CHAPTER ONE

Medicine and Progress

The doctors of today prescribe medicines of which they know little, to cure disease of which they know less, in human beings of whom they know almost nothing.
VOLTAIRE: 1694–1778

Progress is all very well, but it has gone on long enough.
OGDEN NASH: 1902–1971

THE WAITING ROOM

It is Monday morning in the waiting room of an imaginary general practice on the outskirts of the inner city. The patients include students from the nearby university, factory workers, shift workers, business people. Many ethnic groups are represented. Let us suppose that I work in this busy practice with four or five other doctors. We all get on well together and often discuss difficult cases with each other. All of us have areas of special interest in medicine, and we have a wide range of outside interests. Mine is a hobby farm in a bushland environment a few hours out of the city. These various interests form the subject matter of many of our lunchtime conversations.

In the waiting room on this busy morning are a group of typical patients who could be in any city, any suburb. Some have cuts or sprains from weekend sporting activities or need a routine check, but most have chronic health issues such as high blood pressure, depression, menstrual disorders, headaches.

My colleagues and I have recently been to courses on nutritional and 'alternative' medicine. We felt that it was time we learnt about the safety of the things our patients are taking. Lately they have been asking us about treatments such as St John's wort and glucosamine. One of us has a pregnant wife who is taking vitamin supplements. Does my colleague know that *this* is safe? She eats well, why would she need them? Is there any scientific evidence?

My first patient of the day is Mary, who is 28 years old. She has come to see me because of chronic, low-grade depression and a feeling of 'just not being well'. She has a job which she enjoys and good friends. A two-year relationship ended amicably a few months ago, and she currently does not have a partner. She says she wants her own space for a while. She eats reasonably well, although she admits to a sweet tooth and perhaps more coffee than she ought. She drinks a fair bit of tap water because she has heard that this will help to keep her bowels regular. She drinks alcohol within a safe range and is a non-smoker. She gets some exercise, although admits she hasn't had a lot of energy lately.

Her medical history includes mild asthma with seasonal exacerbations, for which she has a range of puffers. She uses at least one of these most days, but regards her asthma as fairly easy to control. Her bowels are usually okay, but if she's not careful she can become constipated. She is on the oral contraceptive pill although she has no current need for contraception. She has been on the pill on and off since she was 16 and says she is scared to come off it because she will have heavy cramping periods and her skin will break out. When she first went on the pill she was still at school and did not need contraception. The doctor she was seeing at the time said it would be the best thing for the cramps that were keeping her away from school one or two days a month, and it would also help her troublesome acne. At the time of commencement she had never had a migraine. She has had three or four migraines since, but the doctor thought that it was okay for her to take the low-dose pill.

Her blood pressure went up a bit on the pill, but as it is in the normal range she and I have agreed just to keep an eye on it. We plan to do this regularly, because I am also treating her mother for mild hypertension. Mostly the pill controls Mary's painful periods but sometimes she has to take an anti-inflammatory. She is totally dependent on these when she is giving the pill a 'rest'. At those times, she often has to take antibiotics for her skin as well. She gets mood swings around the time of her period, and thinks these are a bit better on the pill, although she suspects that her overall well-being is reduced. She has discussed with me her lack of interest in the things which used to give her pleasure. We have talked about an anti-depressant, but she is not keen to take that path yet.

There is probably a Mary in every doctor's waiting room every morning of the week, and few doctors would argue with the treatments she is on. After all, one in four Australians now has a lifetime expectancy of asthma, and although this is one of the highest rates in the world, other developed nations are not far behind.

And it's known that certain illnesses such as asthma, migraine, depression, dysmenorrhoea and irritable bowel cluster together—in individuals, in families and in cultural groups.

So it's *common* for these conditions to occur together, and we've also come to accept it as *normal*. But have we accepted Mary's symptoms too readily? When we see whole families of asthmatics and migraineurs we think of shared genes, but how can such conditions be shared by whole cultures?

If we look at Mary, and the thousands like her, from the perspective of a hundred years ago, or of a rural dweller from the rapidly vanishing tribal peoples of the world, her diagnoses and treatments are nothing short of astonishing. Here she is, still in her twenties, a healthy individual, and yet she has been, or is, taking:

- a beta adrenergic bronchodilator
- oral or inhaled corticosteroids
- synthetic oestrogen and progesterone
- long-term antibiotics
- a non-steroidal anti-inflammatory pain killer
- a specific anti-prostaglandins medication.

As if this is not enough, an antidepressant could soon be added if things don't look up. Most of her medications require a prescription, or at least dispensation by a trained pharmacist, in Western countries. A look at the associated list of side effects, precautions, drug interactions and warnings of use in pregnancy soon explains why. These medications are not to be taken lightly.

If we look at the various treatments Mary has had, there is no underlying pharmacological consistency. Each has targeted a specific problem. The bronchodilator she takes for her asthma is unlikely to do much for her mood swings or her tendency to constipation. If these conditions tend to cluster, it seems intuitive to expect that a treatment for one might have a favourable effect on the others—assuming that the relationship between the conditions is at least partly causal, which commonsense seems to dictate.

But Mary's medications lack logical connection with each other. Some are potentially incompatible. This incompatibility may be pharmacological—that is, the drugs themselves interact in a negative way—or it may be to do with the symptoms. The action of the steroid medication could well worsen the depression.

If Mary is among the 20 per cent of asthmatics who are sensitive to aspirin, the medications she takes for her period pain may make her asthma worse. If she were a severe asthmatic this would rapidly become apparent, but as she is usually well controlled the overall deterioration over time may not be connected to her intermittent use of aspirin-like painkillers.

Even a few decades ago, patients like Mary would have had a much narrower range of medications at their disposal. There might have been something for her asthma, and some aspirin or paracetamol for her pain. Under the age of 40 or 50, only an unusually sick patient would have been taking more than a couple of prescription medications on a regular basis.

What is so bad in the human design that one in four now needs drugs in order to breathe normally? What is so maladaptive about a menstrual cycle that it regularly puts a significant number of women to bed once a month? Mary has not got asthma because she has a Ventolin deficiency, and menstrual cramps are not caused by Ponstan deficiency. Why does she—like thousands of others—have such a constellation of medical problems, and such a galaxy of pharmaceutical solutions to them?

These are the questions that we are beginning to debate in our lunchroom at work. To begin to answer them, we have to start a long way back, at the moment when some humans decided that hunting and gathering was too hard.

AGRICULTURE: THE UNFINISHED EXPERIMENT

Beginnings of agriculture

At some time in a distant past our hunter-gatherer ancestors came to the conclusion, or had it forced upon them, that life would be easier if they were not continually on the move. Food grew from seed; animals grazed on plants. Maybe people would have more control over their lives if they planted those seeds and domesticated those animals.

It was long accepted that agriculture began around 10,000 years ago in the Middle East. Nowadays we believe that it originated in several places, and much earlier than previously thought.[1] The reasons for the adoption of agriculture varied. For example, in North America the end of the last ice age saw the extinction of many of the large game animals, forcing hunter-gatherers to turn to cultivated plants.

But the transition from a hunter-gatherer society to one based predominantly on agriculture brought with it not only profound social change but also unprecedented biological challenges.

Seeds of change

It is easy for us to conjure up a scene of a pastoral idyll, where contented farmers plough their fields with yoked animals. Compared with the stress and pollution of the cities of the modern world, those fields indeed appear as a picture of Elysian bliss. But along with the seeds of those early crops, the seeds of the diseases of civilisation were being planted. Even in those early days, the skeletal remains of Stone Age farmers showed more signs of tooth decay, infectious disease and malnutrition than their hunter-gatherer forebears.[2] The suggestion is that wheat and barley were grown as much for the production of beer and luxury items as for a staple.

Over time, however, these crops came to provide staples, in addition to whatever their original use had been. And with settlement came the motivation to construct more permanent and secure shelter. We began to lose some of our adaptation to cold and to food deprivation. Being settled in one place provided both the opportunity and the motive to construct food storage vessels. We were no longer confined to a rotational diet, no longer had to eat seasonally.

Food storage also provided protection against hunger. Chapter 8 discusses the concept of the 'thrifty gene'. This gene, or genes, enabled people to slow down their metabolism and thus reduce their energy usage in times of starvation. Some people have thrifty genes; some do not. Those who have them fare well in times of famine. Civilisation allowed those without thrifty genes to survive, which was an appropriate evolutionary step. The disadvantage for those retaining the genes was that they found themselves in a world where starvation was rarely a problem. In the face of dietary excess, they became prone to obesity and diabetes.

Over time, changes occurred in the crops that humans grew and the animals they tended. These changes reflected changing social needs, such as ease of handling animals or the timing of the harvest, but sometimes they worked against human biochemical needs.

Evolutionary science indicates that biological systems evolve in parallel. But this takes time and, in the meantime, evolution is a ruthless game of trial and error. Not all change is beneficial. Moreover, evolution never counted on our ability to thwart it. The domestication of animals provides an example of this. Like us, wild animals depend on essential fatty acids (EFAs), such as omega-3 fatty acids, for protection against cold, defence against inflammatory disorders, and many other aspects of health. By and large, omega-3s are derived from plants—animals have limited, if any, ability to manufacture them from dietary precursors. We must eat the plants which contain them, or eat animals which have eaten those plants. One of the richest sources, especially of omega-3 fatty acids, is algae. Another source is seeds that need to withstand extremes of weather, particularly cold spells.

As humans bred animals for their thick hides and wools, their docility and their tolerance of enclosure, and as they turned wild mountain sheep and buffalo into placid merinos and tranquil cows, and wild turkeys and ducks into the modern flightless equivalent, they also reduced their reliance on omega-3s. We kept these animals warm in barns and completely changed their diet. We fed them the crops we grew, which in turn reflected needs other than nutritional. Yield, ease of harvest—such factors took precedence over a chemistry which we did not yet understand.

Thus we produced animals genetically more resistant to a lowered level of EFAs in their tissues. Animals with thick coats can endure the cold, but domesticated animals are provided with shelter. As a result, there was a lower level of EFAs in our food supply—to which, we now know, we are far from adapted. Domesticated animals will incorporate EFAs into their tissues if they are in their diet. Any resistance to deprivation has not erased the need for these essential nutrients.

Free-ranging animals have access to ground plants and seeds. A free-ranging domestic hen ignores her 'layer pellets' and works hard to extract some tiny seeds from a plant we regard as a weed. Perhaps, in our ignorance, we would even prefer to poison the plant. No wonder fish remain one of the best sources of EFAs—all that algae, all that choice. Wild animals in zoos often fare badly, perhaps because they suffer the problems of EFA deficiency. The fleet of foot, the wild and unsheltered, the animal surviving on its wits, the animal which has to endure extremes of temperature—these typically have flesh which is high in omega-3 fatty acids.

When it comes to plants, the story of dietary change is even more interesting. While early humans continued to trap wild animals and fish to conserve their precious herds and flocks, the cultivation of plants created the potential to narrow the dietary intake to a relatively few species—corn, wheat, barley, rice, and some vegetables and herbs. When these were supplemented with game, milk and eggs, our forebears were well fed. But humans had opened the door to the development of monocultures. No longer did we eat whatever we could find, going further afield when that proved inadequate.

Although agriculture opened up possibilities for an increase in variety, one look at the predominance of staples such as wheat and dairy in today's world shows us that the ultimate trend was actually in the direction of narrowed choice. The medical consequences of this will be discussed throughout this book.

Some anthropologists feel that humans have always to some extent been farmers, but Stephen H. Leckson of the University of Colorado is less compromising. He writes:

> Farming is an unfinished experiment. ... Two million years ago our genus first appeared; we've been farming for less than 12,000 years. Fully modern humans have been farmers for less than one-third of *Homo sapiens*' chequered past on this planet. It's too soon to tell if this farming thing will work out: It's not natural.[3]

Agribusiness

Whether we began to live with agriculture 10,000 or 20,000 years ago, there have been two distinct, if overlapping phases. The first was gradual; the second has taken place in the last century or so. In this second phase, the rate of change has paralleled the explosion in industrial, technological, scientific and medical knowledge. If the transition to agriculture posed challenges to human biology, it is a mere hiccup in comparison to the transition from agriculture to agribusiness. Indeed, this second phase is arguably responsible for what are loosely termed 'the diseases of modern civilisation'.

We are not restricted to ancient records to understand how our forebears ate, lived and died. Anthropologists and archaeologists provide all the evidence we need. There are surviving cultures still primarily hunter-gatherer, or who practise a form of agriculture more like that of the last 10,000 years than the last 100. We look more closely at the diets of some of these people in Chapter 10.

When we look at the early hunter-gatherers, or their modern equivalents, one of the things which stands out is the variety of foods they could access. This is in part a consequence of the abundance of plant and animal species in the natural world, and in part a matter of necessity. When you are really hungry, you eat what you can get—a concept alien to the average urban dweller.

Doctors who suggest excluding wheat and dairy products from the diet commonly get the response 'But what is there left to eat?' What indeed, if breakfast is a bagel and a café latte, lunch a cheese and tomato sandwich, and dinner pasta with cheese and tomato sauce or a pizza? Between them, meat, milk, wheat, potato and tomato, provide the bulk of the nutritionally significant part of the Western diet. Young people at the supermarket checkout may ask their customers the names of certain fruits or vegetables. Unusual items such as okra, starfruit or taro we might understand, but I have been asked to name parsnip, brussels sprouts, and—twice in one week at different shops—beetroot.

In 1995 an Australian survey of 3000 young people aged 2–18 showed that one-quarter ate no fruit and one-fifth ate no vegetables on the day of the survey. If fruit juice was excluded, 40 per cent had eaten no fruit. Potato was the most commonly eaten vegetable, and much of that was eaten as fried chips. Less than 20 per cent of surveyed children had eaten any cruciferous vegetables (mustard, radish and the cabbage family) in the last 24 hours, and only one-third had eaten any carotenoid vegetables, such as carrot or leafy greens.

Things are no better in the United States or Britain. In Britain consumption of leafy greens has halved during the past 50 years, and less than one in 10 children could name a cauliflower when shown one. Some thought it was a lettuce; most were simply perplexed.

Freshness, seasonality and diversity

The hunter-gatherers' diet was not only diverse; it was composed of food that was fresh and in season. How long have our fruits and vegetables been in cold storage?

Seasonality was a feature of old-style agriculture, but not of the modern diet. It has two interesting implications. First, we were effectively on a permanent rotation diet, sometimes called the Stone Age diet. The idea is that the constant consumption of any particular food group presents a challenge to the immune system, and this can be the basis for the development of food allergies. Health practitioners sometimes treat medical conditions such as migraine and irritable bowel syndrome by limiting the frequency with which any one food is consumed (Chapter 8).

Second, there is the fascinating theory that defence mechanisms which a plant developed to adapt itself to the local climate and environment could possibly confer similar benefits on people and animals sharing that environment.

Variety is one of the areas most worthy of future research. The food family lists in Appendix 2 may come as a surprise. The *New Oxford Book of Food Plants* (see Further Reading) is also cause for wonder, not only for the abundance of natural produce but also for the amount which the modern diet omits.[4] And yet both of these sources merely scratch the surface. The bush foods of Australian Aboriginals show what else there is in the natural world.[5] Tribal Aboriginals consumed many hundreds of kinds of plants — roots, seeds, legumes, fruits, sea vegetables, fungi, crustaceans, insects and animals (Chapter 10). (In a theme central to this book, the idea of food as medicine blurs with food as nourishment in Aboriginal culture.) Add to this the fruits and vegetables of the Amazon, the African jungles, the herbs and berries of Asia and New Guinea.

Compare this bounty to the total number of plant or animal species that you have consumed in the last week, the last year. And even if you do occasionally eat the more unusual vegetables, such as beetroot or rhubarb, how often do you do so?

As we move away from the old idea of the five or seven basic food groups to a more sophisticated understanding of human biochemistry and its necessary nutritional inputs, we start to see extraordinary complexity. Terms such as 'phytochemicals', 'leucopenes', 'essential fatty acids' and 'ultra-trace elements' are coming into everyday language. Many of these substances are required in small, or even tiny, amounts. Although they may not be essential for survival, they may be essential for optimal health. The distinction between survival and optimal health is only gradually gaining acceptance in the medical world.

Folk wisdom in Japan says that one should eat 30 different food types every day. Counting herbs, spices, oils, nuts and seeds, it is estimated that the typical Italian diet contains approximately 60 different food groups. The comparable estimate for the typical Western diet is just 20 food groups. So it may not be the high olive oil content and low levels of saturated fats in the Mediterranean diet which confer the well-known benefits: it may be the variety as well. This would certainly help explain the French anomaly, where the consumption of butter, cream and cheese is legendary, but where freshness and variety of herbs and vegetables are also paramount. (There are also other reasons why the French may fare better than their British and German counterparts; see Chapters 8 and 10.)

In a delightful essay British science writer Colin Tudge elaborates this theme, suggesting that modern, agricultural human beings, are 'pharmacologically impoverished'.[6] This essay significantly altered my own thinking. Until then I had assumed that some nutrients were important for the maintenance of optimal health, and others were essential for life itself. Inevitably things would sometimes go wrong, and at that point one would look to a pharmaceutical, either a modern drug or a herbal remedy, to fix things. Tudge takes this thinking one step further. These natural 'medicines' were perhaps an *integral part* of an original diet, taken regularly to prevent disease. This theme is developed in Chapter 10.

Agribusiness takes over

We have looked at what might prevail in an ideal hunter-gatherer world or an agrarian society before industrial farming methods were introduced. Western agriculture today has undergone a shift of exponential proportions. Changes have happened so rapidly that there has barely been time to consider the biological effects on the environment, let alone the more subtle biochemical impact on humans and animals, or on the birds, insects, earthworms, plants, fungi and soil micro-organisms on which depends the entire food chain.

The social changes that have accompanied the shift from an agrarian society to an industrial one are obvious; dietary changes deserve equal attention. The new technologies made it possible to preserve or refrigerate food, thus allowing it to be kept much longer, and changes in transport allow food to be moved over vast distances in a relatively short time. It is no longer possible to tell what season it is simply by looking at the fruits and vegetables on display in the local supermarket, as was true just a few years ago.

Now people can eat their favourite food all year round; indeed, they often do. This increases the likelihood of developing a sensitivity to that food, while similarly restricting the range of foods they do eat. You don't like the brassicas—cabbage, broccoli, brussels sprouts, traditional winter vegetables? No matter, eat baby spring peas all year round. Easy to prepare, no shelling required, straight from their frozen plastic pack. Your children get the message. They've never eaten a brussels sprout, and in their Saturday job at the supermarket they will ask the customer the name of this strange vegetable. The supermarket manager gets the message: hardly anyone buys this item, so it always looks stale and unattractive, spoiling the display. The farmer gets the message and plants more peas and less cabbage. So it goes.

In an affluent society, we no longer eat what is available: what is available is what we will eat. This in itself would not necessarily be a bad thing were the choices not so frequently based on convenience. The most commonly given reason for not eating fish or cabbage is not dislike, as one might imagine, but the messiness of preparation and the persisting smells in today's enclosed kitchens

If the changes taking place in the supermarket and the kitchen are profound (and that's without weighing into the debate about freezers and microwaves), what is going on out in the paddocks? In those Elysian fields, we toiled by the sweat of our brow (no Syndrome X there). We fertilised fields with the manure of our animals (not to mention our own); we relied on the birds for pest control, the worms for soil aeration, the trees for topsoil.

Biodiversity

Australia is a country which is already 90 per cent desert. To our knowledge, this has not been largely the result of human activity, but of climatic and geographical events over very long periods of time. However, since European occupation two centuries ago, trees have been felled at such a rate that tree coverage is a mere 10 per cent of what it was at the time of Captain Cook's arrival.

In England and much of Europe the reduction in woodland in the last century or so has been of similar proportions. This has had devastating consequences for both the environment and human health. Biodiversity experts have estimated that individuals, communities and whole ecosystems are becoming extinct at a rate as great as 10,000 times the 'normal' level. (One has to acknowledge that there have been other rapid changes brought about by ice ages and asteroids, but these were out of human control.)

> As a general rule, for a plant species that becomes extinct we can expect 15 animal species to follow. The toll for Australia's plant species amounts to 76 extinctions and more than 300 currently endangered species (not including

> algae, moss lichens and liverworts, the status of which is unknown). This means that there are probably more than 1000 species of extinct animals, most of which are likely to be invertebrates, and more than 4000 threatened animal species. … The flow-on effects of this are clearly devastating. Globally, half the known extinctions of the last 2000 years have occurred during this century. Whereas for the past 250 million years approximately one species became extinct per year, we are losing about fifty species every day.[7]

The implications of the loss of biodiversity are manifold. We lose plant species before we have even begun to tap their pharmaceutical potential. The world's frogs begin to disappear, and we don't know why. Who is to say that we are not next? The outlook for human survival is only as good as the quality of human sperm.

The web of life

As we continue to deforest in order to make way for the combine harvester, we might look at other health consequences.

If Dog is our best friend in the animal world, then Tree is our best friend in the plant world. It provides us with shade and shelter, timber for boats and fence posts, aesthetic and other purposes. It is a carbon sink and a vital link in the food chain. It supplies shelter for farm animals and for the birds which eat pests. In a Queensland pilot program, the use of rodent poison on sugar cane dropped steeply when reafforestation brought the owls back.

Trees hold the topsoil together, preventing its loss to wind and weather, and they renew that topsoil. Minerals which are taken up from the soil by plants and are then sold off-farm are lost to the farmer forever. If they end up in the city sewage, they are lost to the food chain as well, because their destination is often the ocean. The tree puts down roots deep through the clay, breaking up rocks and releasing minerals into the soil. These minerals nourish other plants and are also taken up by the tree itself. Here they nourish the leaves which later fall from the trees and are decomposed by the micro-organisms sustained in and around the tree roots. In this manner, depleted soils have opportunity to renew themselves. Even in climates and lands as barren as Australia, when topsoils become devoid of minerals, there often remains an untapped supply in the rocks and soils below.

If tree felling on an individual farms is a worry, the clear-felling of rainforests to establish cattle and Western agriculture is a global tragedy. As global warming increases, tropical diseases spread. Malaria is now increasingly identified in northern Australia, a phenomenon rare in modern times. Worldwide, epidemics of unknown bugs are expected to emerge, as if nature were exacting a terrible revenge.

In summary, the equation does not consist of humans, a tree, a rock and a sheaf of wheat: every protozoan, fungus, nematode and pollinating insect must be taken into account in this delicate web of life. We have come to regard some of these creatures as pests, but over millennia nature struck a balance that we interfere with at our peril. Farmers realise that when you poison a slug the birds that feed on slugs die, either through starvation or poisoning; so you need to use more poison, which means more expense, and more birds die and then the bugs become resistant to that poison, and so it goes on, with the poison manufacturer earning more than the farmer.

And what of these poisons? Despite massive cover-ups, political and medical indifference, hostility and denial, the evidence continues to mount against agricultural chemicals. They are implicated in the causation of an amazing range of diseases—autism, infertility, cancer, Parkinson's disease.

In animal breeding when you select for one trait, such as beauty, you may lose another, such as vitality. The loss of nutritional value for the incorporation of poison resistance could well be a metaphor for 21st-century agriculture.

Soil health

The relationship of humans to soil can be summarised in one word: minerals. A plant cannot make minerals. For a mineral to be in the food chain, it has to have been in the soil in the first place. This is in distinct contrast to a vitamin, which is an elaborate structure, but is made of a few simple elements. Given a bit of water, a plant can make a vitamin literally out of thin air, using just the hydrogen, oxygen, carbon and nitrogen that surround it. We make use of this phenomenon when we put a few mustard or cress seeds in some water, and eat their vitamin-rich sprouts a few days later.

In the case of minerals—calcium, magnesium, iron, zinc, selenium, iodine, manganese, copper, boron—if it's not in the soil there will be none in the plant. Many factors determine the soil levels of minerals—the underlying geology, how much weathering of rocks has taken place, how many trees remain, how many generations of farming have occurred, whether that farming has been sustainable or not. Geographical location is a crucial determinant, and can vary over short distances. The concept of 'microclimates' within a few acres has recently become of interest both in agriculture and ecology. A further extension of this is the variation of soils and the micro-organisms which inhabit them, again within very short distances. Basalt soils from weathered volcanic rocks are most prized by farmers.

Soil health and human health

Dust to dust ...

Slowly, we are beginning to realise that current farming practices give rise to acid soils, salination, and ultimately, desertification. Nowhere on earth is this more apparent than in Australia, where modern technology and wealth clash with ancient and fragile ecosystems. And nowhere on earth, I shall argue, can we better learn about serious health problems such as asthma, depression, and even cot death. Australia (along with New Zealand) is in the unenviable position of having the world's highest incidence of these conditions.

How does this happen?

We know that many of the nutrients needed for human health are needed also by plants. These include calcium, nitrogen, phosphorous and potassium. Nitrogen is essential for growth, yield and quality of the plant, and is an essential constituent of the plant's protein and chlorophyll. Phosphorous is needed for root development, cell division and growth, and potassium for the transport of sugars and other carbohydrates within the plant. Overworked soils lack some of these elements, and so farmers apply fertiliser. Superphosphate provides phosphate and calcium, while NPK provides nitrogen, phosphorous, and potassium. Calcium in plants has several roles, including a structural one analogous to the human skeleton.

Magnesium, too, is important. Among the roles of magnesium, the most fascinating is the formation of chlorophyll. This compound is almost identical to the 'heme' part of human haemoglobin, except that it has an atom of magnesium at its centre rather than an atom of iron. Anaemia in humans, which makes us look pale and sickly, is often due to iron deficiency. 'Plant anaemia' is caused by lack of magnesium, and like human anaemia it can go neglected, often for a long time. With inadequate magnesium, plants cannot properly form chlorophyll and suffer from 'yellow leaf', a particular problem in citrus plants.

The need for the major nutrients, with the exception of magnesium, is usually met. But elements which are present in trace amounts in the soil are required in trace amounts in both the plant and animal world. The biblical quote above indicates that our bodies reflect the composition of the soils which sustain them. Life may still be possible despite sub-optimal quantities of those trace elements. But the metabolic, enzymatic, gene transcription (how our genes are read) and immune systems supported by those nutrients will not function at their best. And here a difference between the plant and animal world emerges, important in degree though not in kind.

We may share more than 40 per cent of our genetic material with a nematode (worm)—or worse still, a banana—but animal biology is generally more complex than that of plants, and mammalian biology is more complex than that of insects. So soil which sustains a plant may not provide all that is needed by the animal which grazes on that plant. The increased system complexity of the animal may require more nutrients.

Acid soils

If nutrient deficiency is only a matter of depleted soils, perhaps the problem will be solved by fertilisers which contain the missing trace elements. But there are other problems with synthetic fertilisers. Recurrent applications tend to increase the acidity of the soil, reducing its fertility. This problem is widespread throughout the modern agricultural world.

Many minerals, such as magnesium, molybdenum and selenium, can only be taken up by a plant when the soil is neutral—neither alkaline nor acidic. Even when soil analysis reveals adequate minerals, they may as well not be there if the soil is so acid that they are unavailable to plants.

Farmers often apply lime to counteract acidity; but this, too, is fraught. Many lime products contain calcium, which in a calcium-deplete soil may be advantageous. But the chemistry of calcium, one of the most abundant elements in the earth's crust, is similar to that of magnesium. As calcium and magnesium compete with each other at a cellular level, an over-application of calcium can worsen magnesium depletion. High calcium can also reduce selenium absorption (see below, Putting the Evidence to the Test). Magnesium and selenium depletion may play crucial roles in the modern epidemics of asthma, osteoporosis, depression and obstetric intervention (Chapters 4, 7 and 9). Even if the correct ratio of calcium to magnesium is preserved, over-liming brings with it a risk of deficiencies of boron, manganese, zinc and iron, and their associated health problems.

Selenium, too, is an important case in point. In human health this mineral has long been poorly understood and consequently neglected. Some recent American trials have prompted a medical rethink of selenium in relation to asthma, certain cancers, depression and infertility (Chapter 4). Oddly, although selenium-dependent enzymes have been described in primitive life forms such as micro-organisms and phytoplankton, selenium currently is thought to have no known role in plant physiology. Certain plants such as seaweed, garlic, onions and other members of the allium family concentrate it selectively, but the land plants survive, indeed thrive, in a selenium-deplete environment. Moreover, there appears to be no mechanism for active transport of selenium into the plant. It is concentrated by a passive mechanism which, critically, does not operate at all in acid soil conditions.

Similarly, cobalt is essential in Vitamin B12 metabolism, and a deficiency can lead to pernicious anaemia, especially in vegetarians, and yet vegetables can grow well in the absence of cobalt.

To spell out the obvious, a healthy plant from an unhealthy soil may fail to meet the nutritional needs for humans in critical ways. From the farmer's perspective, if the soil is so acid or salty that commercial crops cannot be grown, corrective action is a necessity. (Salination is not discussed here, but it is just as critical as acidity.) Under commercial pressures, applications of minerals that the plant does not need are not a priority. By contrast, if animals grazing on such pastures develop deficiency diseases, there is a strong motive for change. Now, though, they are slaughtered so young that they may not live long enough to develop some of the diseases of deficiency. Mature animals, which are the breeders, may get extra nutrition, but it is not the breeding animals which appear on your dinner table.

The matter of taste

If we are going to want to eat a varied, nutritious diet, it has to taste good. The arguments which follow regarding the taste of mature fruits apply equally to the lost culture of eating mature animals. Most people over the age of 50 remember the flavour of mutton, and of tomatoes, apples and other fruits and vegetables of their childhood. Is this just nostalgia, or did they really taste better?

Green harvesting and salicylates

It is during that last phase of ripening that most of the vitamins, minerals and natural sugars are concentrated into fruits and vegetables. Seed dispersal depends on attractive and tasty fruits and nuts. Mother Nature does not want the seed eaten in the early stages of development, because this will not help the species survive. So she fills the fruit with salicylates, making it bitter and unappetising. As the fruit matures, these bitter compounds are replaced with the sugars and nutrients which make the fruit attractive to the creatures that will spread the seeds.

Those vitamins, minerals and natural sugars (and numerous other important compounds discussed in Chapter 10) give home-grown food its characteristic appeal. As youngsters my children showed disappointingly little interest in many of the fruits and vegetables we offered to them. It was not until a visit to their grandfather's orchard, where they encountered mature fruit, that I began to understand why. Grandfather was an old-fashioned farmer who lamented his buyers' demand for small, unripe fruit. Hard green specimens survive transport, packaging and handling over distances and time periods which would turn mature fruit into mush. High in salicylates and low in nutrients, unripe fruit lacks flavour. No wonder kids don't find fruit delicious, and 'salicylate sensitivity' is so frequently diagnosed.

Home-grown versus commercial products

Sceptics ask whether there is any hard evidence that today's commercial produce is inferior to the organic or home-grown item. Various surveys produce claim and counterclaim, but the trend favours home-grown and organically grown food. An Australian study conducted by the Organic Retailers and Growers Association of Australia examined beans, tomatoes, capsicums and silver beet for levels of calcium, potassium, magnesium, sodium, iron and zinc.[8] Nutrient ranges in the organic products were commonly ten or more times higher than in commercial specimens.

A 2000 British study was also compelling. David Thomas scanned past editions of the respected authority *The Composition of Foods*, by McCance and Widdowson, and found some alarming trends.[9] The overall decline of calcium in all fruit and vegetables was 46 per cent, of copper 75 per cent. Carrots had lost 75 per cent of their magnesium, broccoli 75 per cent of its calcium. Perhaps the discrepancies between the two countries reflects the fact that the ancient Australian soils were in a more parlous state to begin with and are now flogged to adapt to an agriculture to which they are not suited. In either case, the figures are deeply disturbing.

Other research confirms these findings. In Britain, rats fed organic fruit and vegetables 'were slimmer, slept better and had stronger immune systems than those given conventionally grown produce. Japanese researchers reported that organic milk had higher levels of vitamin E, omega-3 essential fatty acids and antioxidants.'[10]

GM foods

The topic of genetic engineering, like that of soil chemistry, is complex. Many nutritional scientists and doctors have deep reservations—not only about the supposed advantages and who will benefit from them, but also about what will happen to thousands of years of slow evolution in the delicate interdependent web of life.

Assurances that we have been genetically modifying food since the agricultural revolution bring little comfort. The story of gluten and casein makes this point vividly (Chapters 2, 9 and 10). A new breed of brussels sprouts has been developed to lose the characteristic taste and smell of the brassica family; this is achieved by drastically reducing the plant chemicals that are thought to protect against a wide range of common cancers. One wonders whether hungry British children during the food shortages following World War II found the smell of brussels sprouts as offensive as do their modern counterparts. But more, one is left breathless by the audacity of humans who blithely ignore the possible consequences of 'improvements' to millennia of gradual adaptive evolution.

Genetic modification takes these concerns into a new realm altogether. Selective breeding is not the same as putting fish genes into corn. An audience of farmers in Sydney heard a startling story from a visiting American, Professor Elaine Ingham of Oregon State University, in 1999.[11] It appeared that the US Food and Drug Administration had been within an ace of approving for release a genetically modified soil bacterium, developed to convert crop residues into useful products, including alcohol. At the eleventh hour, it was found that the alcohol would leach into the soil, poisoning it. Ingham's conclusion was that, had this been released into the environment, the potential for soil organisms to exchange genetic information is such that it could have resulted in a widespread agricultural disaster.

WHAT CAN DOCTORS LEARN FROM VETS?

When I was in medical school, it was a standing joke that veterinary science was much easier than medicine because you could shoot your mistakes. Later, when farming brought me into contact with some rural vets, I wondered what it would be like to deal with owners whose livelihood depended on the health of their animals. Animals have kidneys, livers, hearts, like humans. What would you do if half of your cows needed blood pressure tablets and cholesterol-lowering agents? Would you mix them in the feed or put them in the drinking water?

It is not usually apparent that the health of the soil has a direct impact on the health of the humans and pets that are sustained by plants grown in it. On the farm this relationship is inescapable.

The importance of diet

Doctors who sit in with vets will notice one big difference between human medicine and veterinary medicine. Whether it is a sick household pet or an ailing stud bull, one of the first questions is always 'What are you feeding this animal?' Although a 'good diet' was discussed in medical school, we were never taught that this line of enquiry might help us when a child came in with his fourth middle-ear infection for the winter, or recurrent abdominal pain, or chronic constipation.

Would we confess to the vet that Rover had had Coco Pops for breakfast or routinely finished lunch with an iced donut? Zoos are bedecked with signs saying: 'Do not feed the animals'. The zoo vet fears that we will give the animals the same junk food that our kids are eating on their day out.

The importance of field work

Vets have a significant advantage over doctors as a result of the requirements of the pastoral industry. Far from shooting their mistakes, vets are expected to stand between the farmer and bankruptcy. Where farming provides a significant part of the economy, there might even be government interest in keeping farm animals healthy.

The outcome of this financial interest provides further contrast between human and animal medicine. Comprehensive data exists on animals' nutritional requirements, and farmers aim to meet those requirements from the resources of the farm. Textbooks of veterinary medicine and agricultural science stand in silent admonition to the texts on human medicine.

Most telling is the issue of recommended daily allowance (RDI; Appendix 1). The farmer whose livelihood depends on the meat, milk or wool of an animal knows that this is crucial. If the pasture does not supply enough selenium for the reproductive needs of the animal, it must be supplemented. Farmers cannot afford to dismiss such needs with 'you can get all the vitamins and minerals you need from a healthy diet'. Despite the shortfalls of fertilisers, this topic is at least up for discussion and the health consequences of nutritional depletion are not trivialised.

Contrast this to the human situation. During the last part of the 20th century, Australia and Britain had no human RDI values for most minerals other than iron and calcium. The vet was taught how much selenium his patients needed to stay healthy, but the doctor was not. In 2006, in both Australia and Britain, the values applicable to humans are still not taught in medical school, and are not known by the average doctor.

Putting the evidence to the test

With a limited number of genetic and environmental variables, the vet is much better placed than the doctor to understand what is making patients sick. On the farm controlled experiments are taking place all the time, even if this is not the conscious intention.

The farmer's herds or flocks are of closely related animals; they may all have the same father, because farmers usually aim at conformity for desirable characteristics. So if a farmer decides to topdress one paddock with magnesium or add selenium and Vitamin E to the drench, and the stock yield goes up 50 per cent, this provides valuable data. If word of improved yield gets around, the neighbours might decide to topdress or drench in a similar manner. If their stock yield goes up as well, the database grows. If the neighbours have similar breeds, similar soils and similar clinical problems, before long the vet starts to see the point of all that nutritional stuff she learned for her final exams.

If the particular treatment benefits only cows but not sheep, the vet has learnt something about cows. If it benefits the sheep, the alpacas and the farm dog as well, it may demonstrate something about placental mammals.

Do humans also benefit from this knowledge? Let us compare some entries in the leading standard texts for doctors and vets respectively. The textbook *Harrison's Principles of Internal Medicine* is the most comprehensive English-language medical textbook; *Diseases of Livestock* by Thomas Hungerford (a distant relative) was a major reference in 1990 in both Britain and Australia. It was still being used in 2005.[12] The index under 'zinc deficiency' has four entries in Harrison and 19 in Hungerford. Similarly, for 'magnesium deficiency' Harrison has no entries while Hungerford has 11; and for 'selenium' Harrison has five references, none relating to deficiency, while Hungerford lists over 50 for selenium all up, and 34 for deficiency.

Selenium deficiency in the veterinary text makes interesting reading, especially in contrast to Harrison, whose entry is notable for its brevity and contains no deficiency listings at all. The author of the veterinary textbook wrote about such omissions:

> In the past thirty years, each time I have written a new edition of *Diseases of Livestock*, I am appalled at the fact that white muscle disease is a well recognised and common condition in lambs and sheep, goats, cattle and, to a lesser extent, in horses, pigs and rarely other species, but no comparative observations are available on humans.
>
> If a veterinarian has multiple cases of cardiac failure with sudden deaths in lambs, calves or kids he automatically looks for myocardial infarction and selenium deficiency, and with clinical pathology and biochemical backup may find it as the common cause. If a medical man in humans has a cardiac arrest and myocardial infarctions, on post mortem, he automatically looks for coronary

> occlusions, thromboembolic emergencies or atheromatous conditions, and may find them. He thinks in terms of cholesterol excess, nicotine, alcohol, etc. but never in terms of selenium deficiency as one possible cause.
>
> In the animal field we all know of the relationship between selenium and sulphates, nitrates and calcium, so that sulphates, nitrates and high dietary calcium decrease the absorption of selenium in cattle and has been associated with muscular dystrophy, metritis, clinical mastitis and retained placenta. In this context note the human fact that post-menopausal women are encouraged to take more calcium by recommendation of dieticians. Indeed, the matter of trace mineral inter- relationships is very delicate. Think of dietary intake of molybdenum, sulphur, zinc, iron, cadmium and calcium—all decrease the availability of dietary copper to animals ... To summarise, selenium deficiency and its possible inter-relationships with heart and muscle conditions in humans needs critical investigation. *The veterinary profession has so much data at its fingertips it is a tragedy if this is not brought to the forefront of thought by the medical profession.* [my italics][13]

In 1989 vets knew that selenium deficiency could cause mastitis and retained placenta, and yet in 2005 doctors still treat the former with massive doses of antibiotics, and the latter remains a serious cause of birth trauma. Why are we still encouraging menopausal women to ingest obscene quantities of dairy products in order to 'get your calcium', with scant regard to the intake of magnesium and other minerals? Perhaps it is time for doctors to leave their comfortable offices and do some compulsory field work?

The problem is not confined to selenium. Let's look at another example. Merv was a young doctor working in an Australian country town in the 1950s. Deciding to do the country thing, he bought himself a few acres and a small herd of cows. He knew nothing about animals or farming, but was confident that his medical knowledge would be transferable. When the time came for his cows to calve he found that the first cow to give birth was in trouble. Rolling up his sleeves he proceeded to do an assisted delivery, only to find that that the next cow was in a similar predicament. Envisaging a long night ahead, and noticing that several other cows were 'down', he called the vet.

What happened next changed his thinking forever. The vet arrived and