Dying to Eat

Dying to Eat:

Health, Heresy and Hysteria

By

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This book is dedicated to my wife, Marilyn, in honour of the endless support and the endless patience she has shown over this seemingly endless project. Without her, this book would never have been completed.

The more we learn the less we know

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Any errors of interpretation or misconceptions that appear in this book are entirely mine.

CHAPTER ONE

BEFORE WE BEGIN: THE SCIENCE BEHIND NUTRITION AND HEALTH

1.1 Why this book was written and how it came to have its title

The more we learn, the less we know

For the past 49 years since I graduated in 1969 with a degree in biochemistry from the University of London and subsequently a PhD, I have been intrigued by society's formulation of the relationship between what we eat and how healthy we are; and how the woman, or man, in the street can distinguish the good from the bad (or mad) advice that is thrust at them daily from the spectrum that goes from reputable medical sources to "cookie" fadists. During the course of my career as a university professor and administrator I have retained an essential interest in the relationship between diet and health, publishing scientific papers with colleagues on the subject, but always from the point of view of what can our knowledge of nutritional biochemistry tell us about the latest dietary recommendation?

Recently I was asked by a journalist where it was I thought that my interest in food had come from. I replied that I had no real idea, but that I suspected it came from being born in England just after the end of the Second World War – for the first 6 years of my life the official rationing of some foods was still in place. Under those circumstances, and because of the relative depravations of the previous 8 years, food in society in general, and my family in particular, assumed a significance beyond that found in countries where overt rationing had not existed. Occasionally, when teaching university undergraduates in recent years in Canada, the topic of feeding the world's predicted 9.5 billion arises. Invariably when I suggest one possible scenario to ensure all get adequate food, that is governments rationing food, many of the students look incredulous and say, “You could not possibly do that, it would not work!” They say this not because they are musing on the immense logistical issues, but because the concept seems so totally foreign and beyond their experience. Also, and we were not unique in this respect, food and eating together was a major social plank in our home. The family ate breakfast together; the children ate school lunches with their friends (the lunchtime food left much to be desired, but at least it allowed and was associated with sociable behaviour); the family ate their evening meal together, sometimes in the company of friends. My mother taught me to cook. I would try my hand at making bread, or a cake, usually with disastrous consequences. Then one day in my teens I lighted on a copy of Elizabeth David’s “French Provincial Cooking”[i], and it was a revelation! A world of nutrition, cooking and gastronomy revealed through the eyes of a young woman who had lived the experience with a French family.

Four issues over this time-period have prompted me to write this book. The first was the development in the 1970’s of the hypothesis that cholesterol was evil because it clogged your arteries and would give you a heart attack and, to be healthy, one should give up eating any form of animal fat or other cholesterol containing foods such as eggs or shrimp. The result of this medical hypothesis was that several generations of elderly people, often on low pension incomes, were told to stop eating eggs, a cheap and easily cooked form of excellent protein. And this despite the fact that it was well known at that time, to biochemists at least, that the body controlled its total cholesterol, balancing the amount of cholesterol ingested by reducing the amount synthesized by the liver. When later this cholesterol hypothesis moved on to view the total amount of cholesterol in the blood as irrelevant, but what mattered was the ratio of cholesterol in the form of “good” High Density Lipoprotein Cholesterol (HDL-C) to “bad” Low Density Lipoprotein Cholesterol (LDL-C) that might predict susceptibility to heart disease, still the dogma persisted that eating cholesterol containing foods, or saturated animal fats, was bad. But it was not just cholesterol containing foods that were vilified. Any foods containing saturated fat, which was used a totally inaccurate proxy for animal fat, were promoted as foods containing “bad fat”, because it was now held that it was saturated fat that increased the bad cholesterol (LDL-C) in your blood. The remedy prescribed was to increase the consumption of vegetable fats. This even though some animal fats contain less saturated fat than some fats from plant sources, and, for example, beef muscle fat

[i] Elizabeth David was the English version of America’s Julia Child

can contain more of the predicated healthy mono-unsaturated oleic acid than olive oil. This might not have matter too much except that, at that time at least, most of the processed vegetable fats that were recommended for a healthy diet contained significant levels of *trans*-unsaturated fat. As early as the 1970s studies on rats of the effect of eating *trans*-unsaturated fats (derived from corn oil) had shown that they had a directly damaging effect on heart muscle tissue.

My second issue is that by 1980 European food processors had largely removed *trans*-unsaturated fats from their products. For example, Unilever formed in 1930 by the amalgamation of the British soap company Lever Brothers and two Dutch margarine producers van den Bergh and Jurgens, had modified their premium vegetable fat soft margarine (Flora) so that they could claim that it was totally composed of natural *cis*-unsaturated fatty acids: but it took 30 years for the perils of *trans*-unsaturated fatty acids to cross the Atlantic Ocean to the North American continent.

The third issue was the promotion of low fat diets as being the healthy option for nations with growing problems of obesity, and the suggestion that high carbohydrate diets would reduce blood fat concentrations. As a medical student in the 1960s one of our key text books was Harper and Rowe's "Physiological Chemistry", which stated quite clearly that a diet high in carbohydrates (and thus low in ingested fats) was lipogenic, that is, it would increase the levels of fat, particularly triglycerides or VLDL[ii] in the blood. This lipogenic effect was greatest with fructose (the supposedly healthy fruit sugar), somewhat less with sucrose (cane or beet sugar) and least with glucose. And yet over the intervening years dietary specialists have advised the consumption of "natural sugars", especially honey which is an equimolar mixture of fructose and glucose. And the USA food industry has been economically seduced to sweeten food products with high fructose corn syrup, a mixture of 55% fructose to 45% glucose, manufactured from subsidized corn (maize) production.

The final seminal influence occurred sometime in the 1970s in the UK. I attended a one-day conference on diet and heart disease where the dominant theme was the need to avoid animal fats. The conference was attended by, amongst others, over 80 of the UK's leading cardiologists. A buffet lunch was provided where there were clearly labelled tubs of butter and of margarine. The organizers, unbeknownst to the delegates, weighed

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[ii] Very Low Density Lipoprotein

the tubs of margarine and butter before and after lunch. The relative ratio of consumption of butter to margarine was 4:1.

This is where the initial impetus to write this book came from, but it is not where it ended. This is a book that is about much of our understanding of nutrition, not just the relative effects, evil or otherwise, of fats and sugars, and how that understanding has been derived.

My purpose is not to judge or vilify any professionals who seek earnestly to discharge their responsibilities by advising their patients or clients on the most appropriate diet for their individual needs. My task is only to bring some objective sense to the whole issue of what is a healthy diet, based on my best understanding of the available scientific evidence, and modified by the genetic predispositions of distinct populations.

Thus, my purpose is to examine the relationship between scientific knowledge, how it has been obtained and translated into medical advice on diet across the centuries from the 1500s to date, and in particular to discover whether in the 21st century we are any better at translating knowledge to practical advice than were our forebears 500 years ago.

Then there is the issue of how what we eat relates to the agricultural production system on which we depend. Historically, most people were confined to eating what could be grown or raised locally; only the very wealthy could afford exotic food ingredients like spices, salt and sugar. In many agrarian societies, particularly subtropical regions, a huge variety of food and feed crops can be grown: the nearer to the Arctic the more limited this range becomes. From the beginning of the 20th century the advent of mass transportation, ever cheaper fuels, and the gradual mechanization of farming led to raw food commodities travelling across and to other continents. Wheat grown on the Canadian Prairies has fed the mills of British bakers for well over 100 years. Since the 1950s and the advent of the so called “green revolution”, the productivity of agricultural land has increased many fold, the result of plant breeding, the use of fertilizers and pesticides, and improvements in agronomic practices. Across the developed world food is no longer seasonal, or necessarily local. But even here habits are beginning to change, with the increased popularity of farmers’ markets, the 100-mile diet, and demand for organic foods. The latter has increased by 20% year on year to the extent that in 2008 one of the world’s giant “budget” retailers, Walmart, introduced organic food products to its stores.

None of this might matter much were it not for changes in society over the last 50 to 60 years that have radically affected how we come to view and deal with issues surrounding our food. Over that time course at least we have adopted, or allowed, a number of influences. Concern for population health has encouraged "authorities", by which I mean governments and public organizations, to prescribe our behaviour, especially our eating habits. I would contend that this has led to the professions who are mandated to look after our health operating from the official handbook of their government or profession, not as they once did from wisdom derived from their own observation and experiment, or that of others. It would be a brave dietician or doctor who eschewed the official thinking on healthy diet and posed a contrary view or, worse still, prescribed something more radical or different to their patients. They are the heretics, sometimes wrong, but equally sometimes correct in their alternative views. We shall meet some of these along the way, individuals like John Yudkin and Ancel Keys.

The other change that has had a major impact is the adoption of the internet with its easy access to information, accurate or not, opinion well-argued or not, and the purely wacky. It is a medium in which those that shout the loudest are heard the most. It is also the medium that scientists and their promoters use to tout their latest discovery on the topic of food and health. Too often they allow the implications of their studies to be overstated thus generating hysteria, or worse still confused indifference, in their public. How often do you hear or read the phrase, "The trouble is, these scientists are always changing their minds"? Those under the age of 22 or so will of course never have known a world without the internet.

One compounding factor in this is the loose and inaccurate use of the terminology of risk. What does a 13% or 15% increased risk of death from this or that actually mean, apart from sounding scary. As we all have a 100% chance of dying, the real question should be when will we die and of what? It is these factors that have been responsible for the generation and adoption of some of the strangest ideas about eating in the history of humankind, and have fundamentally perverted our approach to the role of food in our lives, and engendered hysterical attitudes. Of everything that we do, apart from breathing, eating is the only obligatory task required for individual survival – everything else is optional. We therefore cannot be expected to be totally unemotional about the subject, but it is the muddling of the emotional subjectivity with the objective fact that confounds our ability to act and think rationally.

As I have hinted above, the title of this book, “Dying to Eat: Health, Heresy and Hysteria” needs some explanation, at least in terms of what is meant by heresy and hysteria in this context: I hope that food and health do not need such a detailed explanation.

Quite simply to me hysteria means over-reacting to a possibly threatening situation because a calm, rational and evidence-based analysis of that situation has been avoided, rejected or misunderstood. Hysteria is redoubled when we face a possibly threatening situation when there is no rational evidence base to guide us.

Heresy means rejecting a commonly held belief, because of a conviction that the belief is not supported by the available, testable evidence.

Whereas value judgements have a role to play in promoting hysteria – “I will react badly to this because it is contrary to what I believe to be true”, heresy is in many ways the reverse, a rejection of the beliefs or value judgements of the many, because the available evidence does not support such beliefs, or because the heretic has for some reason rejected the evidence as unreliable or has synthesized an alternative hypothesis.

We have seen the spectre of heresy raised in recent pronouncements of the IPCC: “The science is certain [that anthropomorphic climate change is real], there is no more debate.” Those who seek to question the official view of climate change are stifled and they are labelled as “climate change deniers”, in other words heretics. Real science has no room for the concept of heretics, because real science, by definition, must always be open to challenge and debate. When debate ceases, “science” is no longer science, it is dogma: it moves from a situation where its tenets and theories may be rationally challenged (indeed that is exactly how science advances) to one where its hypotheses and theories become immutable beliefs and value judgements. Unchallengeable beliefs are the stuff of dictatorships and tyranny, not democracy, nor science.

So it has been for millennia in the “science” of food, nutrition and health. Since time immemorial the “science” of what we eat and why we eat it has been hugely influenced by the advice of the “experts”, those who profess a right to know, either because of some divine or spiritual guidance, or because they have objectively observed reality (or possibly both); and some simply because they have an emotional need to be heard. In prehistoric times, by which I mean to say before the present interglacial period, as far as we can discern man was a hunter-gatherer and his diet was informed by what he could hunt and gather, and not by any philosophical or rationalized treatise. However, beginning approximately 10,000 years ago, humans began to settle in geographically fixed colonies, a process encouraged and made possible by the gradual development of agriculture, the twin achievements of the domestication of animals and edible crops. The rise of agriculture was in all probability a process that took several millennia before it irresistibly converted most of the itinerant human race to a sedentary life. Agriculture has been variously attributed with laying the foundations for the development of organized civilization: before agriculture almost every member of a community was engaged in the hunting and gathering of food to feed that community, but after agriculture, food for the many could be produced by the few, and therefore there were members of the agrarian society who had the leisure time to develop culture. And in the words of Ecclesiastes:

> *To be wise a scholar must be given ample leisure.*

Not every advance in agriculture had a positive effect. Archaeological remains show quite clearly that two thousand years after the agricultural revolution took hold, the "New Ag" man was considerable shorter than his previous "hunter" forefather, a result presumably of a less varied and inferior diet. Starvation was seen on a whole population, not just on a limited local, scale. Civilizations had to plan to avoid famine, and often rationalized their culture and beliefs to fit the natural disasters that were bound by their circumstances to haunt them. The biblical references to lean years and famine in Egypt, and the response of the Israelite Joseph to plan for such difficulties, is an excellent example of the problems of relying on agriculture to feed an expanded population, where increasingly fewer and fewer of the population are engaged in producing food, and more and more are engaged in other, non-productive occupations such as being courtiers and priests whose main purpose was to massage the ego of the ruler and convince them that they were indeed a wonderful, just and beneficent deity: or building pyramids to bury them when they died. And this particularly in an environment where no-one understood, nor could control, the vagaries of nature. But from the point of view of the nutrition of a populous, agriculture vastly increased the availability and range of foods available for those at the top of the socio-political pyramid: the poor, as ever, got to eat the left-overs, if there were any!

Thomas Kuhn, one of the previous century's great philosophers of science, in his book "The Structure of Scientific Revolutions"[1] forcefully makes the point that science does not develop through a smooth continuum, but rather that it evolves by a series of sudden, and at first controversial, paradigm changes. He suggests that once a new idea or discovery has emerged, scientists will test the new hypothesis, until either it is rejected, or a sufficient number of the influential elite come to believe that the new idea is true. What all too often happens next is that scientists will work endlessly to perform experiments designed to refine the original hypothesis, either to ingratiate themselves with the elite, or because the elite control the flow of research funding, and thus significant effort is expended (particularly by the originator of the hypothesis) to advance understanding by ever decreasing degrees. But along the way, and quite capriciously, a body of evidence is generated that, when taken together, begins to suggest that maybe the original hypothesis is not correct. At first the scientific establishment will remain unconvinced. Critics of the status quo will be branded as, at best, misguided – in centuries past they could well have been executed for heresy.

In 1988, shortly before the disintegration of the Soviet Union, I visited Moscow State University. Inside the main entrance was an area called "Hyde Park Corner": Hyde Park Corner in London has traditionally been the place where any individual with a view contrary to official or general belief can stand (literally on a soap box) and tell it the way that they see it. In MSU their version of Hyde Park Corner was a corner of the main entrance hall full of posters and bulletins highly critical of the Soviet establishment's ways. This surprised me, so I asked one of the professors how this was possible, were they not afraid that the KGB would detain the writers and readers? His answer was candid. He explained that what had changed was that enough ordinary citizens woke up one day and realized that the KGB could not possibly send them all to Siberia, there would not be room, and anyway who would be left to sweep the streets and drive the buses? And that is a good metaphor for how a scientific paradigm change occurs. Eventually enough scientists come to believe that the old hypothesis or theory is no longer supported by the available evidence. Of course, those whose reputations have been built on their own discovery, or their ardent support for the discovery of another, are often amongst the fiercest defenders of that discovery, and work the hardest to protect it and dispute the new evidence as being irrelevant or of poor quality. This is entirely human and reasonable, even if it does not seem particularly scientific. It is in fact at the heart of science, because no theory should be abandoned without rigorous debate. Francis Bacon, the 16th century philosopher usually credited with codifying, if not inventing, the scientific method, had this to say:

> *Some in their discourse desire rather commendation of wit in being able to hold all arguments than of judgement in discerning what is true, as if it were a praise to know what might be said and not what should be thought*[2].

A good example of this process from the mid-20th century stems from the work of two young scientists James Watson and Francis Crick, who worked out both the chemical structure of DNA and how it was able to reproduce itself. In the 1950s Watson and Crick met at the University of Cambridge. A number of internationally known scientists were already working on the problem of the structure of DNA, including the American protein chemist Linus Pauling, who in the late 1940s had shown that protein molecules could adopt a form of spiral structure he called an alpha-helix.

The story of what happened next has been recorded many times elsewhere, but suffice it to say here that the real point of this story is that it was quickly accepted that genetic information flowed from the structure of DNA to create the structure of proteins, and that this information flow went from DNA through RNA to protein. For no reason, other than it would appear nobody challenged it, it soon became the accepted dogma that this was the **only** direction in which genetic information could flow. Thus, when Howard Temin in the early 1960s proposed that it might be possible to create DNA from RNA (by reverse transcription) he was regarded as an interesting heretic who was just plain wrong. Everybody knew that genetic information could only flow from DNA to RNA: it was proven beyond doubt, there could be no debate. It took ten full years for Temin and (independently) David Baltimore of MIT to accumulate and distribute the convincing scientific evidence of this reverse transcription, and for enough of their peers to become convinced. They shared the 1975 Nobel Prize in Physiology and Medicine[iii] for their work, and their contribution to the present understanding of cancer and retroviruses such as HIV is incalculable.

In this book there are two William Harveys. Both were physicians. William Harvey the first lived in England at the time of the Renaissance and was responsible for determining that blood flowed around the body in a continuous circuit and was not simply pumped out and then sucked back by the heart as had been thought since Roman times. William Harvey the second was an English Victorian physician, a specialist audiologist. As we will see later, both of these Williams significantly influenced existing

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[iii] http://genesdev.cshlp.org/content/9/11/1303.full.pdf

medical dogma, not for the deliberate want of causing controversy, but in the end because they believed that their new understanding, and the evidence on which it was based, had to be revealed.

William Harvey the first had set out to prove, as was the point of the Renaissance – the re-discovery – that the legendary Greco-Roman physician Galen was correct in his theory that the heart pumped blood into either the lungs (to be charged with vital spirit) or the peripheral tissues (to deliver the vital spirit), and then sucked it back in again, and that the blood charged with vital spirit in the lungs crossed between the ventricles of the heart by way of minute pores in the inter-ventricular septum. Try as he might to find evidence to support Galen's theories, Harvey's experiments on pigs continually contradicted this idea, so that eventually he was forced to accept the evidence he had generated that blood somehow flowed continuously around the body: the heart pumped blood to the lungs from the right ventricle which returned via the left atrium of the heart into the left ventricle to be pumped to the peripheral tissues and then back to the right atrium, right ventricle, into the lungs and so on. He had no idea how it might pass from the arteries to the veins. It would be some decades before the work of the Italian Malpighi showed, through microscopic investigation, that there were minute blood vessels in the peripheral tissues, capillaries, that connected the arteries to the veins, and that the pores in the septa of the heart that were essential to the validation of Galen's pump-suck version of the workings of the heart did not exist. To the Renaissance William Harvey it seemed that his work, if published, would be regarded as a heresy, and thus he delayed its publication by almost a decade, and even when he did publish it, the work was couched in the most apologetic and deferential terms.

The Victorian William Harvey faced an equally interesting publication dilemma. He was an audiologist who was convinced that many of the middle-aged patients who came to him complaining of increasing deafness had lost their hearing because they were obese. He reasoned that the depositions of fat in the linings of the throat, and the accompanying inflammation that obesity induced, caused a partial or total blockage of the Eustachian tube that equalizes air pressure between the atmosphere and the middle ear. The temporary loss of hearing caused by a sudden reduction or increase in air pressure, such as in flying, is a result of temporary obstruction of the Eustachian tube: chewing gum or a candy helps to relieve the block. In 1860 an obese, fashionable London funeral director by the name of William Banting consulted Harvey about his increasing deafness. The details of Harvey's treatment diet for Banting is discussed in detail in chapter 5. Suffice it to say for now that Banting lost weight, regained his hearing and published a leaflet detailing his success. He was roundly criticized by the medical press for muscling in on their profession.

Harvey also came under some measure of disapprobation, after all he was not an "expert" in treating obesity. His practice declined as a result, and he did not publish any of these findings until 1872 in order not to upset his professional applecart any further, and then it appears only reluctantly and from pressure of his non-medical peers. His account of his prescription for Banting appears in his book "On Corpulence"[3] and then almost as an addendum, and apologetically so. Interestingly, in this book Harvey recognizes the connection between obesity and diabetes and states,

> *I have also, as before observed, seen many instances of diabetes in corpulent, middle aged females.*[4]

This alone suggests that diabetes in Victorian England was not uncommon, nor was obesity; these are not diseases of the modern age, but rather diseases of over-consumption in any age. The point is that it took Harvey over ten years to commit his therapeutic principles to print, and then he did so only because he could support his empirical observations with the theoretical considerations of his eminent peers. Given the connection that Harvey correctly draws between obesity and diabetes, it is ironic that his famous obese patient had the same surname as the discoverer of insulin, the Canadian Frederick Banting[iv]! However, Harvey had based his treatment on a tentative hypothesis, and the results from Banting's case and the many others who followed Banting's promotion of his diet, supported the hypothesis that reducing weight was a case of eating properly, not eating less. Banting's "diet" of meat and green vegetables, and which also contained generous amounts of wine and spirits (up to 5 glasses of wine and a tumbler of spirits each day), amounted to some 2,800 calories per day. But this diet ran counter to the theories of the time that the only way to lose weight was to eat less. The cheap tailors of London used to have a catch phrase to entice buyers, "never mind the quality, feel the width." Harvey and Banting were caught in a similar trap, "never mind the evidence, feel the opinion." Finally, it must be recorded that William Banting, having lost nearly 30% of his body weight at the age of 66, lived an active life until his death at the age of 81. The evidence and history has vindicated Harvey, even if his peers at first did not.

[iv] In fact, the two Bantings were distantly related.

But of course, today we are much more objective and ‘scientific”, are we not? Well, sadly the evidence suggests otherwise. This treatise attempts to substantiate this claim and also to show that it was forever thus. If it were simply the fact that history repeats itself whilst historians repeat each other, then the repetition of our past follies might not matter much. However, much more is now at stake. Health is not just a matter of private prescription between physician and patient; governments and world organizations are in on the act, attempting to persuade whole countries to change their habits for the sake of their health. And the food industry is adept at picking up these messages and using them to design ever more added value “healthy” food products such as “gluten free” potatoes. So long as the prescription does no actual harm this may be an irrelevant, but albeit expensive, interference. But if, as history suggests, medical authority has too often got the wrong end of the stick, attempts to “reform” public behaviour *en masse* may result in catastrophe. At this point I will give but two exemplars.

During World War I the provision of green vegetables in the UK was running low. The Ministry of Food offered advice that to compensate for this people should eat the leaves of the rhubarb plant. Several people died as a result before the advice was withdrawn: rhubarb leaves contain high levels of oxalic acid that removes calcium from the diet and blood and as a result can cause a rapid and agonizing death.

The second example is more recent, and an example of the spread of misinformation. In 1981 at the beginning of the “fat is scary” era, R B Shekelle and colleagues published the findings of their analysis of a major diet-heart health study, the Western Electric study.[5,6] They found that large amounts of poly-unsaturated fatty acids (PUFAs) from plant sources in the diet gave slight protection from coronary heart disease (CHD), but that the amount of saturated fats (from animal sources) was not significantly associated with the risk of death from CHD. A report on this research appeared in the Washington Post and stated that diets high in cholesterol and animal fat can cause heart disease; Jane Brody writing in the New York Times incorrectly quoted Shekelle:

> *These findings show that it is prudent to decrease the amount of saturated fats and cholesterol in your diet.*

This, you might think, would not matter that much, after all it is only two newspaper reports. However, in 1990, the American Heart Association (AHA) referred to Shekelle’s study as one of the seven key studies that demonstrated that saturated fats cause CHD. An interesting question, and one to which I have no answer, is did those who put together the AHA's report actually read Shekelle's paper, or did they just remember the press reports?

Finally, it is not an exaggeration to say that the fortunes of nations can be decided by nutrition. There is a view that the American civil war was won because the troops of the northern states were significantly better fed than those of the Confederate south. The agriculture of the north produced cattle and grain: the south grew cotton and tobacco.

So, is there a theme to this book? Whilst I think that revealing the theme is a bit like telling the readers of a thriller up front that it was the butler who did it, I believe it might help to reveal that there was, if not a theme exactly, at least an idea. This book is really about the way in which science evolves and is developed: in this case the medical and nutritional sciences. It is about the tension that has always existed between the scientific concepts of the day and the new findings, thoughts and interpretations of diligent scientists. It is about the way that science has been used and misused by those who govern, provide advice to the public, or try to sell food. I have been privileged to have been in a profession where I have been granted the time and the facilities to research and think about these things. For students new to the study of nutrition or food science, this book will I hope frame all you hear and read in a holistic context and help explain the fragility of the scientific evidence of healthy eating. And it occurred to me that this book might be useful to the many others who would not have the luxury to research this subject in detail, but still would want to know how they might divine a truth about what they should eat for the sake of their health and wellbeing. I have no answer to that enquiry for reasons that I hope will become clear in the rest of this book, but I hope that it might be useful to lay out why it is that the science of these things is never certain, but nevertheless "experts" can give the impression that it is.

Throughout this book there are examples of nutrition studies and media reports. These have not been carefully chosen so that I might highlight some point I wish to make: I have not been deliberately selective to prove my case. Rather, the examples I have used have presented themselves, often because I was intrigued to discover the full story behind the media headlines. And the media headlines were randomly selected by my friends and especially my family based on something that caught their eye. This then might not be a truly dispassionate and objective selection process, but, if it uses examples that have attracted the attention of others it is perhaps more relevant than a truly blind sampling of media headlines and research findings, because it highlights the issues that will influence public attitudes and actions.

Finally, it is not my purpose to provide guidance and advice on what to eat for health. If there is any advice I can give it is this: eat less, mostly in the morning, do it with friends and family, and move more, or, as we shall see, perhaps it is to eat a bit more and move much, much more all day!

1.2 Stuff you need to know: some biochemistry

One of the major purposes of this book is to attempt to explain the controversies and divergent evidence that informs us of what is good or bad to eat.

Some background knowledge of basic science is assumed, for example that the universe is made up of subatomic particles that combine into relatively stable atoms that can combine in countless ways to form the molecules that together make up us and our world; that biological organisms are based on reproducing units known as cells: some like bacteria, yeast or algae might be made of just one cell, and others such as ourselves are made of millions of cells each of which has developed from the one fertilized single cell ovum of our origin, but have differentiated into the substantially different cellular forms that can be found in the brain, liver, bone, muscle and other tissues.

But there are subtleties in the science, which if the expositions in this book are to be fully understandable, should first be grasped. For the overall clarity of the text I concluded that, whilst pedagogically these details might be best introduced by incorporating them into the text where they are especially relevant, it would be better for the flow of the text to include them in either stand-alone text boxes (hated by publishers and a test of my word processing skills) or collected together into one section. As you might guess I would not be writing this were it not that I have chosen the latter approach. For those of you who are comfortable with crashing on with the main text on the grounds you know enough, then be my guest: this section will remain for reference anyway. For those who want more information than is contained in this section and want a basic introduction to biochemistry on which all considerations of human health and diet must be based, then there are plenty of good text books available that take the approach of explaining the subject using the minimum of jargon. One such book, which introduced me to the wonders of biochemistry when it was first written in 1966, is Steven Rose's "Chemistry of Life". Now in its fourth edition, publish by Penguin Scientific Press in 1999, it is available in paperback or a Kindle edition on-line for a few dollars. For those who have decried or avoided the life sciences it is highly recommended.

But next go and raid the kitchen, or local supermarket, and acquire a bunch of grapes, currants and sultanas, and a few cocktail sticks – the double-ended sort, not the ones with fancy coloured plastic bits at one end.

The importance of carbon and water

Were it not for the remarkable chemistry of carbon and the odd behaviour of water, none of us or our world would exist. Of all elements that are important to life, carbon is the most intriguing because it has the ability both to combine with itself to form the scaffolding of a vast range of polymeric substances, and to form small, reactive molecules that drive the processes of our bodies. It can do this because of its unique atomic structure.

The nucleus of the carbon atom is made up of six positively charged protons and six similar sized but uncharged neutrons[v]. Surrounding the nucleus is a cloud of six negative electrons. For purists of atomic theory, it is impossible to say with any degree of certainty where exactly around the nucleus these electrons are, but for the clarity of our explanation it is sufficient to approximate and think of planets orbiting around the sun, and say that two electrons are in orbits around and very close to the nucleus, and the remaining four electrons orbit further away in what has been called the valence shell. That there are four electrons in its valence shell means that a single carbon atom can form a so called covalent bond with four other atoms. The bonds are called covalent because they are made from two electrons, one from each atom, that are shared to make the bond. Covalent bonds are the strongest interatomic bonds and a lot of energy is

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[v] In fact, carbon can have between 5 and 9 neutrons creating what are called isotopes. Chemically they are all the same. The C-11 isotope (5 neutrons) is unstable and if you found any, half of it would be gone 20.3 minutes later (its so called half-life: 20.3 minutes). The C-12 isotope (6 neutrons) is the one we are concerned with here and is stable like the C-13 version (7 neutrons). C-14 is relatively stable, its half-life being 5730 years, which is why the amount of C-14 in a fossil or geological sample can be used to date when it was formed. The less C-14 the older the relic. C-15 disappears in a few seconds – its half-life is 2.5 seconds.

required to break them. Another feature of electrons is that they, a bit like internet celebrities, hate being in the same place as other electrons. This means that when it comes to thinking about the three-dimensional structure of a molecule made up of carbon atoms it is useful to visualize the bonds being attached to the carbon atom in a way where each of the four electrons is the furthest away from the others that it could be. What this means is that the angle between any two of the four bonds is 109.5^0. To visualize this, get a grape and four cocktail sticks: stick three of the cocktail sticks in evenly just below the "waist" of the grape to form a tripod on which it can stand and then insert the fourth into the top of the grape. Now take 4 currants to represent 4 hydrogen atoms and stick one on the end of each cocktail stick and you have got a molecule of methane (CH_4). The cocktail sticks represent the covalent bonds. Make another molecule of methane with another grape, cocktail sticks and four currants. Take the two methane molecules and remove one currant from one, and one currant and its stick from the other, insert the currantless stick of the one methane into the gap left by the removal of the currant and stick from the other methane and, if you have followed the instructions carefully, you have made a molecule of ethane (C_2H_6). You will also notice that you have two currants left over. Were this reality and not a bar experiment, the currants would have reacted with a passing sultana (oxygen atom) to form a molecule of water (H_2O). If you like you can repeat the above *ad infinitum* to make in succession, propane (C_3H_8), butane (C_4H_{10}), pentane (C_5H_{12}) and so on. As a variation, take your ethane molecule, temporarily remove one currant, replace it with a sultana, and then re-attach the currant to the sultana. You have just made a molecule of ethanol (C_2H_5OH). Even if you did not know it before you will by now have realized that the formula C_2H_5OH means that the molecule is made up from 2 carbons, 1 oxygen and 5+1=6 hydrogens. You might also have noticed that whereas a carbon atom can form four covalent bonds, a hydrogen atom can only form one, and oxygen can form two.

Two more experiments to try before you eat the produce. Take your ethane (C_2H_6) molecule, or reassemble it. If you hold onto the two carbon atoms (the grapes) you will find that you can rotate one of them in relation to the other around the stick holding them together. Now remove one currant and stick from each grape and use one of the sticks to form a second (or double) bond between the two grapes (you might have to stick it in at an odd angle to do this). You have just made ethene[vi] (or ethylene C_2H_4) and

[vi] About 156 million tonnes of ethene (ethylene) are produced globally each year – its principal use is to make plastics like poly-ethylene.