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INTRODUCTION

Bariatric Surgery Outpatients Clinic, London, December 2012

Clinic K is where people come to discuss having their stomach removed.

The office, occupying a whole corner of University College Hospital's first floor, has a backdrop of London through large floor-to-ceiling windows. Looking out onto the red buses and black cabs of Euston Road, I remember recognizing one of my patients slowly making her way over to the hospital's main entrance, sheltering her large body under a flapping umbrella in the storm, vainly trying to keep dry for her appointment. I felt sad for her.

Minutes later she entered, trepidation and despair etched on her face. She had finally given in, held up the white flag, surrendered in her battle with her weight – she had lost the diet wars. She wanted me to remove most of her stomach. She eased herself into our over-sized clinic chair and tearfully recounted her years of dietary failure. And as she talked I listened and learned.

Why We Eat (Too Much) was inspired by patients just like this lady – normal people who had suffered with their weight for years; people who came to me looking for treatment.

My patients encouraged me to write this book. I had listened to them over the years and what they said did not fit with my own understanding of obesity. I wanted to close this gap between what scientists, doctors and dieticians told us about it, and how to deal with it, and what obese people actually experienced – because the two stories did not fit together. Someone had got it wrong.

If, as the scientists told us, it was simple to lose weight by dieting and exercise, and if the benefits of that weight loss were so great in terms of happiness, confidence, health and finances, then why could people not achieve it? Over the next five years I became intrigued by this question: why something seemingly so simple could in practice prove to be so difficult. Why can't people sustain weight loss? How could weight loss through dieting be so difficult that people resorted to such extreme measures as stomach-removal (or bypassing) surgery?

University College London Hospital (UCLH) has a fantastic metabolic research unit, run by my colleague Professor Rachel Batterham. Her cutting-edge research gave me a head-start in understanding how our appetite is controlled by strong hormones (originating in the stomach and intestines) that have a profound effect on what we eat and how much we eat. Appetite did not seem to be under a great deal of conscious control; instead, it was governed by these newly discovered hormones.

My studies took me from appetite on to metabolism. How is the amount of energy that we burn controlled? More hormones seemed to be involved. But, curiously, much of the ground-breaking research that explained our metabolism was being ignored by mainstream medicine. Why was this?

If our appetite and our metabolism are being controlled by powerful hormones, then this would explain why it is so difficult for my patients to lose weight using simple willpower. The hormonal triggers that drive our eating and resting behaviour seem to be mainly influenced by our changing environment.

In this book, I will use the newly emerging scientific understanding of metabolism and appetite and combine this knowledge with what obese people have been trying to tell us for years. I will explain why most of the things that you have been told about obesity are myths, based on poor research and vested interests. I will explain:

- Why it is so difficult to lose weight if you use the current advice from medical and nutritional experts
- How some of this dietary advice can be counter-productive and make weight loss even more difficult
- The best strategies for long-term weight loss and health, whether you want to lose 5lb or 5 stone
- Why many very obese people have the feeling that they are trapped and cannot escape, no matter how hard they try.

Once you have read this book you should have a better understanding of why medical professionals have been failing in their advice on weight loss for so many years and, more importantly, you will be able to use this knowledge to improve your own health and wellbeing. By the end of this book I hope that you will feel a sense of relief that, finally, you have not only an explanation, but also a solution. I will avoid excessive medical jargon (and explain any terms that need to be used) and present my ideas in an accessible (sometimes light-hearted) way to keep you reading.

But first, some background. I am a surgeon at University College Hospital in London. My job is to treat people who cannot lose weight by dieting and have reached the end of the road. They have accepted that for them it is impossible to lose weight and keep that weight off. They know that unless something drastic is done they will spend their lives feeling trapped beneath layers of fat, slowly getting sicker and more frustrated and unhappy. In the last fifteen years I must have interviewed over 2,000 people in this situation.

The solution my patients seek is surgery. Not surgery like liposuction to suck out the fat, but an operation that will change their stomach and intestines to make it easier for them to lose weight: bariatric surgery. You may have heard about this type of surgery in the media. A popular bariatric operation is the 'gastric band'. This entails having an adjustable band (made of a type of plastic) placed around the upper part of the stomach. The band works by stopping you eating very fast – making you feel full (and sometimes uncomfortable) after a very small meal. The gastric band has now been overtaken in popularity by two other procedures: one where the stomach is completely bypassed (so food doesn't ever see the stomach), and another where three quarters of the stomach is completely removed, leaving what remains in the shape and size of a narrow tube. This is called the sleeve gastrectomy (more on this in chapter 6).

My first weight-loss operation was a gastric bypass in 2004, using laparoscopic, or keyhole, surgery. This is quite a difficult procedure to perform. I had been trained well, but when the morning of the operation came, and I saw my patient, I was anxious for him. He was high risk: a very large 210kg (33-stone) young orthodox Jewish chef called Jac.

The surgery went well. It had taken two and a half hours, although it hadn't felt that long. Once you are performing a procedure you concentrate so hard it is as if you have been sent to a different world.

When you begin, you do not usually feel nervous about all the responsibility because you know that you should be able to deal with most problems if they arise. Performing an operation, especially if you have become familiar with it, can almost be a meditative, deeply relaxing experience.

Jac made a great recovery, and because keyhole surgery means that there are no large cuts in the abdomen – only small nicks – the pain afterwards is minimal. Happily, he walked out of the hospital pain-free soon after surgery.

Many of my fellow doctors think that bariatric procedures are unnecessary and mutilating. They think, or say, 'Why can't your patients just lose weight on a diet and have a little bit more willpower?' And it is not just doctors who think this. Many politicians and journalists, people who wield real power, would also argue that this type of surgery should not really be necessary, or available. My belief is that they are wrong. This book sets out to explain our fundamental misunderstanding of the causes of and treatments for obesity. And it is because of this flawed thinking by many experts and advisers that the obesity crisis has become worse and anyone who suffers from it gets more frustrated. If we, as a society, understood obesity and came together to tackle it, then we would not need my services, or the services of any weight-loss surgeon.

After my first successful operation in 2004, I started to do more and more of this type of bariatric surgery: gastric bypass, gastric bands and sleeve gastrectomies. As I became more proficient at them, the Homerton University Hospital, where I first started as a consultant, grew to be the busiest weight-loss surgery centre in London. With experience, the time I required for an operation was reduced to one hour and most patients needed to stay in the hospital for only one night and then needed just a week off work.

As the months and years passed, my outpatient clinic became increasingly swamped with patients suffering with different degrees of obesity. I spoke to many hundreds of patients about their views of the condition and what they had experienced first-hand. Then I had a revelation: they all seemed to be saying the same things to me repeatedly. There was no collusion between patients – they did not know what others might have been saying. Their views and their experiences of obesity went against the conventional view of doctors, dieticians and other health professionals. As they vocalized their thoughts, I started to listen and think.

I recalled the teaching of David Maclean, an immaculately dressed surgeon I had worked with at the Royal London Hospital who, at the age of sixty-eight, had carried on working past retirement age because they could not find an adequate replacement for him. He would look me in the eyes and say, 'Always listen *closely* to what your patients are telling you.' This advice stayed with me – I listened. These were some of the typical things that I heard, time and time again:

- 'I can lose weight, doctor, but I can never keep it off'
- 'I think that I have a slow metabolism compared to other people I live with'
- 'I think obesity is in my genes'

or

- 'Diets don't work for me, I have tried them all and I end up gaining more weight than when I started the diet'
- 'I only have to look at a cream cake and I get fat!'
- 'I can't control my hunger, I feel weak if I don't eat.'

When I first started doing these clinics I relied on my limited training in obesity from medical school. I had become very good at doing the operations to treat the condition but, as with many doctors confronted with a patient suffering with obesity, I had poor empathy – I didn't *really* appreciate what they were experiencing. I understood the simple principle of energy balance – if you take in more energy in the form of (food) calories than you burn off (through exercise), then you will store that extra energy inside your body as fat. Therefore, in my mind, it was very simple to lose weight. You merely had to eat less and exercise more – that's how us medics understood it, but it didn't seem that simple to my patients.

What also struck me in those first few years of treating obesity was the transformation of my patients after the surgery. Their lives had been turned around. This condition, obesity, that they had been fighting all their lives, was no longer present. Many said they were back to their former selves – their pre-obese selves. The problem that they had been trying to deal with for years and years, with diet after diet, and disappointment after disappointment, was now gone. They had been released from their obesity trap.

Realizing that each of my patients was telling me virtually the same story before surgery, and that they had become different people after surgery, I started to wonder whether what they, the patients, were saying was correct, and what we, the doctors, were saying was wrong – whether our conventional understanding of obesity was flawed. Was this a condition that arose in patients without them having any control over its development? In other words, was it more of a disease than a lifestyle choice? I wanted answers to these questions.

The tabloid journalists, the doctors, the policy-makers, the public and the politicians were pointing their fingers at my patients and saying, 'This is your problem, you made it and if you had enough willpower you could solve it.' But my patients were giving me a different message: 'I will do anything, but I am trapped.' So I thought that I should try and establish the truth. What if my patients were right and the medical establishment was wrong? I went back to the books and I studied and researched the whole area of metabolism, weight regulation and appetite. I wanted to square what I had heard and seen from my years of speaking to and treating obese patients with what was in the medical research literature. I embarked on a further journey into the depths of metabolic research, into the genetics and epigenetics of obesity, how anthropology, geography and economics affected our foods, and how scientists and lobbyists influenced our understanding.

Once I had done my research I had my answer. Patients liked my way of explaining to them exactly why they were trapped in this condition. How weight is not under conscious control and therefore cannot be manipulated down by dieting. How you should encourage the body to want to be lighter by changing the day-to-day signals it receives. This is the basis of *Why We Eat (Too Much)*.

I hope that this book will be read by anyone who is interested in controlling their weight, but is tired of dieting. I hope that people who want to fully understand obesity and weight regulation will pick up this book – anyone who has a friend or relative who is struggling with obesity and cannot control it. Finally, I hope that the people in power – the politicians, journalists and (dare I say it?) even doctors – will study this book. It will change your perception of obesity and, maybe, help future generations to avoid the suffering it brings.

PART ONE

Lessons in Energy

How Our Body Works to Control Weight

ONE

Metabology for Beginners

How Our Weight is Controlled

> Humans talk, write, walk, and love using the same amount of energy per second as a light bulb, a device that does nothing but shine light and get hot. This amazing fact, far from denigrating humans, is a testament to how efficient a human body is. But more importantly, it is a testament to the wondrous complexity of our bodies, which can do so much with so little.
>
> Peter M. Hoffmann, *Life's Ratchet: How Molecular Machines Extract Order from Chaos* (2012)

I distinctly remember the first class on my first day of medical school. We were issued with starched white coats to cover up our student sweaters and ripped jeans. The superintendent ushered us into a bright neon-lit room, chilled like a walk-in fridge. Along the length of the room were many evenly placed narrow tables, each with a cotton sheet obscuring what lay below. We paired up, took a table each and jokily grappled to get our latex gloves on. One hour later, if you could have observed this group of eighteen-year-olds coming out of their first lesson, you would have noticed several distinct differences from when they walked in. Two of the group needed to be helped out of the room – and did not consider a career in medicine again. The rest of us were ashen-faced. The sheets over each table had hidden a human cadaver. Each one was drained of blood, with a shaven head, the bodies grey in colour and infused with acrid-smelling formalin to preserve them. This was our first lesson: ANATOMY.

During our anatomy classes of that year, we dissected, and examined, all the different organs that run the body. We learned how each individual part of the body worked to maintain health. The organ systems that we learned about included:

- Cardiology – how the heart and circulation work
- Pulmonology – how the lungs oxygenate our blood
- Gastroenterology – how we digest and absorb food
- Urology – how the kidneys maintain fluid balance in our body
- Endocrinology – how glands and hormones work.

These systems gave us the grounding to eventually understand the entire workings of the human body and a basis from which to go on and learn about the diseases that affected them. The classes were supposed to cover all the diseases that we would encounter in our future careers as doctors. However, there was one major omission – none of the organ systems that we learned about adequately explained obesity, the condition that would go on to affect a quarter of our patients throughout our careers, and would trigger unprecedented levels of diabetes, blood pressure and heart problems.

When we took our sharp scalpels in hand and dissected our cadaver, the first layers to be discarded were the skin and fat. These handfuls of human jelly were thrown into bins for later incineration. What we were unaware of at the time was that by getting rid of the fat we were rejecting an important part of the body. Where was the organ that controls our metabolism and appetite; that coordinates and stores our energy reserves? As we busily dissected a lung, a heart or a kidney, this vital organ was in the tissue bin – discarded and ignored.

Have medical schools now caught up? When I quiz my students on the training they currently receive in order to understand obesity, it remains similar to the curriculum of the 1980s, with only minor changes. Experts in obesity are therefore by definition self-taught, and because of this their views often differ from regular doctors, who still rely on the limited training they received in medical school.

In this book, we will go to my 'virtual' medical school to cover the subject that should be on the curriculum, but sadly remains ignored. So let's give the subject a brand new medical name: *metabology*, from the prefix *metabo*-, for 'metabolism', the chemical processes in cells related to energy, and the suffix -*logy*, meaning 'the study of'.

Metabology – the study of appetite and metabolism, of fat storage or fat loss; the study of the energy flows into and out of the body.

Metabology is simple – there are only two main rules that you need to remember to master it. You know one of these rules already – energy in (food) minus energy out (exercise) equals energy stored (usually fat). But the other rule is less widely understood. It states that our bodies try and maintain a healthy internal environment by a process called negative feedback. This is the way the body works to stop you losing (or gaining) weight too fast. Remember these rules and you will understand obesity and its causes and treatment better than most. You will have a superior understanding of obesity compared with most doctors, and if you have struggled with weight control in the past all those struggles will become much clearer.

Before we discuss the Two Rules of Metabology in more detail, let's first take a look at that organ that was thrown away into the incineration bin in the anatomy class – fat. Fat, or adipose tissue as it is known in medical language, is now recognized as one of our vital and life-preserving organs. An organ is defined as being part of a living thing, but separated from other parts, and having a specific function. The specific function of fat is energy regulation. As we will see, fat not only stores energy but also controls how much we use.

A Light, Insulating Energy Source

Fat is made up of individual cells called adipocytes. These cells play a critical role in the survival of any mammalian species – from seals to camels to humans. It has three major properties. First, it is light, compared to muscle or bone; therefore it is efficient to carry around. Second, it provides insulation against the cold and therefore prevents too much thermal or heat energy loss to the air, especially in cold climates. Handy if you are a seal enveloped in a thick layer of blubber, swimming around in ice-cold oceans, not so handy if you are a camel in the 40°C heat of the desert – unless of course you store all the fat in one big lump, or hump, and let the rest of the body breathe. Third, it can store large amounts of energy. Fat is an efficient, lightweight, insulating energy source.

Each fat cell has the unique ability to store energy for times when it may be needed. The more energy it stores, the more bloated it becomes and the more the fat cell *expands in size*. In the initial process of becoming fatter, you do not grow more fat cells. The number of cells stays the same, but each one becomes swollen with its stored energy, growing to six times its original volume. When there is no more room within the cells, the number of fat cells in the body increases – from an average of 40 billion to over 100 billion in some cases. Unfortunately, if you suck the fat cells out with liposuction (a common, short-term fix performed by plastic surgeons), more and more fat cells are produced to compensate.

Energy storage is the most important function of fat as an organ. It is critical to have a store of energy to survive in times of famine and food shortage. The brain needs a constant level of glucose (sugar) in the blood to function. When there is no food readily available, this is replenished constantly by our fat cells. In many types of mammals, including man, there does not need to be an actual famine for our fat stores to be called upon. During migrations, fights to defend territory, fights to obtain a mate, the act of mating, pregnancy and breast-feeding, the amount of energy taken in as food can be reduced even though the amount of energy needed increases. This is when the fat-storage function comes into play. An energy bank in the form of fat, like a fuel tank in a car, is critical to our survival and for our ability to reproduce and raise the next generation.

You might therefore think that there would be a major evolutionary advantage to having a large energy store. However, it isn't in your interest to be carrying an oil-tanker's worth of energy around as this is going to limit your ability to go about your normal survival activities like hunting or running away from hungry predators. So there must be a mechanism to control the size of these fat tanks: fat is very clever, and very efficient, at self-regulation.

Metabology Rule 1 – Energy Use and Storage

The first rule to remember is already in the curriculum for medical students. In most people's opinion, this rule is what defines obesity: it explains, simply and precisely, energy use and storage. But it is this rule that causes so much prejudice against people who struggle with weight control. It is grandly named 'The First Law of Thermodynamics' and is used by physicists to calculate the amount of energy stored in any given object – from a rock, to a plant, to an animal (including a human). Its basic premise is: the energy stored in an object equals the amount of energy taken in minus the amount of energy taken out.

If you want to simplify things, then just think of a human as a box. This box transforms chemical energy from food into heat, movement and thought. The rest is stored.

(Energy In) – (Energy Out) = Energy Stored

In humans, the 'Energy In' is what we eat – a combination of proteins, fats and carbohydrates. The 'Energy Out' part is just as important and is often misunderstood. Often people think that most of the energy they use up comes from how active they are in the daytime and whether they go to the gym or not. This is not the case. Most of the energy that we use does not involve any type of movement. If we were to lie in bed all day and all night we would still use up to 70 per cent of the energy that we normally do – through breathing, heartbeat, temperature control and all our cells' chemical reactions. The amount of energy that we use to perform these subconscious tasks is called our *basal metabolic rate* (or BMR). The concept that over two thirds of our daily energy expenditure is not within our conscious control is an important one to grasp when understanding our metabolism – and how we control our weight and why some people develop obesity.

What about the remaining 30 per cent of the energy that we normally use? This is made up of two parts:

1. *Passive energy expenditure* – the energy that we use to get on with our everyday lives. This can be anything from walking to work, doing the cleaning, moving around the office or doing a hobby. For most of us – those who don't go to the gym or have a manual job – this will make up almost all of the remaining 30 per cent of energy used.
2. *Active energy expenditure* – this is the amount of energy that we use up when we perform active exercise. For some this could be going to the gym or jogging. For others, such as builders in England, rickshaw drivers in India, or hunters in the African savannah, it could be part of their daily lives. For sedentary people, meaning most of us working in cities, active energy expenditure may just be running for a bus, or climbing a few flights of stairs, and accounts for just 2 or 3 per cent of our total daily energy used.

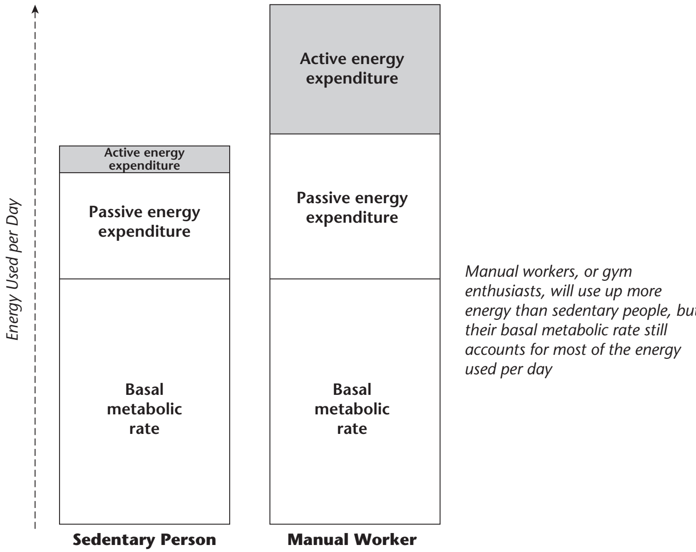

Figure 1.1 Energy used per day by sedentary people compared with active people

FACT BOX

The sugar energy in the liver needs water to hold it in place; this makes it quite a heavy energy source (water is much heavier than fat). When you go on a very low-calorie diet, the liver's stores of energy are the first to be used up. As the sugar in the liver is used, so the water is flushed out and hey presto you think that you have lost a lot of weight in a few days – but it is mostly water and not fat. This is one of the main tricks that fad diets play on people: you think you are making real progress with initial weight loss but it is mainly fluid and the weight loss is transient.

The 'Energy Stored' part of the equation is simpler. Any excess energy is stored first in the liver (as a type of sugar) and then in fat cells (as fat). The liver can only hold a couple of days' worth of energy; it is generally full to capacity, so in practice excess energy is usually stored in fat. The energy in fat can help keep us going for about thirty days without food. Knowing this takes us on to the rule that is almost always overlooked when explaining obesity.

Metabology Rule 2 – Negative Feedback System

The second rule is called the *negative feedback system*. You may wonder, isn't that what I get from the boss when he catches me coming into work late? And yes, in a way you would be correct. Negative feedback describes the regulation of a system: it can be an office system or a mechanical system (like a machine) or a biological system (like that of a human). The system has a set way of working (like nine-to-five office hours) and if it senses the way of working deviates from the set rule, then it will automatically correct itself.

Negative feedback systems are simple. They just need a sensor connected to a switch which changes the system back to where it should be. In our office example, the boss is the sensor to your late arrival and his warning is the switch to change your future behaviour.

An example of this in a machine would be a household thermostat. It is designed to maintain a set temperature. It senses when the temperature in the house falls below this and switches on the central heating. When the temperature then exceeds the setting, it automatically turns the heating off.

In the organ systems we explored in medical school we saw many examples of biological negative feedback. These are protective mechanisms that keep us on an even keel (in medical language this is called *homeostasis*). It means that harmful changes are sensed and automatically counteracted – the reason for negative feedback is to maintain order and health. Let's demonstrate a couple of examples in humans. For us to function efficiently we need to be at the correct temperature and have the correct proportion of water in our bodies. Here's how negative feedback works to automatically regulate this.

Sweltering (Drip) . . . or F-F-F-Freezing

It is essential that we keep our own body temperature at around 37 °C. All the chemical reactions in our bodies rely on thermal motion (the continuous movement of our atoms) at a particular rate. This rate is set by our temperature. If our temperature goes up to 40 °C, then we get heatstroke; if it goes down to 35 °C we develop hypothermia.

Our own internal thermostat tries to control our body temperature to within quite a narrow range. We have all experienced getting too hot or too cold. What happens? Sensor says too hot: switch on coolant mode and start to sweat (when the sweat evaporates it cools the body by taking heat). Sensor says too cold: switch on heating mode and start to shiver (the muscular activity of shivering produces internal body heat).

Thirsty?

Another example of negative feedback is our hydration system. Once we understand how our body regulates its water content, it becomes easy to understand how it also regulates its energy content, and therefore how much fat is stored – the hydration and energy storage systems are similar. All doctors know how we regulate water in our bodies – this *is* taught in medical school – but I imagine that only a minority of them grasp energy regulation.

Let's look at the hydration system. This negative feedback system has one sensor connected to two switches. Water makes up 70 per cent of our bodies. Beneath our skin, we are basically immersed in a 37 °C salt-bath. We need to make sure the water in our bodies is not too concentrated or diluted. If we become over-hydrated it can lead to seizures (and eventual death), and if we become too dehydrated we become weak and dizzy (and also, in severe cases, die).

The Sensor – the Kidney

The sensor to detect dehydration or over-hydration in the blood is in the kidney. Once it senses a change it secretes a hormone (called renin) which leads to a message being sent to the two switches. The two switches control:

1. The amount of water we take in – by controlling our thirst
2. The amount of water we let out – by controlling how much urine we make.

We Only Need 700cc But are Thirsty for More

The kidneys need to purify the blood of waste (urea) by producing urine. They can do this by producing just 700cc per day.* If we excrete

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* In critically ill patients, the minimal urine output should be 30ml per hour to prevent kidney failure and to ensure survival. This equates to 700ml per day. We

below this volume of urine, we become unwell and start to develop kidney failure, so the kidneys signal for us to drink about double the minimum amount of water needed for health. We therefore drink about 1.5 litres of water per day and produce the same amount of urine. We don't need to drink 1.5 litres – we could survive on about 700ml per day – but as an insurance mechanism our thirst switch is ratcheted up so that we have plenty of essential water going through our system.

Biological systems like to be on the safe side, so, in this case, they habituate us to drink much more water than needed. Biology likes a safety buffer – this is an important point to remember when we compare our water-regulating system to our energy-regulating system. If we go without anything to drink for a few hours, then the kidney senses this. It sends a signal to turn on the switch located in the brain that controls thirst – the water-in switch. The brain gets the thirst signal and all you can think about is getting water. The more dehydrated you are, the stronger the thirst signal. At the same time the kidney sends a signal to turn off the water-out switch. We then produce only the minimal amount of concentrated, dark urine – less water is excreted and more is retained. Dehydration fixed.

The sensor also works the other way around, so that if you have drunk too much water and the blood is over-hydrated, it will turn off the first signal to the brain and you will not want to drink any more. It also flicks on switch number 2 in the kidney, leading to lots of dilute urine being produced. Less water in and more water out – over-hydration corrected.

Counting Calorie Intake? We Never Count Water Intake!

This negative feedback system works constantly to regulate the amount of water that we have in our bodies. It works subconsciously. In a whole year, we drink over 550 litres of fluid. That's the equivalent of five full bathtubs of water passing through our bodies every year. But we never have to measure that water to make sure that we are drinking the correct amount. Doctors don't have to warn us that if we take in 6 litres of water more than we excrete we could die of over-hydration – they know it is powerfully regulated without

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also lose water through our breath (400ml), through sweating (400ml) and in faeces (100ml), but this is offset by the amount of water we generate through our own metabolism (400ml) and the water contained within the food we eat (500ml).

having to think about it. We don't have a 'water in – water out = water stored' equation in our minds. This is because we know that our water balance is controlled by our biological negative feedback mechanism. And the mechanism is exquisitely accurate. Of the 550 litres consumed per year an identical amount is lost from our bodies, all without a conscious thought.

People do occasionally die from drinking too much water (6 litres in a short period of time), but they are consciously over-hydrating. Rare examples are: inexperienced runners in a marathon, who fear dehydration and therefore force themselves to drink too much, or young students playing drinking games. Either can be rapidly fatal.

Just like the hydration systems, energy metabolism (i.e. the amount of energy taken in, the amount used and the amount stored) is critical for the survival of any species. All species go through times of feast and famine; the ones that survive and thrive are the ones that can predict exactly how much energy may be needed and should be stored for the future.

Six Big Macs . . . with Six Sides of Fries . . . and Six Cokes

Let's go back to Metabology Rule 1. This is the rule that most people use to understand obesity: (Energy In) – (Energy Out) = Energy Stored. Scientists have calculated that to store 1kg (2lb) of fat you need to take in 7,000 extra kcal.[1] That's the equivalent of six Big Macs, six sides of fries and six Cokes – on top of the usual calories that are needed every day. So, fit in a Big Mac meal on top of your normal meals for a week (excluding Sunday) and you will gain 1kg or about 2lb.

The traditional explanation for the overwhelming rise in obesity in the last thirty years is that we have been consuming too many delicious Western-type foods, too many Big Mac meals. On top of this, we have more cars, dishwashers, video games etc. and therefore do not move around as much as we used to. Basically, the conventional wisdom is that we have created a society in which it is easy to become too greedy and too lazy and this has led to us getting fat. It's our fault. If we just take Metabology Rule 1 to explain obesity, then this conclusion must be correct.

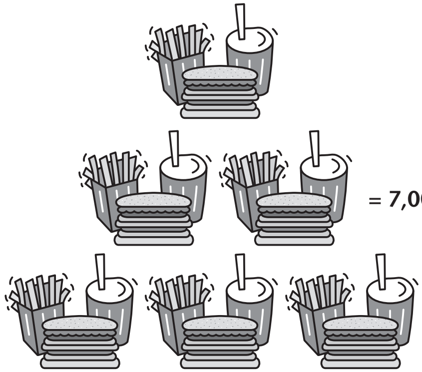

Figure 1.2 7,000kcal translate to 1kg of weight gain

Why aren't All Americans over 300kg?

If we look at the data, it seems that this conclusion is correct. The rise in the rates of obesity started in the early 1980s and this seemed to coincide with the rise in the consumption of calories by the population. In fact, if you look at the statistics from the US, the rise in the calories in the food supply exactly corresponded to the rise in obesity rates.*[2] In 1980, the average American man consumed 2,200kcal per day. By 2000 he was consuming 2,700kcal per day.[3] In 1990, he weighed 82kg (12 stone 12lb) and twelve years later the average American man weighed in at 88kg (13 stone 12lb). The data seems to back up the traditional theory of obesity – that it is a simple energy-in/energy-out equation. But there's more to the story.

So, at first glance it seems to be clear: calories cause obesity. But hang on, if we look at the figures more carefully, they don't add up. The average American man is eating 500kcal more per *day* during this period. What's that per year? 500 x 365 = 182,500kcal extra. How much weight should the average American man gain per year if we use Metabology Rule 1?

* Calories taken in from the food supply, when adjusted for food wastage, are the most accurate method of determining a population's calorie consumption. Several studies have used self-reporting of food intake to estimate consumption. This was recently confirmed by the UK's Office for National Statistics to be up to 70 per cent inaccurate.

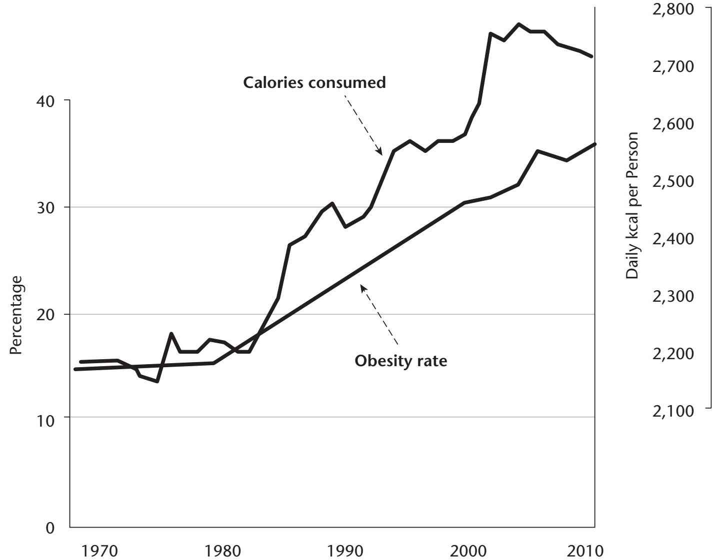

Figure 1.3 Obesity rates started to take off in 1980, coinciding with the rise in calories consumed

Source: C. L. Ogden and M. D. Carroll (2008). Prevalence of Overweight, Obesity, and Extreme Obesity Among Adults: United States, Trends 1960–1962 Through 2007–2008. *National Health and Nutrition Examination Survey (NHANES)*, June. National Center for Health Statistics.

If we assume that the amount of physical activity wasn't increased, and there is certainly no evidence of this, then applying our rule over a year leads us to the following conclusion:

500kcal per day over one year:
extra energy in – extra energy out = energy stored
182,500kcal – 0kcal = 182,500kcal
1kg fat = 7,000 extra kcal
Expected weight gain over one year = 182,500 / 7,000
= 26kg (4 stone)

A predicted 26kg weight gain in one year. In twelve years, the weight gain of the average American man would be 312kg (49 stone)! But the actual figures say that in this period the average American man gained 6kg (13lb) in total (or 0.5kg per year, not 26kg per year). What has happened to Metabology Rule 1?

This takes me back to my first few visits to the US, usually for conferences or to teach surgery. When you first visit, everything seems bigger, including the people. I observed the portion size and the type of foods that Americans eat. I went to their gas stations and supermarkets and saw how everything had been supersized, with tremendous amounts of sugar and fat added to their foods. My thought at the time was, 'Why aren't Americans even larger?' Looking at the figures now – 182,500 extra calories per year – I wonder again why all Americans do not weigh 300kg.

The actual weight gain for Americans who, as a population, were consuming 500kcal extra per day was only 0.5kg (1lb) per year. This equates to 3,500kcal extra, stored as fat, over the year, or just 11kcal per day, the equivalent of one potato crisp, per day, over the calorie limit. Not one packet of crisps, but one crisp. This means that although the average American is consuming so much more than necessary, they regulate their energy balance to within 0.4 per cent of perfection. A separate validation study that more accurately measured energy usage over a year and weight gain found the system to be even more accurate, with only 0.2 per cent of calories ingested being stored as fat.[4]

What happened to the 'missing energy' of 489kcal per day? To answer this, we need to go back to the rule that is often ignored when explaining obesity: negative feedback.

Hoarding Energy

Remember that the negative feedback rule is designed to protect the body against unhealthy changes – by activating processes that will oppose those changes. We know that there are many of these types of mechanisms at work in the body, helping to preserve a healthy state. The regulation of our temperature and hydration are just two of these systems. We know that energy regulation and storage is a critical part of survival in animals. You need to store energy for times of need, but you cannot hoard energy indefinitely, because if you do, as with any hoarding behaviour, things get messy and there is no room to move. So, we should not be surprised if the amount of energy stored within our bodies (just like the amount of water) is also controlled by a negative feedback mechanism. This would explain why, in the presence of so much over-consumption of food, American men's weight edged up by much less than predicted.

But how could a negative feedback system work to stop massive weight gain? We know the energy has gone into the body, but the body has not stored it. Therefore it must have been used up somehow. But where? Let's recap energy expenditure:

Energy expenditure = Active energy expenditure (gym)
+ Passive energy expenditure (walking/moving)
+ Basal metabolic rate (breathing/ heartbeat/temperature control)

How is the extra energy used up? Do people sense they need to exercise when they over-eat? Most people give it a few seconds' thought but don't act on it, so we can discount *active energy expenditure* as the most likely scenario. Some scientists say that people might fidget more when they over-eat and this uses up the extra energy in the form of *passive energy expenditure*.[5] But to use up nearly 500kcal per day just twitching your legs is a lot of twitching considering that walking for a mile uses less than 100kcal. I don't think we fidget our way through that much energy. What about the *basal metabolic rate*? Does the body ratchet this up in order to stop us storing too much energy?

The Vermont Prison Feast

To start to answer this question we must go back fifty years to an extraordinary experiment.[6] A team of American scientists, led by Ethan Sims, set up their lab in Vermont State Prison in Burlington, Vermont. They were studying obesity and wanted to observe and analyse what happened when a group of men deliberately over-ate to increase their body weight by 25 per cent over a three-month period. Over-eating takes time and needs to be supervised. The scientists had started the study using students, but aborted it as the students did not have enough time, between their studies, for supervised over-eating. Prisoners were much more suitable for the study. They had nothing else to do and their activity could be monitored (they were to be barred from physical exercise). The scientists negotiated the promise of early releases for the prisoners who were able to gain enough weight to meet their target.

The scientists employed a dedicated chef for the prisoners and upgraded their plates from tin to china. Breakfast was a full American: eggs, hash browns, bacon and toast. Lunch was unlimited sandwiches. Evening meal was steak or chicken with potatoes and veg. Before bed they sneaked in another full American breakfast. The men started out by increasing their calorie consumption from 2,200kcal to 4,000kcal per day. The scientists observed a steady rise in the weight of the prisoners, but then a strange thing happened that puzzled the scientists. Despite eating 4,000kcal/day, the prisoners stopped gaining weight. They could not put on any more and were still a long way short of their target of a 25 per cent weight increase.

2,200 to 4,000 . . . to 10,000kcal

So the scientists ratcheted up the calories. Most men had to eat 8,000–10,000 calories per day to keep putting on weight, four times what the scientists had calculated would be required. Astonishingly, a few of the prisoners seemed resistant to further weight gain, even at 10,000kcal. Why could they not put on any more weight? The answer came when the scientists measured the metabolic rates of the over-fed, and now overweight, prisoners. In all cases their metabolism had increased considerably. The men seemed to be adapting to the over-eating environment by burning off more energy in order to protect themselves from runaway weight gain. Does this sound familiar? It may explain why our average American male put on 6kg rather than the 200kg-plus that we had calculated from the increased consumption of processed foods in the 1980s and 1990s.

In 1995, a research group from Rockefeller University Hospital in New York investigated the effects of a 10 per cent weight gain on two groups of patients.[7] One group started with a normal weight and the other group were obese. Interestingly, the obese group had a higher than predicted resting metabolic rate than the non-obese group at the onset of the study, before any weight gain. A high-calorie drink made up of protein, fat and carbs was used to drive weight up. This helped the scientists calculate more precisely how much energy was being taken in. What happened to their energy expenditure when the two groups made the 10 per cent weight-gain target? As with the Vermont Prison study, the basal metabolic rates of all the subjects in the Rockefeller study increased – in the non-obese group by over 600kcal/day and in the obese group by even more, over 800kcal/day.

In a later study in 2006, researchers at the Mayo Clinic in Rochester, Minnesota, analysed twenty-one previous over-feeding experiments, including their own.[8] They confirmed that on average the basal metabolic rate did indeed rise by an average of 10 per cent in response to the over-feeding. The more energy that was taken in by over-feeding, the more the body tried to burn up those extra calories to stave off weight gain.

More Firewood – More Fire

These over-feeding studies suggest that, yes, there is indeed a negative feedback mechanism controlling our weight and stopping us gaining too much weight too fast. Imagine that you have a log fire at home. Every winter's day you have one log of wood delivered and every evening you relax by the fire and burn that piece of wood. Imagine, now, that you receive three logs of wood each day. What would you naturally do? You may not have much space to store the wood, so you would probably burn the excess, keep warm, have more energy and avoid the chill.

The scientific evidence that we compensate after over-eating by burning off more calories is compelling – and it fits in with our epidemiological evidence: we don't gain 26kg (4 stone) per year, just 0.5kg (1lb). But, if you ask most dieticians or doctors if they are aware of this mechanism – metabolic adaptation to over-eating – they will say no. This is not covered in their training. Why not? You would expect that something so fundamentally important would be understood by the medical profession, and should be accepted public knowledge.

Some scientists still argue that the increased energy expenditure that we see when we put on weight is because the body has become physically larger. A larger body burns more energy. However, when we analyse the figures this theory doesn't add up. Most people who gain weight, especially in over-feeding experiments, but also in everyday life, put on the excess weight as fat and not muscle. Fat expends a minimal amount of energy; compared to muscle it is a very efficient organ. In the Vermont study the prisoners had to consume 50 per cent more calories than expected just to maintain their increased body weight. Because their metabolisms were so 'hot', they all lost their extra weight as early as twelve weeks after the experiment ended and they were able to resume normal eating. None of them needed any type of diet to get back to their normal pre-study weight.

A study from Arizona, looking at fourteen men who over-ate 100 per cent more calories than normal, found that within the first forty-eight hours of over-eating (i.e. before any significant weight gain had occurred) their BMR had increased by an average of 350kcal per day.[9] The conclusion? Over-eating leads to the burning of energy through an increasing metabolic rate. When we compare how most of our organ systems are kept in check by negative feedback, then it should come as no surprise that there is some sort of negative feedback to protect us from storing too many calories.

Are our bodies trying to protect us from ourselves by burning more energy when we take in too much food, in a similar way that our kidneys rid us of excess fluid when we drink too much? This would explain why some people seem to be resistant to excessive weight gain despite eating far too many calories.

But here is an important issue raised by Metabology Rule 2. If the negative feedback mechanism is working to stop some people gaining as much weight as predicted, then it should also be working to stop people losing weight when they go on a diet. Could this explain why diets often fail?

'I Can Lose Weight, but I Can't Keep It Off!'

I hear this statement in every clinic that I have worked in. At least one patient will have said it in every clinic, every week, every month over the fifteen years that I have been seeing patients struggling with their weight control. Sometimes I tell the medical students who sit in on the clinic that my next patient will tell us this, and almost all patients prove me correct. Here is a typical example:

I have been dieting since my teenage years. I have tried all the diets out there. Weight Watchers, Slimming World, LighterLife, the red and green diet, the cabbage soup diet. I have tried them all. I can lose weight but I can't keep it off. I can lose 5 or 10kg (1–1½ stone) on a diet but then after two or three or four weeks the weight loss stops. I'm still on the diet, I'm still counting my calories and starving hungry and tired and irritable, but after a while the diet doesn't seem to work any more. When I go and see my doctor and tell him that the diet is no longer working, he tells me that it is impossible and that I must be sneaking extra food in. He basically doesn't*

* In chapter 12 of this book, we will look at the most common diets, how they work, and why they fail.

believe me. So, I stop the diet and the weight piles back on . . . fast. Usually I regain all of the weight that I had lost and then gain even more!

This is the classic story that I have heard many, many times in my clinic. But it does not correspond with the simple 'calorie in and calorie out' rule. It's difficult to understand why someone can restrict calories, sometimes to 1,200 calories a day, and after a while they stop losing weight.

Let's see what happens if we apply the same type of system that maintains our bodies' hydration – our negative feedback system – to weight control and our energy storage, i.e. our fat. Let's apply Metabology Rule 2. If the system mirrors our hydration system – and we know all biological systems work in a similar way, so this is likely – then there will be one sensor and two switches.

The sensor will detect the amount of energy stored in the body as fat. Once it senses a change in the amount of fat stored, whether it goes up or down, it secretes a hormone which leads to a message being sent to the two switches. The two switches control:

1. The amount of energy we take in – by controlling our appetite
2. The amount of energy we use up – by controlling our basal metabolic rate.

If the energy storage system in our bodies is really like our hydration system, then it will direct more energy intake than we really need. Remember, we can just about survive on 700cc of water/liquid per day but our hydration system wants us to drink 1,500cc.

The insurance mechanism built into our bodies tells us to drink double the amount of water than the minimum required for survival. Biological systems like to be on the safe side, so they habituate us to drink much more water than needed. In the same way, maybe our energy-regulating system directs us to consume more calories than we need and then burns off the excess. This would also mean that, when we calorie-restrict, it is all too easy for the body to cope with this. It would be similar, in the hydration system, to consuming 1 litre of fluid per day and not the recommended 1.5 or 2 litres. You would be able to survive indefinitely on 1 litre of water per day, but your biological feedback system would be screaming for more fluid by giving you a raging thirst and reducing the amount of urine excreted to a minimum. You would survive, but feel pretty terrible.