have more testosterone and oestrogens compared to men who eat plant-based foods. This may be due to over-production of these hormones in the body or, since fibre in the diet is essential for the normal excretion of sex hormones, a lesser ability to get rid of them. This hormonal boost can affect the prostate and, according to the Physicians Committee for Responsible Medicine, is probably the reason for increased cancer risk among those on a meat-based diet (PCRM, 2009b).

A lower risk of prostate cancer is associated with diets higher in rice, soya bean products and vegetables (PCRM, 2009b). Not surprising then that vegetarians have been found to have low rates of prostate cancer (Phillips, 1975) and increasing consumption of pulses, fruits and vegetables are all associated with significantly decreased prostate cancer risk (Mills *et al.*, 1989).

Other Cancers

Although not as extensively studied as breast, colon, and prostate cancer risk, many studies have found a significant link between meat consumption and the risk of kidney and pancreatic cancer. Three of eight case-control studies examining the relationship between renal cell cancer and meat consumption found a statistically significant increase in cancer risk with high meat consumption. A Japanese study found that people consuming meat daily had higher death rates from kidney cancer than those eating meat less frequently (World Cancer Research Fund, 1997).

Pancreatic cancer is relatively uncommon, yet it is frequently fatal, with fewer than 20 per cent of patients surviving for one full year. No relationship has been demonstrated between dietary fat, saturated fat, and protein intake and pancreatic cancer risk, which implies that cooking methods, and possibly HCA and PAH formation in cooked meat, might explain the link (World Cancer Research Fund, 1997).

Risk factors for pancreatic cancer were evaluated in a 20-year study between 1966 and 1986. This study of over 17,500 men in the United States revealed – after adjustment for other risk factors – that those who ate meat were three times more likely to develop cancer of the pancreas than those with low meat consumption (Zheng *et al.*, 1993).

International comparison studies have shown that as Japan's diet has Westernised and become more reliant upon animal fat and protein, the incidence of pancreatic cancer has increased. Consumption has steadily increased from a daily level of 6.5 grams of animal fat per person in 1955 to 27.6 grams in 1987. Animal protein consumption has doubled in these 30 years (Wynder *et al.,* 1991).

A case-control study of diet and endometrial cancer published in 1993 revealed that women eating the most animal fat and animal protein had more than three times the risk of developing this particular cancer. High consumption of meat, eggs and fresh fish were all associated with elevated risk (Shu *et al.*, 1993).

White Meat and Pro-oxidant Damage

A leading theory behind ageing and disease is the Oxidant Stress Theory. This theory suggests that free radicals cause both the age-related deterioration in our bodies and the tissue damage behind most chronic diseases. Put simply, ageing and disease can be thought of as the oxidation of our bodies – just like rust is the oxidation of metal.

Free radicals are unstable molecules which are a product of oxidation. In stable molecules, electrons normally associate in pairs, providing a balance. Everyday functions, such as simply breathing, digesting food or moving about can remove one electron from a molecule, creating a free radical. This now unstable molecule tries to regain an electron by snatching one from another molecule. When it succeeds, another free radical is created and a chain reaction is set up in which the DNA, the body's vital genetic information, may be damaged.

The Oxidant Stress Theory explains why plant foods (fruits and vegetables, pulses (peas, beans and lentils), nuts, seeds, and wholegrains) seem to protect against numerous diseases, including Alzheimer's, cancer and cardiovascular diseases. The antioxidants contained in these foods help to destroy the free radicals produced in our own bodies and those present in the environment.

A healthy vegetarian diet made up of the aforementioned foods results in higher intakes of dietary fibre, antioxidants and protective plant nutrients known as phytochemicals (Rajaram, 2003). Higher blood levels of antioxidants, as found in vegetarians, leads to correspondingly lower rates of chronic disease. Researchers in the Slovak Republic have demonstrated that vegetarians have lower levels of the intermediate indicators of oxidised tissue damage than meat eaters.

The researchers gauged the levels of tissue damage in vegetarians and meat-eaters by measuring the level of something called peroxidised conjugated dienes. These are caused by the highly toxic free radical, hydroxyl. Over 40 per cent of the meat-eating subjects exceeded safety limits for these damage indicators, compared to just eight per cent of those who had followed a vegetarian diet for an average of ten years (Krajcovicová-Kudlácková *et al.*, 2004).

The researchers believe that levels of oxidant damage in vegetarians would be lower still if those in the study had not had elevated levels of homocysteine due to inadequate vitamin B12 intake. To get the full health benefits from a plant-based diet, they recommended that vegetarians ensure a reliable source of vitamin B12 (from fortified foods including breakfast cereals and reduced salt yeast extract or supplements).

The results of the study: "document a better antioxidant status of vegetarians as a consequence of higher consumption of protective food." Furthermore, the researchers suspect that the haem (blood-based) iron found in red meat, chicken and fish was a particular cause of pro-oxidant damage (Krajcovicová-Kudlácková *et al.*, 2004).

White Meat in the Heat

Advanced Glycoxidation End-products (AGEs)

Advanced Glycoxidation End-products (AGEs, also known as glycotoxins) are toxins, naturally produced by the body each day. Cigarette smoke is a powerful source of glycotoxins, (Cerami *et al.*, 1997) although they are also obtained via the diet.

AGEs have numerous detrimental effects on the body. They accumulate in joints and cause arthritis (Verzijl *et al.*, 2003); they accumulate in the brain contributing to Alzheimer's disease (Münch *et al.*, 1998); and in arteries, causing high blood pressure (Silacci, 2002) and atherosclerosis (Stitt *et al.*, 1997).

AGEs can also build up in the eyes, causing cataracts, (Stitt, 2001); in the kidneys, contributing to kidney failure (Miyata *et al.*, 2000); and in the penis causing male erectile dysfunction (Seftel *et al.*, 1997). The Maillard Theory blames nearly all of the complications of ageing on the build-up of these toxic compounds (Baynes, 2002).

Researchers at Mount Sinai measured the amount of AGEs in over a hundred common food items. The highest amounts were predominantly found in meat products, including oven-fried chicken, McDonalds Chicken Nuggets, and cooked chicken breast (Goldberg *et al.*, 2004). Investigators with the Women's Health Study reported that the AGEs in meat may be why women who eat meat five or more times a week are at significantly higher risk for developing diabetes (Song *et al.*, 1994).

Dry heat, protein and fat seem to be the combination of factors needed to produce these glycotoxins. The researchers comment: "Foods that contain mostly carbohydrates, starches, fruits, vegetables…

contain the lowest AGE concentrations." However, at high enough temperatures, high fat and protein plant foods such as roasted nuts can also form significant amounts of AGE.

The researchers propose three ways of decreasing dietary intake of AGEs. Firstly, reducing the intake of high-AGE foods such as full-fat cheeses, meats and highly processed foods. Secondly, using cooking techniques that minimise AGE formation, such as boiling, steaming and microwaving, rather than frying, roasting or grilling. Thirdly, by selecting unprocessed nutrients when possible.

Centring the diet around whole plant foods which have ideally not been exposed to temperatures above about 400ºF (204ºC) is an ideal way to reduce exposure to AGEs.

Heterocyclic Amines (HCAs)

Heterocyclic amines, or HCAs, are a group of hazardous chemicals linked to cancer in humans. They are produced when many animal products are cooked – including chicken, beef, pork and fish. Even normal grilling, frying or roasting can produce significant quantities of HCAs (Skog *et al.*, 1998; Robbana-Barnat *et al.*, 1996; Thiebaud *et al.*, 1995). The longer and hotter the meat is cooked, the more these compounds form (Knize *et al.*, 1994). Consequently, the concentrations of HCAs in different meats can vary by more than 100-fold.

In January 2005, HCAs were added to the US federal government's list of known carcinogens (US Department of Health and Human Services, 2005). Several HCAs also occur in tobacco smoke and diesel exhaust.

HCAs were first discovered in cooked foods by Professor Sugimura and colleagues more than 30 years ago (Sugimura, 1997; Sugimura *et al.*, 2004). Since that time, more than 20 HCAs have been identified in cooked meats. PhIP (2-amino-1-methyl-6-phenylimidazo[4,5-b]pyridine) is one of the most abundantly formed HCAs in cooked meat. PhIP is associated with an increased risk of cancer of the colon, breast and prostate (Wilson *et al.*, 2007).

PhIP is formed when creatine (an amino acid found in muscle) and other amino acids and sugars, which are naturally present in meats, are heated during cooking (Jagerstad *et al.*, 1991). All meats, including white meat and fish, are high in creatine, which is mostly found in muscle tissue. Unsurprisingly, fish shows significant HCA formation. Grilled veggie burgers and other vegetarian foods such as portabello mushrooms contain either no HCAs or negligible levels (Nagao and Sugimura, 2000).

Some of the highest concentrations of HCAs are found in grilled meat, especially chicken. Grilling is particularly carcinogen-forming because it involves high heat and long cooking times. On the grill, chicken produces more than ten times the amount of HCAs found in grilled beef. Chicken contains large amounts of the amino acids phenylalanine, tyrosine and isoleucine, which contribute to HCA formation.

Frying and oven-baking also frequently produce large amounts of HCAs (Skog *et al.*, 1998; Robbana-Barnat *et al.*, 1996; Thiebaud *et al.*, 1995).

The concentrations of HCAs formed in meats prepared by common household cooking practices are generally in the low parts-per-billion (ppb) range. Concentrations in meats or poultry that are well-done (Skog *et al.*, 1998), or the grilled pan scrapings often used for gravy, can be as high as 500 ppb. However, even at low concentrations, HCAs have been shown to induce DNA damage and initiate cancer (Felton *et al.*, 2002). DNA adducts of HCAs have been detected in human tissues.

Cooked meat has been shown to contain up to 50ng PhIP per gram of meat, thus intakes of between 1 and 50 micrograms PhIP per day are feasible (in Lauber *et al.*, 2004). PhIP consumed in meat is extensively absorbed (Boobis *et al.*, 1994).

Exactly how PhIP increases cancer risk is uncertain. It has been suggested that PhIP produces harmful molecules called reactive oxygen species which cause DNA strands to break, thus increasing cancer risk (Wilson *et al.*, 2007). An alternative suggestion by researchers at Imperial College in London is that PhIP is a potent mimic of the hormone oestrogen (Lauber and Gooderham, 2007). Many studies link higher oestrogen levels to breast cancer (eg Ali and Coombes, 2002). Oestrogens have also linked to cancers of the ovaries (Lacey *et al.*, 2002), endometrium (Sherman, 2000), prostate (Oh, 2002) and colon (English *et al.*, 2001).

PhIP has oestrogenic activity even at the low concentrations typically found in home cooking. Lauber *et al.* conclude that: "Exposure to PhIP even at low doses, could result in oestrogenic effects," (Lauber *et al.*, 2004).

Recently a not-for-profit organisation in the USA (Physicians Committee for Responsible Medicine, or PCRM) filed a lawsuit against seven high street restaurant chains over carcinogens in grilled chicken. In independent laboratory tests by Columbia Analytical Services, 100 grilled chicken items from American restaurants including McDonalds, Burger King and TGI Friday's were all found to contain PhIP. Every sample from every restaurant was found to contain PhIP (PCRM, 2008b).

The lawsuit was filed in Los Angeles Superior Court under proposition 65, which was designed to 'protect the health and safety of California residents'. Burger King, based in Miami, settled the lawsuit by agreeing to warn customers that its grilled chicken entrees contain PhIP. PCRM reports that warning signs have been posted in Burger King's California restaurants (PCRM, 2008b).

In addition to HCAs, cooked meats also contain a variety of carcinogens at low concentrations, including: polycyclic aromatic hydrocarbons, N-nitroso compounds, lipid peroxides, other pro-oxidative agents, and fungal products. Cross and Sinha suggest that the carcinogenic potency of grilled meats, and health risk, may be related not only to HCAs, but also to this complex mixture of genotoxic compounds (Cross and Sinha, 2004). Genotoxic compounds are chemicals which are thought to interact with DNA to cause cancer.

The Food Standards Agency comments: "It isn't possible to establish a safe level of consumption for genotoxins but independent experts advise that intakes should be as low as possible," (Food Standards Agency, 2008d).

Polycyclic Aromatic Hydrocarbons (PAHs)

When foods are grilled over a direct flame – with fat dropping down on to it – polycyclic aromatic hydrocarbons (PAHs) are contained in the flames. PAHs stick to the surface of the food: the more intense the heat, the more PAHs are present (World Cancer Research Fund, 1997). They are believed to play a significant role in human cancers (Norat and Riboli, 2001). There is a fairly consistent link between grilled (but not fried) meat consumption and stomach cancer. This implies that dietary PAHs may play a role in the development of stomach cancer (World Cancer Research Fund, 1997). While HCAs only form in meat, poultry and fish, PAHs may also be formed in other foods.

PAHs are also produced when fossil fuels or refuse are burnt, and are found in tobacco smoke and vehicle exhaust emissions.

Avoiding animal products – including white meat – is a key step in steering clear of HCAs, PAHs, nitrosamines, and other cancer-promoting substances.

Cardiovascular Disease (CVD)

Cardiovascular disease (CVD) describes conditions that affect the heart and blood vessels. It usually occurs as a result of atherosclerosis (hardening and narrowing of the arteries). Atherosclerosis starts when the blood vessels are damaged. This can occur for many reasons, such as stress, high blood pressure or even a viral or bacterial infection.

The body's response is inflammation. It sends in certain fix-it cells (white blood cells) to try to repair the damage. Over time, the white blood cells collect fatty deposits (plaques). These plaques build up on the inner artery walls, narrowing the arteries. The more cholesterol in the blood, the faster plaques grow. The plaques may eventually become so thick that they completely block the flow of blood through the arteries.

Many diet and lifestyle factors can cut the risk of atherosclerosis – and therefore reduce the risk of CVD.

CVD is the single largest cause of death in the UK, accounting for approximately 200,000 deaths per year. Most of these deaths result from either heart disease or strokes (NHS, 2009e).

The Role of Atherosclerosis in Coronary Heart Disease

The heart is a pump which circulates blood around the body. Like other muscles, it needs oxygen and other nutrients to provide the energy for its work. The coronary arteries provide this, supplying the heart with oxygen-rich blood.

Coronary heart disease usually occurs as a result of atherosclerosis. Plaques in the coronary arteries reduce blood supply to the heart muscles. In some cases, plaques rupture, causing a blood clot to form. If blood flow to the heart is blocked by a blood clot a heart attack can occur.

Heart attacks can be silent and painless or they can be extremely painful and deadly. Permanent damage to the heart can occur – in fact the affected part of the heart can die. In the following weeks this dead muscle is replaced by scar tissue. Unlike the rest of the heart, scar tissue cannot contract, which makes the heart work less efficiently.

Coronary heart disease is the UK's biggest killer, with one in every four men and one in every six women dying from the disease. In the UK, approximately 300,000 people have a heart attack each year (NHS, 2009f).

With angina, the blood vessels supplying the heart are partially, rather than fully, blocked by atherosclerosis. This reduced capacity allows enough blood to the heart when a person is resting but not enough to provide sufficient oxygen for physical activity. This can lead to discomfort or severe chest pain. The pain may also occur in the shoulders, arms, neck, jaw or back or feel like indigestion. There is also sometimes difficulty in breathing, weakness, sweating, fear of death, nausea, numbness or tingling in the arms or fingers. In some cases there are no symptoms at all.

Angina affects about one in 50 people, and in the UK there are an estimated 1.2 million people with the condition. It affects men more than women, and the chances of getting it increase with age (NHS, 2009f).

White Meat Consumption and Cardiovascular Disease Risk

A large recent study shows that white meat intake increases the risk of death from cardiovascular disease in men, and in both male and female non-smokers. National Cancer Institute researchers investigated the diets of approximately half a million people aged 50 to 71. They examined the relationship between red, white, and processed meat intake and mortality. Among those who had never smoked, higher white meat intake was associated with increased cardiovascular disease mortality. This was true for both men and women. Surprisingly, given all of the other evidence to the contrary (see ***Cancer***, page 21, and HCAs, page 27) the study also reported a link with higher white meat intake and reduced cancer mortality (Sinha *et al.*, 2009).

With all heart-related diseases, vegetarians suffer less than meat eaters and the more meat you eat, the more likely you are to end up with atherosclerosis. According to the WHO's report on diet, nutrition and disease published in 1991, dietary factors clearly play a role in CVD: "All the available evidence suggests that, for cardiovascular disease and cancer, diet has an influence throughout the life cycle, even though the end-points are manifested in the adult," (World Health Organisation, 1991).

After 30 years of surgery, world renowned heart surgeon Christiaan Barnard concluded that most heart attacks are preventable. He states that our diets lack sufficient fruits and vegetables, are not properly balanced and that we should live like the people of Crete, where heart disease is almost unknown. Fruit and vegetables are the mainstay of the diet and meat consumption is 32 per cent less than in northern Europe (Barnard, 2001).

Many of the countries performing best in terms of health are characterised by such diets (Evans *et al.*, 2001; McKee, 2001). A well-balanced vegetarian diet is by its very nature along the lines of a Mediterranean-type diet – with higher intakes of plant foods, especially fruits and vegetables, and of course zero meat consumption.

A number of studies have demonstrated that a vegetarian diet can cut the risk of heart disease (Key *et al.*, 1998; Key *et al.*, 1999). Compared with non-vegetarians, Western vegetarians were found to have lower blood cholesterol levels and lower mortality from heart disease by about 25 per cent. The widespread adoption of a vegetarian diet could prevent approximately 40,000 deaths from heart disease in the UK each year (Key *et al.*, 1999).

Apart from being slimmer, having lower cholesterol levels and lower blood pressure levels, research suggests yet another factor may protect vegetarians against heart disease. Scottish researchers found that levels of salicylic acid in the blood of vegetarians were up to one-and-a-half times higher than in meat eaters. Some vegetarians had levels up to 12 times higher (Blacklock *et al.*, 2001). Salicylic acid is the main component of aspirin – widely prescribed to reduce the risk of heart attacks – which helps fight the inflammation that causes most cardiovascular illness. Salicylic acid is also present in fruits and vegetables suggesting a high dietary intake may produce some of the same good effects as aspirin.

Dr Dean Ornish

Back in 1990, Dr Dean Ornish, a Harvard-trained doctor, published a study that set out to test whether heart disease could not only be prevented, but might also actually be reversed. He wanted to see whether it could be done with diet and lifestyle changes alone rather than surgery or drugs.

Before then, most doctors did not even attempt to reverse heart disease even though, as now, it was a major cause of death. Most believed that the plaques of cholesterol and other substances that clog arteries to the heart could not be reduced. The traditional way to remove them was to wait until they became severe enough to warrant a bypass or angioplasty.

Dr Ornish studied 47 patients in the San Francisco Bay Area, all of whom had significant heart disease with some already having had heart attacks. One group of heart patients was given the standard care that doctors usually prescribe – a diet based on 'lean' meat, poultry and fish, along with various medications, and were advised not to smoke. Another group went on a low-fat, vegetarian diet (less than 10 per cent of their calories from fat) exercised moderately (brisk walking for half an hour per day or an hour three times per week), were taught stress management and were also advised not to smoke.

A year later, all patients had an angiogram – an X-ray showing any blockages in the coronary arteries. The results were astonishing. For the patients receiving standard medical care, blockages were, on average, worse than at the start of the study; they still had chest pain and still needed medication. For patients in the experimental group, however, the story was very different.

Chest pain had begun to disappear within weeks, cholesterol levels dropped dramatically and at the end of the year, 82 per cent saw deposits (plaques) in their coronary arteries start to dissolve without medication, surgery or side effects! The only 'side effects' were good ones – the average patient lost around one-and-a-half stones in the first year!

Many doctors still recommend 'chicken and fish' diets even though numerous studies have shown that heart patients who just tinker with their diets in this way generally get worse over time. Those who adopt a low-fat, vegetarian diet, take daily exercise, avoid tobacco and manage stress stand the best chance of reversing heart disease.

Dr Caldwell Esselstyn

A surgeon named Dr Caldwell Esselstyn used the same type of diet for severely ill heart patients, the majority of whom had, in effect, received a death sentence. Doctors had told them there was nothing more they could do and some had been given less than a year to live.

Just about everything had been tried – repeated open heart surgery, angioplasties, stents and a plethora of medications. There was no longer any useful effect and almost all the men were impotent, most had angina and for some, things were so bad that they couldn't lie down and had to sleep sitting up.

Having completely run out of options they agreed to the demanding conditions Dr Esselstyn set for entry into the trial cure he had come to believe in. They agreed to join him in a diet not unlike two-thirds of the world's population (outside the West) – a low-fat, plant-based diet.

Of the patients who stuck to Dr Esselstyn's programme, there was not a single cardiac event over the next 12 years! All were alive and well and had reversed their disease.

Dr Esselstyn has since gone on to counsel and treat many more patients.

The Effect of White Meat on Cholesterol

Cholesterol is a type of lipid (fat) called a sterol made by the liver and present in every cell in an animal's body, including human animals. It is found only in foods of animal origin – white meat, fish, eggs, and every other meat and dairy product. Foods from plants (all types of fruits and vegetables, pulses (peas, beans and lentils), wholegrains, nuts and seeds) are cholesterol-free. The liver makes all the cholesterol we need – approximately 1,000 milligrams per day – used in the manufacture of hormones and cell membranes, and in other parts of the body. This means that people have no dietary need for cholesterol at all.

Cholesterol cannot be avoided by choosing lean cuts of meat, as cholesterol is mainly found in the lean portion. Neither is white meat lower in cholesterol than red meat – chicken contains as much cholesterol as beef (Pennington, 1989). One small grilled skinless chicken breast contains around 100 milligrams of cholesterol (Food Standards Agency, 2002). Just this amount of cholesterol in your daily diet adds roughly 0.13 mmol/L (or 5 mg/dL) to your cholesterol level, although this varies from person to person. The American Heart Association recommends that people limit their average daily cholesterol intake to no more than 300 milligrams (AHA, 2008).

When cholesterol is transported in the bloodstream, it is packed into low-density lipoproteins (LDL), sometimes called 'bad cholesterol'. Although LDL is necessary in limited quantities (to deliver cholesterol to various parts of the body), a high LDL cholesterol level can dramatically increase heart attack risk.

When cholesterol is released from dead cells, it is picked up for disposal in another kind of package, called high-density lipoproteins (HDL), or 'good cholesterol'. The lower your total cholesterol level, and the higher your HDL as a proportion of this, the lower your risk of a heart attack.

The ratio of total cholesterol to HDL should, ideally, be less than 4 to 1. Vegetarians average at about 2.8 to 1.3 – much lower than the average Westerner (PCRM, 2009c).

Vegetarians have consistently been found to have lower levels of both serum total and LDL cholesterol. This would perhaps be expected because their intakes of saturated fat and cholesterol are lower, and intakes of dietary fibre, phytosterols, and, sometimes, polyunsaturated fat are higher. All of these factors favourably affect serum LDL cholesterol levels (Howard and Kritchevsky, 1997; Van Horn, 1997). Some of these studies have been observational in design, comparing a group of vegetarians with a group of non-vegetarians (they are usually matched by age, sex, and other factors) – for example, Appleby *et al.*, 1995.

There is always a concern that factors aside from diet will differ among vegetarians and omnivores – and that these may be the cause of any lipid differences. However, if the groups are well matched, evidence of a dietary effect on blood lipids can be strong.

West and Hayes (1968) compared 233 Adventist non-vegetarians with 233 Adventist vegetarians in Washington DC. The participants were matched by the specific church they attended, sex, age (within five years), marital status, height, weight and occupation. The non-vegetarians were grouped into four categories ranging from those who ate meat less than once each month through to those eating meat more than three times weekly. Those who ate meat just once a week or more had blood cholesterol levels that were, on average 19 mg/dL (approximately 0.5mmol/L) higher than those for the vegetarians.

Lipid levels were also compared among 1,344 meat-eaters (more than once per week), 136 fish-eaters (fish, but not meat, more than once per week), 374 semi-vegetarians (meat or fish less than once per week), 1,785 strict vegetarians (but excluding vegans), and 134 vegans (who ate no animal products) in the Oxford Vegetarian Study (Appleby *et al.*, 1995). Total cholesterol levels were significantly lower in all non-meat-eating categories, but particularly so for vegans, where the difference was 16 per cent to 18 per cent.

In an attempt to isolate the effect of meat, the investigators adjusted for the other significant dietary factors that were also related to blood lipid levels – such as dietary fibre and cheese (for men), type of fat spread, dietary fibre, and tomatoes (for women). On average eating meat at least five times weekly raised serum total cholesterol by 8.6 per cent in men and 8.8 per cent in women.

Low-fat, vegetarian diets, devoid of all meat, can bring cholesterol down by up to 32 per cent. When lean meat was substituted by soya bean curd (tofu), again levels fell considerably (Ashton *et al.*, 2000).

Animal products also contain saturated fat, which causes the liver to produce more cholesterol (see ***Saturated Fat***, page 9). Unsaturated fats do not have this effect.

The Effect of Animal Protein on Cholesterol: The China Study

Although saturated fat and dietary cholesterol raise blood cholesterol, animal protein is even more effective at doing this. Several studies have shown that consuming animal-based protein raises blood cholesterol (Sirtori *et al.*, 1983; Carroll, 1983; Kritchevsky *et al.*, 1982).

In rural China, animal protein intake (for the same individual) averages at only 7.1 grams per day – roughly the amount of animal protein found in about three chicken nuggets from McDonalds. Even this small amount of animal-based food raises the risk of Western diseases.

In the China Study, animal protein consumption by men was associated with increased levels of harmful LDL cholesterol, whereas plant protein consumption was associated with decreased levels of LDL (Campbell and Campbell, 2005). Studies in people show that eating plant protein is more effective at lowering cholesterol levels than reducing fat or cholesterol intake (Sirtori *et al.*, 1983).

Despite the welter of evidence that a vegetarian diet is the best way to avoid high cholesterol levels and the diseases which go with them, official advice, amazingly, is not to go vegetarian but to switch to a lower fat diet – avoiding fatty cuts of red meat, eating white meat and fish and ditching butter for margarine.

Dr Neal Barnard, president and founder of the Physicians Committee for Responsible Medicine in Washington DC states that: "…chicken-and-fish diets are not low enough in fat or cholesterol to do what vegetarian diets can… The leanest beef is about 28 per cent fat, as a percentage of calories. The leanest chicken is not much different, at about 23 per cent fat. Fish vary, but all have cholesterol and more fat than is found in typical beans, vegetables, grains, and fruits, virtually all of which are well under 10 per cent fat.

"So while white-meat diets lower cholesterol levels by only about five per cent, meatless diets have three to four times more cholesterol-lowering power, allowing the arteries to the heart to reopen," (Barnard, 2003).

The Effect of White Meat on Blood Pressure

Hypertension (high blood pressure) is a well-established risk factor for CVD. It increases the risk of dangerous health problems such as heart attacks and strokes – the higher the pressure, the greater the risk. High blood pressure is common, with 40 per cent of adults in England having the condition. The number of people who have high blood pressure increases with age. For reasons that are not entirely understood, people of Afro-Caribbean and South Asian (India, Pakistan and Bangladeshi) origins are more likely to develop high blood pressure than other ethnic groups (NHS, 2009g).

Although blood pressure rises as people age, some people defy this seemingly inevitable development. Regular exercise, maintaining a healthy weight, a low-fat (especially saturated animal fat) and low-salt diet, not smoking and cutting down on alcohol all have an effect. Even allowing for all that, the blood pressure of vegetarians doesn't increase in the same way as meat eaters' – in fact, it goes up little with age. It's not surprising, then, that a vegetarian diet can be used to treat high blood pressure. It is the totality of the vegetarian diet that works, not any specific ingredient.

Vegetarians' lower risk of high blood pressure is considerable and can be anywhere between 33-50 per cent. There is an inescapable link with meat and a Californian study as long ago as 1926 showed this. For 13 days, five students were fed a lacto-ovo vegetarian diet, and then for 16 days, meat was introduced. The calorie content of the diet remained constant, but protein however increased from 10 per cent to 20 per cent of calories. Vegetarians' blood pressure was raised by 10 per cent simply by feeding them meat – and it happened in only two weeks. On the vegetarian diet, blood pressure levels averaged 107/62, and on the meat diet they were 120/66.

Not surprisingly, many studies have found that changing to a low-fat vegetarian diet can significantly lower blood pressure. The switch can also reduce the distressing symptoms associated with hypertension, according to a Swedish study. At the end of the trial period, most patients had been able to give up medication, 50 per cent felt 'much better', 15 per cent felt 'better' and 30 per cent felt 'completely recovered' (Lindahl *et al.*, 1984).

Two studies looking at blood pressure changes that occur with vegan diets illustrate the potential of plant-based diets in controlling hypertension.

As long ago as 1984, Lindahl and colleagues demonstrated the sort of changes that can occur on a vegan diet. 29 patients who had suffered from hypertension for an average of eight years, all of whom were taking medication, were put on a vegan diet for one year. In almost all cases medication was withdrawn or drastically reduced. A number of reported symptoms disappeared and there was a significant decrease in both systolic (contraction of the heart) blood pressure and diastolic (resting period between heartbeats) blood pressure (Lindahl *et al.*, 1984).

More recently, in 1995, a study on the blood pressure-lowering effects of a vegan diet found beneficial changes in blood pressure in just 12 days on such a diet. Blood pressure for all patients fell from 128/75 to 119/71 mm Hg (mercury) on average – representing a six per cent fall. Participants with higher blood pressures at the beginning of the trial had even greater reductions in blood pressure (McDougall *et al.*, 1995).

Blood pressure was measured for 116 men and women living in Boston. These people had eaten a mainly plant-based diet for at least three years. Their blood pressures were compared with those of a randomly selected group of non-vegetarian controls from the Framingham study, who were matched with the vegetarians by age and sex. The systolic and diastolic blood pressures of the controls were 119 and 77 mm Hg, respectively, whereas for the vegetarians equivalent values were 108 and 63 mm Hg.

One mechanism explaining their lower blood pressure might be lower average weight (Stamler, 1991). The vegetarians, as is often the case (see ***Overweight & Obesity***, page 45) were, on average, 15 kg lighter. However, evidence suggests that body mass index difference accounts for some, but not all, of the blood pressure difference.

Rouse *et al.* (1983) compared the blood pressure of 98 Adventist lacto-ovo vegetarians and 113 Mormon omnivores in Perth, Australia. The vegetarians' systolic blood pressures were lower by 6.2 mm

Hg in men and 7.9 mm Hg in women. When differences in body mass index were factored in, systolic blood pressures remained significantly lower by 5.6 mm Hg in men and by 5.8 mm Hg in women. The diastolic pressures were 3.5 mm Hg lower in vegetarian men and 5.9 mm Hg lower in women.

Other studies have produced similar results and a whole range of studies have shown vegetarians to have considerably lower blood pressure than meat eaters. It is also the finding of the World Health Organisation and American Dietetic Association.

Diabetes

Diabetes mellitus is a group of disorders that all lead to raised sugar (glucose) levels in the blood. In the UK alone, diabetes affects approximately 2.3 million people. An estimated half a million more have the condition but are unaware of it (NHS, 2008a).

Type 1 and type 2 are the most common forms. The causes of both types are different, but both result in too much glucose (sugar) in the blood.

In type 1 diabetes (also known as insulin-dependent diabetes) the body produces little or no insulin, the hormone that steers sugar into the cells of the body. Without insulin, the cell membranes keep sugar out.

Symptoms include a frequent urge to urinate, extreme thirst and hunger, weight loss, fatigue, irritability and nausea. Type 1 diabetes is usually treated with regular injections of insulin to regulate blood sugar levels.

Type 2, or non-insulin dependent diabetes, occurs when the body does not produce enough insulin, or when it cannot use the insulin produced. There may be plenty of insulin in the bloodstream, but the cells are resistant to it, meaning that it builds up in the bloodstream. 80 per cent of people who develop type 2 diabetes are overweight or obese, tend not to get much exercise, and have a large waist (NHS, 2008b). 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, blurred vision, tingling sensations in the hands and feet and dry, itchy skin. Blood sugar levels in type 2 diabetes can be controlled by lifestyle changes including regular exercise, diet control and weight loss.

In the long term, untreated diabetes is a factor in the development of premature heart disease, kidney problems, disorders of vision and nerve damage (Cox, 1986). In pregnant diabetics the disease may have an adverse effect on the foetus.

The World Health Organisation (WHO) estimates that by 2025 there will be at least 300 million diabetics worldwide. Diabetes is less frequent among vegetarians and vegans as a 21-year study in the USA found. Over 25,000 adults were studied. Those on meat-free diets had a 45 per cent reduced risk of developing diabetes compared to the population as a whole. Meat consumption was positively associated with self-reported diabetes in both males and females (Snowdon and Phillips, 1985).

Not only are vegetarians as a group typically leaner than omnivores (see ***Overweight & Obesity***, page 45) but in addition a vegetarian diet tends to have a lower glycaemic index (Jenkins *et al.*, 1995). This means that the diet contains fewer foods that stimulate insulin production. Additionally, vegetarians may have enhanced insulin sensitivity, which could be due to their lower iron stores (Hua *et al.*, 2001).

New research also suggests that eating just one serving of meat (including white meat) per week significantly increases the risk of diabetes. Published in March 2008, the study looked at the link between meat intake and the occurrence of diabetes in adults. The study participants were more than 8,000 Seventh Day Adventists, all of whom were non-diabetic at the start of the study (Vang *et al.*, 2008).

Those who followed even a 'low-meat' diet over the long-term (the study period was 17-years) had a staggering 74 per cent increase in their risk of developing diabetes compared to following a meat-free diet for the same period.

At least part of this difference was attributable to obesity and/or weight gain. However, even after the researchers made allowances for weight or changes in weight, weekly meat intake remained an important risk factor.

Twenty-one diabetics with diabetic neuropathy (characterised by numbness and shooting or burning pains in the lower limbs) volunteered to follow a vegan, whole food diet and exercise programme for 25 days. Within 16 days, 17 of the patients reported that the pain of neuropathy had been completely alleviated. Although the numbness persisted, it was noticeably improved within the 25 days of the programme (Crane and Sample, 1988).

A 2006 study conducted by the Physicians Committee for Responsible Medicine with the George Washington University and the University of Toronto, looked at the health benefits of a low-fat, unrefined, vegan diet (excluding all animal products) in people with type 2 diabetes (Barnard *et al.*, 2006). Portions of vegetables, grains, fruits, and pulses were unlimited.

The vegan diet group was compared with a group following a diet based on American Diabetes Association (ADA) guidelines. Over the 22-week study, 43 per cent of the vegan group and 26 per cent of the ADA group reduced their diabetes medications. Furthermore, the vegan group lost an average of almost two stones (13 pounds), compared with just over half a stone (9 pounds) in the ADA group.

This research illustrates that a plant-based diet can dramatically improve the health of diabetics. Study participants also found this way of eating highly acceptable and easy to follow.

Kidney Stones & Kidney Disease

Kidney stones are stone-like lumps that can develop in one or both of the kidneys. There are four main types of kidney stone – calcium, struvite, uric acid or cystine stones. They are usually formed following a build up of a substance in the body, such as calcium, ammonia, uric acid, or cystine. In the UK, they affect around 3 in 20 men, and 1 in 20 women (NHS, 2008g).

Drinking plenty of water and adopting a high potassium, low sodium (salt) diet can help reduce the odds of developing stones. Plant foods such as fruits, vegetables and pulses are all naturally high in potassium and low in sodium. Salt, sugar and animal protein are all implicated as problem foods. As Dr Neal Barnard states: "Animal protein is the worst enemy of people with a tendency toward kidney stones, or any kidney disease for that matter," (Barnard, 1999).

Chronic kidney disease is a long-lasting and irreversible condition that is caused by damage to the kidneys. The kidneys carry out several important functions within the body, such as filtering waste products from the blood and regulating blood flow. Therefore, chronic kidney disease can be very serious. The most common cause of chronic kidney disease is damage that is caused by other chronic (long-lasting) conditions, such as diabetes and high blood pressure (hypertension).

The condition affect between 1-4 people in every 1,000. The risk of developing chronic kidney disease increases with age. The average age of somebody with the condition is 77 (NHS, 2008g).

According to the American Dietetic Association: "A well-planned vegetarian diet may be useful in the prevention and treatment of renal [kidney] disease. Studies... suggest that some plant proteins may increase survival rates and decrease proteinuria [proteins in the urine]… and histological renal damage [kidney tissue damage] compared with a non-vegetarian diet," (Messina and Burke, 1997).

Animal protein tends to overwork the kidneys which in turn can cause a gradual decline in their ability to carry out their function in filtering waste from the body in the form of urine. Animal protein is high in sulphur-containing amino acids (see ***The Acidifying Effects of White Meat***, page 41) and these tend to leach calcium from the bones where it is excreted in the urine and may form stones. Vegetarian diets would therefore be expected to show less wear and tear on the kidneys than meat-based ones. A Harvard study found that intake of animal protein was directly associated with the risk of kidney stone formation. Researchers here found that an increase in animal protein from less than 50g per day to 77g per day was associated with a 33 per cent increased risk of stones in men (Curhan *et al.*, 1993).

Research published in 1996 found that a vegan diet can be regarded as a valid alternative to the standard conventional low-protein diet (CLPD) that is the nutritional treatment for patients with chronic renal failure. The authors concluded that not only could the problems of poor palatability and high costs of the CLPD be solved by the vegan diet but that additional advantages came from such a diet too. Compared with the conventional diet, the vegan diet offered a high ratio of unsaturated to saturated fatty acids, was cholesterol-free and led to a lower net acid production (Barsotti *et al.*, 1996).

Gallstones

The liver produces bile which is stored in the gallbladder and which helps with digestion, mainly of fats. Gallstones are pieces of hard, stone-like material, composed mostly of cholesterol crystals. They are formed when bile becomes saturated with cholesterol. Gallstones tend to be more common in overweight women, women who have been pregnant, and people who have recently lost weight (NHS, 2008f).

In more than 80 per cent of cases, gallstones occur when the liver produces bile with a high cholesterol content. This may be due to a high cholesterol diet, advancing age, too many refined carbohydrates in the diet, the use of oral contraceptives, a genetic disorder such as hypercholesterolaemia, or liver disease that reduces the levels of bile salts (NHS, 2008f).

Gallstones are far more common in affluent societies and in people who consume meat and dairy products. Treatment options include surgery (cholecystectomy) to remove the gallbladder. Gallstones made of cholesterol can sometimes be dissolved using a medication that includes ursodeoxycholic acid, which may have to be taken for up to two years.

However, diet can prevent such drastic action. NHS Direct advises people to avoid eating fatty foods with a high cholesterol content, and instead follow a low-fat, high-fibre diet including plenty of fresh fruit and vegetables (five portions a day) and wholegrains (NHS, 2008f). Plant foods are cholesterol-free and contain fibre (see ***White Meat: A Superfood?***, page 11).

Being overweight also increases the amount of cholesterol in bile, and the likelihood of developing gallstones (NHS, 2008f). Most overweight people lose weight when they switch to a vegetarian diet (see ***Overweight & Obesity***, page 45).

Fibre intake is effective in reducing cholesterol saturation of the bile, since fibre can block the recycling of the bile acids from the intestine (see ***Colorectal Cancer***, page 23) and increase the amounts of bile and metabolites excreted in the faeces. The World Health Organisation therefore recommends a starchy diet as a protective measure, and also because it may help reduce the likelihood of overweight and obesity (World Health Organisation, 1991).

A study in the *British Medical Journal* confirms this advice. This research found that non-vegetarians have about a two-fold increase in risk of developing gallstones than vegetarians, even after controlling for potentially confounding factors. The main risk factors appear to be low fibre intake, saturated fat and cholesterol intake and obesity (Pixley *et al.*, 1985).

Rheumatoid Arthritis

Rheumatoid arthritis (RA) is a condition causing pain, swelling and inflammation in the joints. Symptoms also include feeling generally unwell and tired. At first, the joints in the hands and feet are affected, but any joint may later become affected.

RA affects approximately 350,000 people in the UK and is more common in women than men. It is most common after the age of 40, but can affect people of any age (NHS, 2008c).

The exact cause of RA is unknown. There were no medical reports of the disease until the early 1800s. The condition attacks the joints: the immune system sends antibodies to the lining of the joints, where instead of attacking harmful bacteria, they attack the tissue surrounding the joint. It is not yet known what triggers the initial attack. Some have suggested that an infection or a virus may trigger rheumatoid arthritis, perhaps by setting off an autoimmune reaction, but none of these theories have been proven. Genetics may also be a factor, in that it may influence susceptibility to the disease.

Research shows that foods may be a more frequent contributor to arthritis than is commonly recognised. Physicians Committee for Responsible Medicine lists the major arthritis triggers as dairy products, corn, meats, wheat, oats, rye, eggs, citrus fruits, potatoes, tomatoes, nuts and coffee. It recommends that dairy products should be avoided, including skimmed and whole cow's milk, goat's milk, cheese and yoghurt. Likewise, all meats should be avoided, including chicken, turkey, beef, pork and fish (PRCM, 2008c). Meat, dairy produce and eggs can encourage hormone imbalances that may contribute to joint pain (Barnard, 1999). Once the offending food is eliminated completely, improvement usually comes within a few weeks (Sobel, 1989).

One study tested a very low-fat vegan diet on subjects with moderate-to-severe RA. After just one month on this diet, subjects experienced a significant reduction in almost all symptoms (McDougall *et al.*, 2002).

A gluten-free vegan diet has also been shown to improve the signs and symptoms of RA (Hafstrom *et al.*, 2001). The researchers suggest that a gluten-free vegan diet may, in some people, reduce the immune response that triggers RA.

An uncooked vegan diet, rich in antioxidants and fibre has also proved effective in easing joint stiffness and pain (Hanninen *et al.*, 2000).

Some research has focused on a period of fasting, followed by a vegetarian or vegan diet. A review of this research concluded that this might be a useful approach to the treatment of RA (Muller *et al.*, 2001). Taken together, these studies provide good evidence that modifying the diet can benefit those with arthritis.

Vegan diets noticeably decrease the total fat content, and the fat composition, of the diet. This in turn can affect the immune processes that influence arthritis. The omega-3 fatty acids in vegetables may be a key factor, along with the near absence of saturated fat. The fact that patients also lose weight on a vegan diet contributes to the improvement.

In addition, vegetables are rich in antioxidants, which can neutralise free radicals. Oxygen free radicals attack many parts of the body and contribute to heart disease and cancer, and intensify the ageing processes generally, including of the joints (see ***White Meat and Pro-oxidant Damage***, page 25). Iron acts as a catalyst, encouraging the production of these dangerous molecules. Vitamins C and E, which are plentiful in a diet made of vegetables and grains, help to neutralise free radicals. Meats supply an overload of iron, no vitamin C, and very little vitamin E, whereas vegetables contain more controlled amounts of iron, and generous quantities of antioxidant vitamins.

A diet drawn from fruits, vegetables, grains, and pulses therefore appears to be helpful in preventing and, in some cases, improving arthritis.

The Acidifying Effects of White Meat

When certain foods are digested, acids are released into the blood. The body attempts to neutralise the acid by drawing calcium from the bones. This calcium is then excreted in the urine (the calciuric response). The calciuric response may be a risk factor for the development of osteoporosis (see ***Osteoporosis***, page 42).

Many high-protein vegetable foods, including soya and other pulses, and grains such as pasta and bread produce some acid because they are high in phosphorus. The body turns this into phosphoric acid. However, this is easily balanced by eating some fruit and vegetables (see below). These plant sources of protein also contain phytoestrogens which help to replace the body's own oestrogen after the menopause and are therefore protective of bone.

Vegetables and fruits such as lemons produce large amount of alkalis (also known as bases) when they are metabolised. This is because they contain organic salts such as citrates and succinates, which are metabolised into alkaline bicarbonates. These neutralise acid by mopping up hydrogen ions.

The sulphur in high-protein foods such as meat, fish, eggs and dairy products is metabolised into sulphuric acid. Meat and eggs contain two to five times more sulphur-containing amino acids than are found in plant foods (Breslau *et al.*, 1988). As the sulphur content of the diet increases, so does the level of calcium in the urine. Research suggests that animal protein increases the risk of uric acid stones (Breslau *et al.*, 1988).

The mechanism by which plant proteins – unlike animal proteins – seem to protect bone health is thought to centre around plant proteins having a lesser acidifying effect, and also on the role of phosphorus. Zemel demonstrated that soya, for example, is lower in sulphur amino acids and a higher in phosphorus, which has a positive effect on calcium excretion. Calcium balance is maintained even when calcium intakes are modest (Zemel, 1988).

Estimates suggest that our consumption of acid-producing protein has increased by 50 per cent over the past forty years (Plant and Tidey, 2004). A typical Western diet is rich in acid-producing meat, cheese and cereal-based products such as bread and pasta, with insufficient fruit and vegetables to balance out the acid which such a high-protein diet generates. This can lead to such acidic body fluids that alkalis are leached from the skeleton, and the muscles are attacked to generate ammonia as a source of alkalis.

Vegetarian diets based on protein sources such as pulses and cereals yield a much lower acid production in the body than mixed meat and vegetable diets, even when the protein content of the diets are equal. Plant-based diets frequently yield no net acid or alkaline residue in the body.

In her book, *The Chemistry of Success*, Dr Susan Lark links an overly acidic diet to a range of inflammatory conditions: "As we age, our ability to maintain a slightly alkaline balance in our cells and tissues diminishes… Maintaining the cells and tissues of the body in their healthy, slightly alkaline state helps to prevent inflammation. In contrast, over-acidity promotes the onset of painful and disabling inflammatory conditions as diverse as.... rheumatoid arthritis and interstitial cystitis."

In 1995 scientists Thomas Remer and Friedrich Manz developed a calculation for estimating the renal (kidney) net acid excretion from various diets. The scientists used their findings to adjust the urine pH of healthy adults, using diet alone (Remer and Manz, 1995).

Their results are presented in Table 5 (page 43). They are expressed in units called PRALs (potential renal acid loads) per 100g portion of food – basically, the end result of the metabolism of food in the body. The higher the PRAL value for the food, the more acid, and hence the more potentially damaging, it is predicted to be to bones and muscles, unless balanced by adequate intakes of foods with negative PRAL values.

The lowest PRAL values are for certain herbs and spices, raisins, fruits, fruit juices and vegetables. Chicken and turkey are both acid-forming foods.

Osteoporosis

Osteoporosis is a condition that causes the bones to thin and weaken, making broken bones more likely. Approximately three million people in the UK have osteoporosis and there are over 230,000 fractures every year as a result (NHS, 2008d).

Bones are usually at their strongest in people's mid-twenties, when peak bone mass is reached. This is maintained for about ten years, with roughly equal amounts of bone creation and breakdown. After the age of about 35, bone loss begins to overtake creation as part of the normal ageing process. This causes the bones to become thinner, fragile and more likely to break (fracture) – particularly the bones of the spine, wrist, and hips. With osteoporosis, this process happens much more quickly, making the bones weaker and more prone to fracture.

Bones are repaired and reinforced by a range of proteins and minerals – including calcium, phosphorus, proteins and amino acids – which are absorbed from the blood. Changes in hormone levels affect the amount of mineral substance deposited in the bones, and can therefore affect bone strength. The female hormone oestrogen offers some protection against osteoporosis. After the menopause, oestrogen levels fall, often causing the bones to thin quickly.

Getting enough calcium in the diet has been emphasised in the press. However, calcium intake alone does not protect against osteoporosis and fractures – nor do low calcium intakes predict fracture risk. A 1992 review of fracture rates in many different countries showed that populations with the lowest calcium intakes had far fewer fractures than those with much higher intakes. For example, South African blacks had a very low average daily calcium intake – only 196 milligrams – yet their fracture incidence was far below that of either black or white Americans (Abelow *et al.*, 1992).

When it comes to bone mineral loss, calcium intake is only part of the equation. It is equally important to reduce calcium losses. A combination of genetics and dietary and lifestyle factors – particularly the consumption of animal protein, salt, and possibly caffeine – along with tobacco use, physical inactivity,

Table 5: Potential Renal Acid Load (PRAL) of Selected Food Groups (Related to 100g Portions)

	Very strongly alkaline	Strongly alkaline	Alkaline	Moderately alkaline	Nearly neutral	Moderately acid	Acid	Strongly acid	Very strongly acid
Herbs and spices	Parsley, dried – 62.4; Basil, dried – 57.9; Ginger -23	Curry powder -19.9; Black pepper 19.7		Chives -3.6					
Fruits and juices	Raisins -21	Blackcurrants - 6.5; Bananas -5.5	Apricots -4.8; Kiwi fruit -4.1; Tomato juice -3.8; Cherries -3.6; Orange juice -2.9; Pears -2.9; Oranges -2.7; Pineapple -2.7; Lemon juice -2.5; Peaches -2.4; Apple juice -2.2; Apples -2.2; Strawberries -2.2; Watermelon -1.9						
Vegetables		Spinach -14	Celery -5.2	Carrots, young -4.9; Courgette -4.6; Cauliflower -4.0; Potatoes, old -4.0; Radish, red -3.7; Eggplant -3.4; Tomatoes -3.1; Beans, green -3.1; Lettuce -2.5; Chicory -2.0; Leeks -1.8; Lettuce, iceberg -1.6; Onions -1.5; Mushrooms -1.4; Peppers -1.4; Broccoli -1.2; Cucumber -0.8	Asparagus -0.4				
Pulses and nuts			Soya flour -5.9	Soya beans -4.7; Natto -3.2; Hazelnuts -2.8	Soya milk -0.3; Soya beans, sprouted, raw 0.3	Peas 1.2; Tofu 3.4; Lentils 3.5; Soya sauce 4.5	Miso 6.9; Tempeh 8.2; Tofu, prepared with calcium sulphate 8.3; Walnuts 6.8; Peanuts, plain 8.3		
Grain products						Rice, white, boiled 1.7; Bread, wheat wholemeal 1.8; Bread, wheat, white 3.7; Bread, wheat, mixed 3.8; Bread, rye, mixed 4.0; Bread, rye 4.1; Rice, white 4.6	Rye flour, whole 5.9; Cornflakes 6.0; Noodles, egg 6.4; Spaghetti, white 6.5; Wheat flour, Wholemeal 8.2	Oat flakes 10.7; Rice, brown 12.5	
Meat						Frankfurters 6.7; Beef, lean 7.8; Pork, lean 7.9; Chicken, meat 8.7; Steak, lean and fat 8.8; Veal 9.0; Turkey, meat 9.9	Luncheon meat 10.2; Liver sausage 10.6; Salami 11.6; Corned beef 13.2		
Fish and eggs						Eggwhites 1.1	Haddock 6.8; Herring 7.0; Cod 7.1; Eggs, whole 8.2	Trout 10.8	Egg yolks 23.4
Dairy products						Butter 0.6; Ice cream 0.6; Milk, whole 0.7; Milk, evaporated 1.1; Creams, fresh, sour 1.2; Yoghurt, fruit 1.2; Yoghurt, plain 1.5; Soft cheese 4.3	Cottage cheese 8.7	Fresh cheese 11.1; Camembert 14.6; Cheese, Gouda 18.6; Hard cheese 19.2	Cheese, cheddar-type, reduced fat 26.4; Processed cheese 28.7; Parmesan 34.2

Reference: Plant and Tidey, 2004. From Remer and Manz, 1995.

and lack of sun exposure tend to contribute to bone mineral loss. As an acid-producing food, white meat tends to leach calcium from the bones, leading to its excretion in the urine (see ***The Acidifying Effects of White Meat***, page 41).

The wide difference in fracture incidence between South African blacks and Americans may be due, at least in part, to differences in protein intake. Countries with high calcium intakes also tend to have high protein intakes. Since dairy cattle are slaughtered for meat when their milk consumption is no longer cost-efficient, dairy-producing countries also have a constant supply of animal protein. The meat consumption that is common in these countries probably contributes to their high rates of osteoporosis (PCRM, 2008d).

Different sources of dietary protein have differing effects on bone metabolism – and other international comparisons show a strong link between animal protein intake and fracture rates. For example, there have been a number of studies on North Alaskan Eskimos (Inuits). The traditional Inuit 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 higher rate of osteoporosis; even higher than white Americans (Mazess and Mather, 1974; Mazess and Mather, 1975).

While comparisons such as these generally do not take other lifestyle factors, such as exercise, into account, the findings are supported by clinical studies showing that high protein intakes aggravate calcium losses.

A 1994 report in the *American Journal of Clinical Nutrition* showed that when animal proteins were eliminated from the diet, calcium losses were reduced by half (Remer and Manz, 1994). Similarly, Sellmeyer *et al.* found that elderly women with a high dietary ratio of animal to vegetable protein intake had a greater risk of hip fracture than those with a low ratio. The authors suggest that an increase in vegetable protein intake and a decrease in animal protein intake may decrease bone loss (Sellmeyer *et al.*, 2001).

Furthermore, a study by Marsh *et al.* compared bone mineral loss in 1,600 vegetarians and meat-eaters. They found that meat-eating women in their 80s had lost twice the amount of bone mineral compared to those who had followed a lacto-vegetarian diet for at least twenty years (Marsh *et al.*, 1988).

High-protein diets, especially meat- and cheese-based diets, lead to a gradual decrease in bone density over time. If it is rich in acid-forming cheese or yoghurt, even a vegetarian diet can increase osteoporosis risk (Plant and Tidey, 2004).

The benefits of more plant foods were demonstrated by a study published in 1999. Greater potassium and magnesium intake (from high intakes of fruit and vegetables) was associated with less decline in bone mineral density. These results suggest that a diet rich in fruit and vegetables produces alkaline components which contribute to the maintenance of bone mineral density (Tucker *et al.*, 1999).

As well as avoiding meat and eating more plant foods, other measures are important to help the body retain calcium, too. These include reducing sodium (salt) intake, avoiding caffeine, not smoking, performing simple weight-bearing exercises and ensuring a sufficient supply of vitamin D (from sunlight and fortified foods such as soya milks, cereals and margarines). For more information, see the VVF's fact sheet, *Boning up on Calcium*!

Overweight & Obesity

The term 'obesity' is derived from the Latin *ob*, meaning 'on account of', and *esum* meaning 'having eaten'. It is most commonly assessed by the body mass index (BMI), which is calculated by dividing a person's weight in kilograms twice by their height in metres. Adults with a BMI of below 18.5 kg/m^2 tend to be classified as underweight, while a BMI of over 25 kg/m^2 is defined as overweight, and a BMI of over 30 kg/m^2 as obese.

Overweight and obesity can open the gateway to many health problems, such as infertility, type 2 diabetes and cancers. Over 9,000 deaths a year in England are caused by obesity alone.

Adult obesity rates have almost quadrupled over the last 25 years, and two-thirds of UK adults are now considered overweight or obese. Of these, 22 per cent of men and 23 per cent of women are obese. This means that they are at least two to three stones overweight and risk serious health problems.

Obesity is not just a problem that affects adults. The number of obese children has tripled over the last 20 years. At least 10 per cent of six-year-olds and 17 per cent of 15-year-olds are now clinically obese. Childhood obesity is a strong indication that the child will be obese as an adult and is likely to lead to serious health risks in later life (NHS, 2009h).

As discussed in ***White Meat: the Low-Fat Choice?,*** page 7, a study of 75,000 people found that high meat consumption was the food most responsible for weight gain (Kahn *et al.*, 1997). Men or women eating more than a single serving of meat a day showed a 50 per cent increase in 'abdominal obesity'.

Western vegetarians generally consume a healthier diet than omnivores – healthy foods such as soya, nuts, pulses and vegetables replace meat (Singh *et al.* 2003). US vegetarians eat more wholegrain products, dark green and deep yellow vegetables, wholegrain bread, brown rice, soya milk, tofu, meat substitutes, pulses and nuts (Haddad and Tanzman, 2003). Although they eat the same quantity of food as omnivores (1,000 kg per year) vegetarians are usually slimmer (Appleby *et al.*, 1998). The biggest study on vegans to date (Spencer *et al.*, 2003) compared over 1,000 vegans in Europe to tens of thousands of meat eaters and vegetarians. The meat eaters, on average, were significantly heavier than the vegans. Even after controlling for exercise, smoking and other non-dietary factors, vegans came out slimmer in every age group. Less than two per cent of vegans are obese, compared to one in five English adults (National Audit Office, 2001).

A study conducted by Dr Neal Barnard and colleagues from the Physicians Committee for Responsible Medicine (Barnard *et al.*, 2005) showed that low-fat vegan diets lead to significant weight loss, without requiring dieters to restrict calories, portion sizes or carbohydrates, or even to exercise. 64

overweight women were randomly assigned to either a low-fat vegan diet or to a more conventional low-fat comparison diet based on the guidelines of the US National Cholesterol Education Programme. As exercise can cause weight loss, the women were asked not to make any changes to their exercise patterns during the trial.

The control group lost just over half-a-pound per week, whereas the vegan group lost about one pound per week, which is similar to results seen with low-calorie diets.

However, the weight loss on the vegan diet occurred with no limits on energy or portion sizes. The weight loss of the vegan group was attributed to it being lower in calories but more filling. Eliminating animal products meant that the vegan diet contained no animal fat, and making minimal use of oils meant that the diet was very low in fat overall.

The vegan group also showed a 16 per cent increase in its after meal calorie burning speed (referred to as the thermic effect of food). This appears to be due to the vegan diet having improved insulin sensitivity, causing people's cells to be able to pull glucose out of the bloodstream much more quickly.

The researchers comment that, although: "At first glance, a vegan diet sounds like a challenge… research participants rate the acceptability of the vegan approach very similarly to that of other therapeutic diets. And while typical diets demand cutting calories and leave the dieter with nothing to assuage hunger pangs, a low-fat vegan approach provides plenty of choices to make up for whatever is missing. Hunger is not part of the equation," (PCRM, 2005a).

Plant-based diets are not only advocated for adults, but children, too. The Paediatrician Dr Benjamin Spock advised in his book *Dr Spock's Baby and Child Care* that weight-loss programmes for children should be based upon changing the type of food children eat, rather than the amount of food they eat. He encouraged shifting the entire family away from oily fried foods, meats and dairy products and toward low-fat, plant-based foods – grains, pasta, vegetables, pulses and fruit. When this is done, he stated: "weight loss typically occurs without anyone going hungry," (Spock and Parker, 1999).

This advice is echoed in the Physicians Committee for Responsible Medicine report, *Weight Control and Obesity Prevention in Children*: "Instead of centring meals around fatty meats and cheese, meals should be built from healthy grains, legumes [pulses], and vegetables," (PCRM, 2005b).

For a discussion of the health consequences of eating processed meat, see ***Processed Poultry***, page 60.

PART 3: The Rise in Popularity of White Meat

The Origins of Poultry Farming

Chickens

Chickens originate from the jungles of south-east Asia and have been kept by humans for over 4,000 years. These early birds were not kept for meat or eggs but for cockfighting between male birds.

When cockfighting was banned in 1849, specialist breeding began in order to produce an array of different coloured feathers and facial features rather than meat or increasing the number of eggs (Ellis, 2007).

Britain entered the twentieth century as a nation of small-time poultry keepers. Commercial birds were generally tended by farmers' wives who used the egg and meat money as an independent source of household income.

During World War I, poultry keepers were initially told to kill their flocks to preserve grain stocks but the order was rescinded and, post-War, ex-servicemen were encouraged to go into chicken farming. Hattie Ellis, author of *Planet Chicken* writes: "Newcomers were often sold poor stock of the sort that tends to be churned out to supply a booming market. Many of the chickens died of disease; there was widespread disillusionment and bankruptcy amongst the start-up farmers.

"When servicemen returned home with their pay-off after the Second World War, a number of them chose to become poultry farmers just as their predecessors had in 1918. But by this time it was a very different form of farming, thanks to techniques developed in the United States."

For commercial purposes, breeding focused on producing faster growing chickens – such rapid growth that many birds were barely able to stand. Profits were prioritised at the expense of animal welfare. As food systems became more centralised, production units became bigger and bigger units, whether chickens, corn or tomatoes for ketchup.

"Vitamin D, synthesised by chickens in sunlight, is essential for good, strong bones. Once it was discovered that the vitamin could be added to feed, the birds no longer needed to be kept outside and everything could be done indoors… The less the birds moved around, the less feed they needed and the faster they grew, greatly increasing profitability," writes Ellis.

According to the British Poultry Council, the chicken industry has been one of the most successful British food industries since the Second World War. In 1953, production stood at five million chickens a year, soaring to 590 million between 1986-88. Between 1994–96 it increased to 778 million and topped 860 million in 2007 (The British Poultry Council, 2008).

Chicken is now the most popular meat in Britain, accounting for over 40 per cent of all meat consumed. It seems to be marketed in more varieties than any other meat, including whole, ready-to-cook and pre-cooked chickens; halves, quarters, breasts, legs and wings; processed meat formed into breaded 'drumsticks'; and chicken Kievs (see ***Processed Poultry***, page 60).

A third of families eat chicken several times a week (Great British Chicken, 2008) with around 16 million birds farmed every week for consumption in the UK (The British Poultry Council, 2008).

Roughly five per cent of the national chicken flock is produced on outside rearing premises (free-range and organic). The British Poultry Council reports that both of these markets are growing steadily. The remainder is raised intensively on large factory farms (see ***Inside the Broiler Shed***, page 51).

Turkeys

Evidence from fossils suggests that turkeys have been around for 10 million years. The American Indians hunted wild turkey for its meat as early as 1000AD.

It is believed that turkeys were introduced to Britain in the early sixteenth century by Yorkshireman William Strickland, who acquired six birds from American Indian traders on his travels and sold them in Bristol. Turkey meat remained a luxury until the 1950s, when refrigerators and freezers became more widely available.

Until the 1950s turkey production was carried out in extensive systems and focused on seasonal markets. However, technical developments in the late 1950s and early 1960s gave rise to the modern turkey industry. The development of effective drugs to control blackhead disease allowed turkeys to be kept in pole barns and indoor controlled-environment houses. Broad-breasted strains of turkeys from the USA were introduced, which gave rise to British strains of turkeys with better growth feed conversion rates.

Female turkeys are called hens, male turkeys are toms and baby turkeys are called poults. Almost 15 million turkeys were slaughtered in the UK in 2007 (Defra, 2007a). Around a third of that number is killed at Christmas.

Turkey accounts for around six per cent of all meat consumed in Britain. Although traditionally seen as a seasonal meal there is a strong all year round market for turkey meat. Ten million turkeys were sold last Christmas. The British Turkey Information Service reports that 87 per cent of Britons eat turkey at Christmas.

British turkey is marketed by the British Poultry Council, which aims to promote the growth of Quality British Turkey as a brand. Varieties include turkey mince, turkey chunks, breast steak, escalopes, drumsticks, sausages, stir fry strips, burgers, bacon rashers and crown roasts.

Most of the turkeys raised commercially are from the White Holland breed, which have all white feathers.

Ducks

UK farmed ducks are largely derived from the wild Mallard, which is claimed to be the ‘meatiest of ducks – high in breast meat and low in fat’ (Hopper, 1996). Several breeds of duck bred for meat have descended from the Mallard, including the Pekin, Aylesbury, Gressingham and Rouen.

Some 20 million ducks are reared and slaughtered for meat in the UK each year and duck meat accounts for around five per cent of all meat consumed in the UK.

Geese

Through the centuries, domestic geese were eaten during times of festivity and celebration in Britain – especially at Michaelmas (September 29). Goose meat was regarded as superior to other poultry.

Goose quills were used for writing until the late 19th century and feathers and down used for bedding. Archers would use feathers from the only British indigenous goose, the greylag, to make flights for arrows used in warfare.

Before most common land was seized under the various Enclosure Acts, small communities would invest in geese flocks and graze them on open spaces within each parish. Geese were used for their eggs, feathers, down, quills, perceived medicinal uses of their fat – but chiefly they were used for meat.

An increasing number of geese are being processed as three bird roasts (for example, a pheasant within a chicken within a goose). In recent years there has been an increasing market for goose fat. Goose feathers also attract a small value as a byproduct.

While Defra does not collate statistics on the number of geese slaughtered in the UK, industry estimates that they could amount to 300,000 birds per year.

PART 4: From the Egg to the Plate

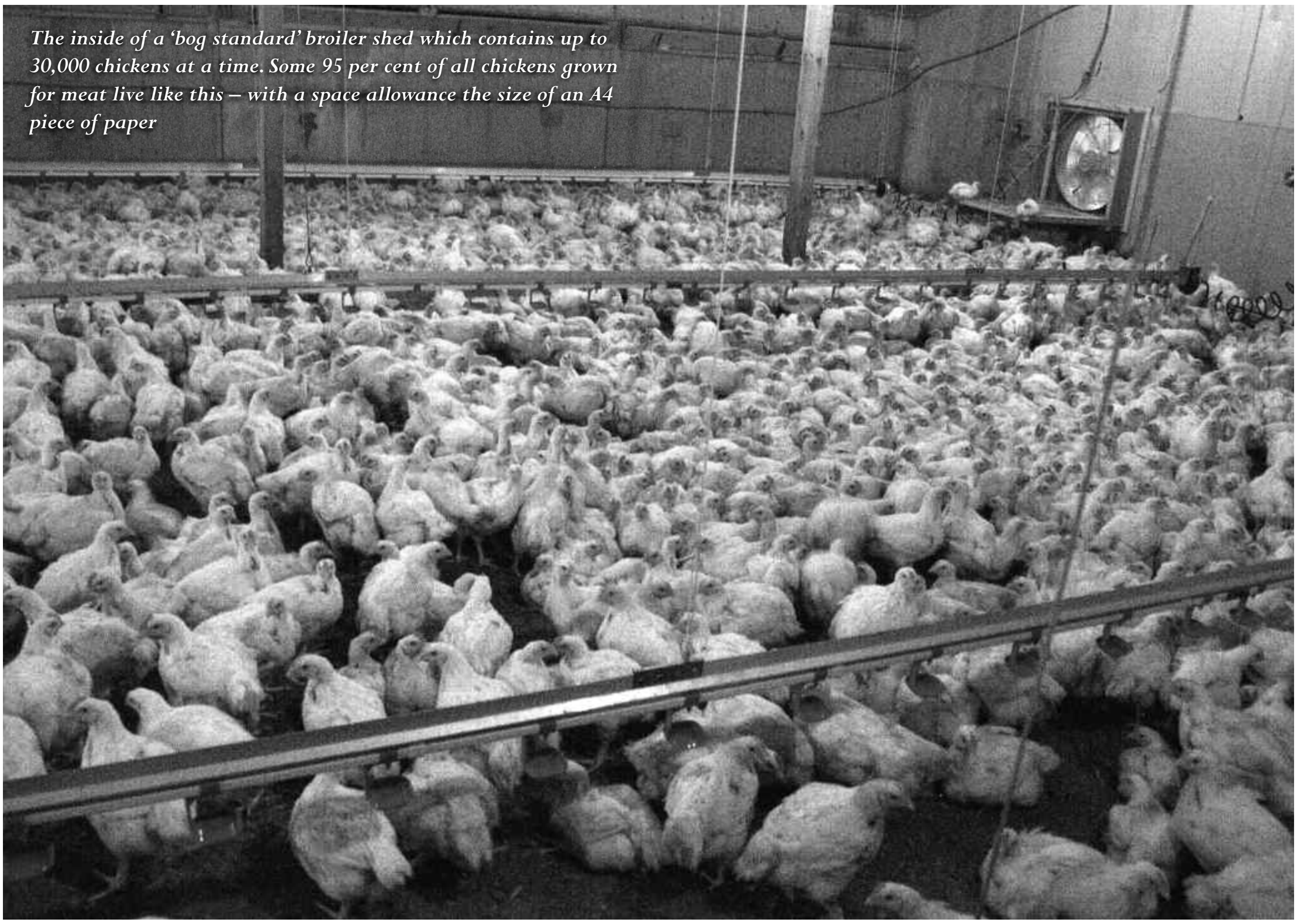
Intensive or 'Factory Farming'

The majority of all chickens produced and consumed in the UK are broiler chickens (broilers). The name derives from a combination of the two traditional methods of cooking chicken: boiling and roasting. They have been selectively bred for their meat rather than eggs (Lawrence, 2004). The UK broiler industry began to take off in the 1950s and by the 1960s, it was the norm. The meat from spent laying hens is used in manufactured products such as meat pastes and pies (Sheppard, 2004).

Modern broiler rearing is intensive and automated – more so than any other type of livestock production. 98 per cent of UK broiler production is intensive (Sustain, 1999) with more than 800 million broiler chickens now being killed in the UK every year (Defra, 2008b).

Most broiler chickens are produced in a standardised and closely regulated environment and are selectively bred (see ***Selective Breeding***, page 51) to gain maximum weight in the minimum time. The time taken for broiler chicks to grow to slaughter weight (2-3 kg) has been halved in the last 30 years. Between 1976 and 2007 it has been reduced by about one day every year. The process – from hatching to reaching slaughter weight – now takes around 40 days (Viva!, 2007).

Barn, free-range and organic production have grown in recent years but remain relatively small. They offer more space, daylight and natural ventilation and the birds take longer to reach the target slaughter weight.



The inside of a 'bog standard' broiler shed which contains up to 30,000 chickens at a time. Some 95 per cent of all chickens grown for meat live like this – with a space allowance the size of an A4 piece of paper

The ballooning weight of modern turkeys causes leg fractures and hip disease, making movement difficult or impossible. Ammonia from the floor causes them to lose feathers and burns their skin

Selective Breeding
Selective breeding is the mating of birds chosen because they show desirable traits, such as robust heart and lungs, leg strength, disease resistance, feed performance and growth rate. Only those with all of the essential traits are chosen for breeding and if a bird shows any sign of a particular condition, such as poor growth rate, then that bird, its parents and all its siblings are removed from the breeding programme.

While chickens are naturally mated, artificial insemination is standard practice in turkey breeding. A significantly smaller hen from one strain will usually be crossed with a large male (stag) from a different strain through artificial insemination. Only a few specialist companies carry out this selective breeding of commercial birds and they operate throughout the world (Defra, 2007b).

Nesting
In Britain, parent flocks of chickens are kept in poultry sheds on a floor litter of chopped straw or wood shavings with nesting boxes provided. There are around 10 hens to each cockerel in the parent flock and both reach sexual maturity at around 20 weeks old.

Each hen lays around 130 fertilised eggs in the nesting boxes during her productive life of around 60 weeks. Eggs are collected several times a day and sent to the hatchery.

Hatching
At the hatchery, perfect eggs containing broiler chick embryos are incubated at a controlled temperature and humidity until they start to hatch on about day 20. Baby turkeys (poults) hatch after the 27th day of incubation.

Day-old chicks or poults are transported to chicken or turkey rearing farms in covered trays in temperature-controlled vehicles. In the UK, 95 per cent of chickens, 95 per cent of ducks, and the overwhelming majority of turkeys are raised on large factory farms.

Inside the...

...Broiler Shed

Recent campaigns spearheaded by celebrity chefs have provided an insight into broiler practices. However, most consumers probably still do not know what broiler production looks like. Although widely distributed, a windowless broiler house viewed from a car or a train reveals nothing of its content – the 30,000 or more birds that are typically housed inside.

Newly hatched chickens and turkeys are placed in large, purpose-built houses on a fresh litter of chopped straw or wood shavings. Heat lamps (brooders) are provided for warmth as well as drinkers and feeders.

Crowded together, the animals eat, breathe and excrete in the same physical space every day. To maximise time spent feeding, birds are frequently given just one hour of darkness in every 24 and they usually remain on the same litter throughout their lives. The accumulated excrement turns it from loose, dry chippings into a moist, spongy mass.

The inevitable result is high disease rates. The overcrowded, unsanitary conditions mean that infectious illnesses spread rapidly through the flock. Death rates of five to 15 per cent of all birds are common on intensive units.

The selectively-bred broilers grow so fast that severe health problems are likely to develop if they are not killed at around six weeks old. Death comes before they reach sexual maturity at around five or six months. The amount of feed needed to achieve this weight gain has been reduced by almost 40 per cent since 1976 (Scientific Committee on Animal Health and Animal Welfare, 2000).

Tight confinement results in little movement and as a result, their muscles stagnate and fat develops. Broiler chickens gain weight so rapidly that often they can no longer support their own body weight and most suffer from leg disorders. At six weeks old, most of their time is spent lying down (Ellis, 2007; European Commission, 2000).

Trained personnel are supposed to inspect the birds two or three times per day by walking the entire length of the floor, up and down, inspecting the birds and picking out any which require attention.

Anywhere from five to 15 per cent of broiler chickens will die in the sheds from a variety of diseases – or simply because their broken bones prevent them from reaching food and water

However, it is not uncommon for a single person to be responsible for the many thousands of birds in a shed. Hattie Ellis, author of *Planet Chicken* writes: "When you look at the sheer number they are dealing with, to what extent could anyone, even if they were skilled and motivated, care for the birds as birds?" (Ellis, 2007).

...Turkey Shed

Around 90 per cent of the turkeys produced in the UK are intensively reared for their meat in 'conventional' closed housing with mechanised feeding and drinking systems. These houses may hold up to 25,000 birds.

Although turkeys were once mainly reared for the Christmas market, today they are produced throughout the year. The UK turkey industry comprises two main sectors – 'all year round' and 'seasonal' production.

Turkeys have been selectively bred for maximal weight gain resulting in an animal that has lost the ability to fly and suffers from a wealth of diseases. Pathologically obese, they suffer from clogged coronary vessels, heart failure, ascites – also known as 'water-belly' or 'leaking-liver' – and congested livers. Victims of ascites are found dead with their bloated stomachs filled with yellow fluid and clots.

Like broiler chickens, turkeys are just as vulnerable to infectious diseases and parasites. They suffer from those diseases that afflict all poultry and have specific diseases of their own (Currie, 2004). These include paramyxovirus 2 and blackhead disease. Pasteurellosis, or fowl cholera, is especially prevalent and its effects range from mild infection to severe illness and death. Turkeys are especially vulnerable to the fungal lung infection aspergillosis, which is found in all poultry.

Turkeys are normally slaughtered at between nine and 21 weeks old, depending upon the size of bird required. Their natural lifespan is around 10 years.

As with broiler chickens, the majority of birds are killed in large, semi-automated slaughterhouses. Due to the additional demand for turkeys at Christmas, seasonal slaughterhouses are also used. Many turkeys are killed by having their necks dislocated and research shows that this does not usually have an immediate effect and therefore unconsciousness may not be instantaneous (Viva!, 2005b). There is no law that requires licensed slaughtermen to kill by neck dislocation.

This is a widespread animal welfare disaster and Viva! estimates that 8.4 million chickens, turkeys, ducks and geese each year are conscious when they enter the slaughterhouse scalding tank to loosen their feathers (Viva!, 2005b).

For more information, see Viva!'s undercover video of factory farmed turkeys, entitled *Stuffed!*, at www.viva.org.uk/campaigns/turkeys/turkeys-companyinfo.htm

...Duck Shed

Over 95 per cent of ducks are reared intensively in conditions virtually indistinguishable from those in which chickens and turkeys are reared. As a consequence, almost all duck meat and feathers come from factory farmed animals. Although they are naturally aquatic, ducks are denied water in which to swim and the law does not even oblige producers to provide water for them to preen themselves.

Imagine life for a duck that contains no sunshine or rain, just artificial light; no water in which to swim, dabble or preen; and obscene overcrowding. That's life for almost all UK ducks

Mortality rates for ducks are about five per cent, equating to a million birds per year and many of the illnesses are similar to those in other poultry: pasteurellosis, bird flu, infectious bursal disease, aspergillosis, starve-outs and *Salmonella* and *E. coli* infections. All are exacerbated by factory farming.

Ducks are also susceptible to duck plaque – an infectious disease caused by the herpes virus – and duck virus hepatitis, which can cause death within hours. They are prone to developing septicaemia (blood poisoning) as a result of infectious illnesses.

Like all poultry, ducks are also prone to leg disorders as a result of selective breeding for greater size. They reach weights of around 3.5 kg in just 49 days compared to 63 days 40 years ago.

For more information on ducks, read Viva!'s report, *Duck Out of Water*, at www.viva.org.uk/campaigns/ducks

Conditions for most ducks are much the same as for chickens and injury, disease and death are commonplace. If it is lucky, this little duckling will be found and killed – or more likely it will be left to die

Geese

Around 210,000 geese are produced on 3,839 holdings in the UK each year (GB Poultry Register) and most of these are hobby enterprises, rather than commercial businesses.

Only 92 premises in the UK contain more than 200 geese with no large-scale producers in Scotland (NFU of Scotland). Some smaller, seasonal turkey producers also produce geese for the Christmas market (Defra, 2007b).

Seasonal goose production starts in late May/early June when the buildings are cleaned. Brooders are heated up three days before the goslings arrive and they usually spend 10 to 20 days under the brooder, depending on the temperature outside the buildings. Bedding is mostly straw.

The birds remain inside for six to eight weeks until they develop their waterproof feathers when they are turned out onto fox-proof pastures to graze. These can be overcrowded with usually no access to water for swimming.

Compound feed is reduced from about 10 weeks of age and the bird's diet is supplemented with daily corn or pellets.

The geese are brought back into the buildings at 22 to 26 weeks of age for slaughter, which generally takes place in specialist buildings on the premises. They are dry plucked after slaughter and dunked in hot wax to remove down and small feathers. Birds are then hung for around 10 days to develop flavour before being eviscerated – gutted (Defra, 2007b).

Broiler Feed

Forget about birds scratching around in the open air for insects, seeds and plants – commercially-grown cereal, high-energy and genetically modified foods in pellet form predominate in broiler production. Pellets are high in protein to encourage rapid growth.

Cereals form the major part of the pellets – even though the birds' digestive tracts cannot properly digest grain. Despite this, the British poultry industry is the biggest user of British wheat, consuming almost one-fifth of the total crop each year.

Pellets also contain 20-30 per cent soya, which is mostly imported from Brazil (Ellis, 2007). Some of this has, in the past, come from deforested areas of the Amazon (Ellis, 2007). Other pulses may be included together with added vitamin and minerals.

A small amount of fishmeal is sometimes used, particularly in organically-reared poultry, but currently no meat and bone meal from poultry, cattle or any other animal is permitted for use in UK poultry feed. According to a report in *The Observer* in May 2008, this may be set to change, with the European Union preparing plans to allow pig remains to be used in poultry feed. Officials in Brussels say that the decision will save farmers millions of pounds as price of cereals soars.

The Poultry Club states: "If you can find an additive-free feed you are fortunate but the trend is going that way. The general ingredients of all feedstuffs are listed on the label in descending order of weight but very few feed mills will tell you precisely which ingredients they use," (Poultry Club, 2008).

This begs the question: why the secrecy?

Genetically Modified (GM) Feed

Chicken, duck, turkey and goose feeds may all contain genetically modified (GM) ingredients, including GM maize and soya. In the EU, foods with GM content must be labelled, as must products such as flour, oils and glucose syrups if they are from a GM source. However, there is no legal requirement for meat, milk and eggs from animals fed on GM feed to be labelled (Food Standards Agency, 2008a).

According to the British poultry industry, except for Iceland, all supermarket own label fresh chicken and turkey and Lloyd Maunder poultry meat is from non-GM fed animals. However, GM feed is probably being used in the production of a great deal of imported frozen and processed poultry products sold by supermarkets, independent retailers, restaurants and the catering trade.

So just how widespread is the use of GM ingredients in animal feed? The Soil Association carried out an investigation of non-organic British animal feed in 2006 with 37 samples of poultry, dairy and pig feed from a range of feed companies. As many as 89 per cent of the samples contained GM ingredients (Soil Association, 2007) with the use of GM soya being particularly widespread: in poultry feed – 37 per cent of it being GM.

The Effects of GM Animal Feed

So what happens when GM food is digested by either animals or humans? The Food Standards Agency reckons that our digestive systems break down the tissue, proteins and genetic material – DNA and genes. It states:

"The DNA in GM food has the same structure as non-GM DNA and is broken down in the same way. Most DNA that is consumed, whether GM or not, is broken down in our stomachs and intestines.

"Sometimes, the DNA from the food we eat isn't broken down. However, it is unlikely that this DNA will become part of our genetic material by passing into our cells – any non-human DNA should simply be broken down in the cell."

Contrary to the Food Standards Agency's assurances, the Soil Association cites scientific evidence showing that small amounts of GM DNA do end up in the tissues and milk of GM-fed animals. At least 13 animal feeding trials show a range of disturbing health effects in animals fed GM: lesions in the gut, toxic effects in body organs, unexplained deaths and stunted growth in their offspring (Soil Association, 2008).

The Soil Association believes that GM-fed animals should not be used for food:

"Earlier studies did not detect GM DNA in meat, milk or eggs. However, new scientific studies have done so: two peer reviewed studies have now detected GM DNA from GM feed in blood, liver, kidneys and intestinal tissue. This means that there are important animal health and welfare concerns over the use of GM feed; there are also concerns about possible long-term effects on people."

The danger is that the alien DNA in GM animal feed may eventually get into humans by transferring to bacteria in the human gut and from there pass into tissue.

Experimental evidence shows 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 might then transfer that DNA into our intestinal epithelial cells and its effects will largely depend on what the gene does. While it may have no effect, is it a risk worth taking?

We simply don't know enough about this science or its long-term effects to say for certain what genetic engineering will do to our health. Because of it, we are ingesting genes that have never before been a part of the human diet and there is no way of knowing what they may do until it is too late.

Broiler Disease and Mortality

Millions of birds suffer from diseases induced by factory farm conditions. Infections spread rapidly in broiler houses with *Salmonella, Listeria, Campylobacter* and botulism all thriving. A huge percentage of birds slaughtered for human consumption have these diseases. Infections can also be carried in by stockmen and visitors, rodents, wild birds and contaminated feed or water. Chicken pieces are often the salvaged parts of damaged or diseased birds that cannot be sold as whole chickens (Viva!, 2008).

A report by Earthsave, *What About Chicken?* said: "Factory farms are fertile breeding grounds for disease and many commercial livestock feeds are tainted with *Salmonella*. Additionally, today's slaughterhouses do an excellent job of dispersing pathogens from bird to bird," (Earthsave, 1997).

For information on how these pathogens impact human health, see ***Food Poisoning***, page 18.

There are many other common diseases in broiler units including ulcers, which are often covered with crusts formed by discharge and faecal material and which can become infected by a variety of bacteria and fungi. The ulcers act as a gateway for infection, which can spread through the bloodstream causing joint inflammation.

Antibiotics

Stringent measures are needed throughout the life of the flock to prevent or control any disease entering the sheds.

Antibiotic growth promotion is the administration of an antimicrobial to growing animals in order to improve their physiological performance (Phillips *et al.*, 2004). It is usually given over a period of time.

The growth promoting effects of antibiotics were first discovered in the 1940s when chickens fed by-products of tetracycline fermentation were found to grow faster (Stokestad *et al.*, 1949). Since then, many antimicrobials have been found to improve weight gain and efficiency in livestock (Preston, 1987; Nagaraja and Chengappa, 1998; Gaskins *et al.*, 2002). It is known as 'growth promotion'.

The use of antibiotic growth promoters was phased out in the EU between April 1, 1997, and January 1, 2006, due to consumer and political pressure. There was also scientific concern that the agricultural use of antibiotics might act as an important source of resistance in bacteria that infect humans (Casewell *et al.*, 2003) – see below.

However, farmers are still allowed to use antibiotics under veterinary supervision to treat specific diseases as a prophylactic measure – disease prevention. It is suggested that antibiotic use improves mortality, morbidity, growth and feed efficiency (Phillips *et al.*, 2004). However, when antibiotics are necessary, they often have to be administered via food or water so the whole flock is treated. Individual treatment is almost never practical for poultry, although it may be practical for cattle and swine. In livestock production, the objective is to limit diseases as they reduce an animal's performance.

After an EU ban of growth promoters in 1999, there was an increase in sales of 'therapeutic antimicrobials' from 383 tonnes in 1999 to 437 tonnes in 2000, particularly tetracyclines (by 36 tonnes), trimethoprim/sulphonamides (by 12 tonnes) and macrolides (by 12 tonnes).

In a review of the European ban on growth-promoting antibiotics and the emerging consequences for human and animal health, Casewell *et al.* conclude that: "...growth-promoter bans have reduced overall antibiotic use in animals. It is increasingly clear, however, that the use of growth promoters was accompanied by other... health promotional or prophylactic effects. After the [ban] animal welfare has suffered and despite efforts to improve other aspects of husbandry, the veterinary use of therapeutic antibiotics, which are identical to those used in human medicine, has increased, and this constitutes a theoretical hazard to human health in relation to resistance in *Salmonellae, Campylobacters* and zoonotic strains of *E. coli*..."

Nicarbazin is an antibiotic feed additive used to treat the poultry disease, coccidiosis. It is routinely given to broiler chickens in their first four weeks of life (Ellis, 2007) but should not be used within five days of the birds' slaughter to: "ensure no appreciable residues of it remain in chicken for human consumption," (Food Standards Agency, 2008e). It is combined in equal amounts with another antibiotic, narasin, in a product called Maxiban. Maxiban is the only UK-licensed product that contains nicarbazin.

Shown to cause birth defects and hormonal problems in animal studies, nicarbazin has never been carefully evaluated for safety in humans (Ellis, 2007). Residues can be found in poultry meat but are more common in poultry liver.

In May 2008, the Food Standards Agency issued a report on nicarbazin residues in chicken (FSA, 2008). Samples of chicken livers and muscle (meat) were taken from 320 farms at slaughterhouses by the Meat Hygiene Service. Forty-one contained detectable amounts of nicarbazin with traces ranging from 60 micrograms per kilogram (μg/kg) to a massive 3,000μg/kg. The UK 'maximum residue limit' for nicarbazin has been set at 200μg/kg, meaning that samples at the upper end of this range exceeded the limit by fifteen times! The more an antibiotic is used, the more likely it is that resistant pathogens – such as antibiotic-resistant *E. coli* – will arise in the intestines and faeces of animal carcasses (see ***E. coli***, page 20). While some bacteria rapidly develop resistance others remain susceptible to the drug, but even low-level resistance is of concern as it may be a first step towards clinical resistance (Phillips *et al.*, 2004).

When consumed, antibiotic-resistant bacteria from animals can either infect humans directly or transfer their genes, passing on their resistance to similar bacteria. Either way, eating animal flesh is the simplest and most direct way of introducing animal infections into our bodies.

Antibiotics are also widely used to treat or prevent infections in humans. Those used belong to the same general classes as those used in animals and even when they are not exactly the same, the way they work is the same.

There is a great deal of evidence demonstrating an association between antimicrobial use in animals and antimicrobial resistance in humans. A summary of this evidence was published by Swartz (2002).

There is also increasing evidence that antimicrobial resistance in human bacteria as a result of antimicrobial use in food animals can have an adverse effect on people. Two review articles published in 2002 link antimicrobial use in animals with excess infections and increased morbidity in people (Barza and Travers, 2002; Travers and Barza, 2002). Furthermore, an international expert consultation in December 2003, convened by FAO, the World Organisation for Animal Health (OIE) and WHO, concluded:

"…There is clear evidence of adverse human health consequences due to resistant organisms resulting from non-human usage of antimicrobials," (Food and Agricultural Organization *et al.,* 2003).

Extensive and Organic Farming

Just five per cent of chickens and ducks, 10 per cent of turkeys, and the majority of geese are reared outside as free-range or organic, although the British Poultry Council reports that these markets are growing steadily.

Food may be labelled 'free range' if animals have spent only a portion of their lives outside or have simply had access to an open-air range. Free range poultry are usually kept in flocks which still number in the thousands or tens of thousands.

Animals reared outdoors can and do fall prey to parasites, infection, the weather and the condition of the land on which they are kept. In part, this is because selective breeding has weakened their ability to resist natural hazards or because the land is unsuitable.

Organic farming is designed to ensure that food and the land used to produce it are as free as possible from artificial chemicals such as drugs and synthetic fertilisers. It is chiefly concerned with the quality of food rather than the treatment of animals – although in practice, organic standards usually set higher levels of welfare than non-organic systems. Where the use of drugs and chemicals is restricted, better care must be taken of individual animals in order to safeguard their health. In general, organic systems favour outdoor rearing, lower stocking densities and more natural husbandry techniques, such as longer periods before weaning.

This approach does not necessarily reduce levels of disease but is reflected in the higher price of organic food, which allows organic farmers to accept greater losses of animals during rearing. The mortality rate of organic broiler chickens is double that of intensively reared chickens because parasites and infectious disease are easily acquired from the environment and fewer drugs used to control them. The organic ideal of chemical-free farming may sometimes be obtained at the expense of animal health.

From the Farm to the Plate

When broilers reach the required market weight they are moved to processing plants. Caught by their legs and carried upside down, they are placed in open drawers, called modules. When full, the modules are taken to a lorry by a forklift truck for transportation. For the 850 million birds transported each year, there is a death rate of around 0.19 per cent. Those birds dead on arrival cannot be processed into meat.

At the plant, birds are inspected under supervision of the independent Official Veterinary Surgeon (OVS) from the Government's Meat Hygiene Service. Broiler chickens are lifted out of the trays and hung upside down shackled by their feet to a moving chain whilst still fully conscious.

The birds' heads and necks are dragged through an electrically charged water bath designed to render them unconscious. The moving line then takes them to an automatic neck cutter to be killed and they are bled before being dipped into a scalding tank of hot water to help to loosen the feathers. Broilers often experience pain and struggle while hung in shackles, and they may suffer during the slaughter process. The still-shackled carcasses are moved to mechanical plucking machines where revolving rubber fingers remove all the feathers, which are carried away by a water flume.

The head, intestines and internal organs are removed and the carcasses examined by an independent qualified inspector to check for diseases that might present a risk to human health. Suspect carcasses are rejected. Selected carcasses are washed and chilled by cold air jets or cold-water sprays and left for eight to 10 hours for the meat to tenderise.

For more information on the slaughter process, read Viva!'s report, *Sentenced to Death* at www.viva.org.uk/campaigns/slaughter/sentencedtodeathreport.htm

Processed Poultry

Birds may be cut into portions by hand or by an automatic portioning machinery. The portions move along conveyors to be examined and packed into the familiar plastic trays seen in supermarket chiller cabinets. Wrapped packs are boxed and kept in cold storage until despatched in refrigerated lorries to the retail store or wholesale markets. Kievs, nuggets, goujons, breaded products, ready-meals and similar poultry meat products are also made in poultry processing plants.

The nutritional content of different cuts of meat varies as cutting exposes more of the surface area of the meat, making it susceptible to deterioration (oxidation). Un-cut products, such as whole chickens and turkey, are more nutritious than cut products (eg chicken fillets, thighs, drumsticks, diced chicken).

That said, water is routinely added to catering chicken together with additives to hold it there. Felicity Lawrence, author of *Not on the Label*, writes: "If you've ever eaten a takeaway, a ready-meal, or a sandwich containing chicken, the chances are that you will have consumed chicken adulterated like this," (Lawrence, 2004).

The process by which frozen, sometimes salted, meat has water added to it is called tumbling. In effect, it is tumbled in water like clothes in a washing machine. Additives may be used instead of, or in addition to tumbling, to help the water stay in the chicken. These include phosphates and hydrolysed protein. This has the effect of boosting the meat's weight and therefore its price! (See ***Chicken Nuggets***, page 62.)

Dr Linda Bacon, lecturer at City College of San Francisco, writes: "Low-fat processed meats tend to be particularly low in nutritional quality. The main way meat is manipulated to lower the fat content is by adding water. And in order to do that, it is necessary to add water-absorbing substances, like carageenan and starch, which have a bitter taste. This typically results in more flavouring chemicals. In the end, these highly processed meats bear little resemblance to the original product they were derived from, and hold little nutritional value," (Bacon, 2005).

Grinding, for such things as chicken and turkey burgers, breaks down the cell structure of meat, causing vitamin and mineral loss, allowing essential fatty acids to oxidise and exposes the food to more bacteria. Freezing causes the cell membranes to deteriorate, resulting in similar problems.

The World Cancer Research Fund (WCRF) warns that processed meats – those preserved by smoking, salting and any other method apart from freezing – can significantly raise the risk of bowel cancer. Research shows that eating 50g (1.8oz) of processed meat a day raises the likelihood of cancer by a fifth (World Cancer Research Fund, 2008). The WCRF advises that the safest amount of processed meat to eat is none at all. "We do recommend that people avoid it completely, but it is not a case of all or nothing. Cutting down on the amount of processed meat you eat can also reduce your risk of developing bowel cancer," Professor Martin Wiseman, Medical and Scientific Adviser to the WCRF recently stated.

Mechanically Recovered Meat (MRM)

Mechanically Reclaimed Meat (or Mechanically Recovered Meat – MRM) is a pinkish grey slurry which resembles mince. It is created by pressure blasting everything left on the carcass after the prime cuts have been removed which is then passed through a fine mesh. This residue, to which fat and skin is often added, is bound together with polyphosphates and gums. Some companies use it to bulk up their meat products although MRM from sheep and cattle has been banned as a consequence of BSE. MRM from poultry and pigs can still be used (Food Standards Agency, 2008b).

One Trading Standards chief who has investigated the use of MRM is in no doubt as to the reason for its use. MRM can be 10 times cheaper than other meat, according to David Walker, chief Trading Standards officer in Shropshire: "It is simply and solely used because of the price of the product," he said (BBC News, 2001).

Chicken Nuggets

Producers often enhance basic meats to allow them to be sold for a higher price and a higher profit. Cuts may be dressed up with spices and an essentially unpalatable product rendered more attractive. Chicken nuggets are often essentially MRM mixed with gums, flavourings (which may include sugar), polyphosphates and soya for bulk, all bound together with breadcrumbs. The resulting paste is marketed as a fun food, mostly to children.

MRM makes its way into the lowest quality chicken nuggets, the kind which once made their way onto school menus, reports Felicity Lawrence, who investigated the state of the chicken nugget industry for her book *Not on the Label* (Lawrence, 2004).

“A lot of manufacturers have told me they have reformulated their nuggets,” says Lawrence. “But the problem is that they are not going to use wonderfully expensive chicken – that is not how they make their money.

“Many have removed the fat and skin, but they have replaced it with some chicken breast and have still added starch, water, sugar, flavouring and additives – all cheap ingredients – to bulk it up. When you buy these products you are paying, essentially, for water and highly processed starch.”

In 2002, Leicester Trading Standards officials tested 21 brands of nuggets. A third did not live up to the labels’ descriptions and one pack contained just 16 per cent meat – 30 per cent less than claimed. Another brand, claiming to be 19.7 per cent fat, actually contained 27 per cent. Two brands even contained hidden turkey!

Similarly, the Food Standards Agency (FSA) discovered pork proteins in samples of imported Dutch chicken that claimed to be halal. Likewise, an Irish study found bovine (cow) proteins in Dutch chicken.

These hydrolysed proteins are taken from animal parts that are not eaten, such as skin, feathers, bone and ligaments. They help the chicken to retain the water that is put inside it. It is not illegal for products to contain water and hydrolysed proteins if they are labelled. The FSA is calling on the EU to impose a 15 per cent limit for added water and wants a ban on hydrolysed proteins in fresh chicken.

The Environmental Impact of White Meat Production

Worldwide, millions of people are taking steps to ‘go greener’ as the headlines scream natural disaster, food shortages and global warming. It is a disturbing fact that people who eat meat produce 988 kilograms (about one tonne) more global warming gases each year than people who don’t eat meat! This amount of gas would not even be offset by a year’s worth of recycling, avoiding tumble drying, driving sensibly, taking showers instead of baths and using low energy bulbs (*Green Your Life*, 2008).

According to Environmental Defense Fund, if every American skipped just one meal of chicken per week and substituted vegetables and grains, for example, the carbon dioxide savings would be the same as taking more than half a million cars off US roads! (Environmental Defense Fund, 2009).

For more information on eco-eating, visit Viva!’s website: www.eatgreen.org.uk

Conclusion

White meat is perceived to be a low-fat food – something to be eaten in quantity by top athletes. However, modern farming's focus on high-energy feed, little exercise and breeding for rapid weight gain means that even organic meat is nowhere close to being low-fat – even after removing the skin and scraping away the subcutaneous fat. A medium-sized chicken contains almost a pint of fat! And contrary to popular opinion, animal protein is not essential for building muscle or for children's growth.

Turkey has even been called a 'superfood' despite containing no fibre, no complex carbohydrates and no vitamin C. And it's the same for other poultry! When white meat takes the place of fruits, vegetables, wholegrains and pulses in the diet, the result is less vitamins, fibre and unwanted dietary fat and cholesterol.

Research links white meat to an increased risk of many serious health problems and diseases. These include food poisoning, urinary tract infections, certain cancers, cardiovascular disease, diabetes, kidney stones and kidney disease, gallstones, rheumatoid arthritis, osteoporosis and overweight and obesity.

An estimated 5.5 million people in the UK are affected by food poisoning each year – and chicken is the main source. It can cause abdominal cramps, nausea, vomiting and diarrhoea – and sometimes fever, organ failure or even death. Urinary tract infections are among the most common infectious diseases in women – and may well be linked to eating chicken and other meat.

There does not seem to be a way to cook meat to an internal temperature necessary to kill off food poisoning bacteria without producing at least some carcinogenic compounds. And even low doses have been shown to cause human DNA mutations which could lead to cancer.

Eating even small amounts of white meat can be detrimental to health as just one serving of meat per week (including white meat) has been found to significantly increase the risk of diabetes and to raise blood cholesterol levels. Five or more weekly servings of white meat have been shown to raise blood cholesterol levels by 8.6 per cent in men and 8.8 per cent in women. Those who avoid red meat but eat white meat less than once a week may face 55 per cent higher risk of bowel cancer than non meat-eaters.

Eating just small amounts of meat also has a huge impact on the environment. By skipping one meal of chicken every week and substituting vegetarian foods, the carbon dioxide savings would be the same as taking more than half a million cars off US roads.

The amount of meat the world eats is expected to rise by over 55 per cent in the next 20 years. Chickens, as the most intensively farmed animals, are expected to be on the front line of this change. Human health will be on the front line, too.

There are however a number of tasty, healthy – and environmentally friendly – meat-free alternatives. For more information and recipes, read the VVF's guide, *White Meat Myths*.

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