Overcoming Common Problems

The Diabetes Healing Diet

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and
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To Ophelia, Yasmin, Rory and Rose – with love

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Introduction

A century ago, children with diabetes lived on death row. Most slipped into a fatal coma within a few months of developing the disease.[1,2] Since then, doctors and scientists have made remarkable progress in understanding and treating diabetes. Nevertheless, it still causes around 1 in 8 deaths among people aged 20 to 79 years in the UK, according to Diabetes UK. Indeed, poorly controlled diabetes can cut up to 20 years from your life expectancy. And it's on the rise. Every 3 or 4 minutes someone, somewhere in the UK receives the life-changing news that they have developed diabetes. Indeed, around 1 person in every 20 in the UK has diabetes – that's around 2.9 million people in 2011. To make matters even worse, up to half a million people in the UK have undiagnosed diabetes. The first hint may be a serious complication such as poor vision, a heart attack or impotence. Indeed, half of people with type 2 diabetes mellitus (T2DM) – the type that usually, but not always, emerges in middle age – develop complications before their doctor diagnoses diabetes.

Tragically, much of this suffering could be avoided if people took control of their diabetes sooner. This book shows how a healthy, balanced diet helps avoid the worse ravages of diabetes. In some people with the early stages of the most common form of diabetes, a healthy diet and lifestyle can reverse the apparently inexorable decline. Unfortunately, diet and lifestyle changes alone usually cannot prevent diabetes-related damage to our critical organs. Many people with diabetes also need to take antidiabetic drugs or inject insulin. Yet even in people taking the most modern medicines, following a healthy, balanced diet still increases their chances of avoiding diabetes-related damage, disability and even premature death.

A complex disease with a simple cause

Diabetes is a complex disease with a simple cause. Cells are, essentially, biological factories. And all factories need fuel. Cells use a type of sugar called glucose to power their activities. The body extracts glucose from the carbohydrates (such as sugars and starch) that we consume as part of our daily diet.

Maintaining adequate levels of glucose in the blood is essential for survival. But people with diabetes have too much of a good thing. Their dangerously high blood sugar levels poison their cells. As a result, poorly treated diabetes can cause debilitating, distressing and disabling complications such as pain, ulcers, amputations, heart disease and blindness. So, treating diabetes aims to control blood glucose levels and counter other factors that worsen the prospects for people with diabetes, such as smoking, obesity and raised concentrations of cholesterol.

Changing diet is one of the longest established treatments for raised blood sugar levels. The Hindu physician Sushruta, probably writing around the sixth century BCE, noted that the urine of people with diabetes attracted ants (the sugar in the urine appealed to the insects). Sushruta suggested exercise and vegetables for corpulent people with diabetes and a nourishing diet for lean patients, who he rightly recognized had a more severe form of the disease.[3]

Sushruta's insights were remarkably prescient. But doctors' view of the ideal diet for people with diabetes has changed dramatically over the decades. For example, in the years just before the first successful treatment with insulin in 1922, some doctors told patients to eat large amounts of fat – the reverse of advice today – and cut back on carbohydrate.[1,2] Around the same time, some doctors suggested diets for people with diabetes based around specific foods, including skimmed milk, potatoes and oatmeal.[3]

Other doctors, led by Frederick Madison Allen, suggested cutting carbohydrate consumption dramatically, often to starvation levels. People with diabetes following the Allen diet ate a maximum of 600 ml of clear meat soup and between three and six bran muffins daily for 10 days. They then gradually increased their carbohydrate intake until the doctor detected sugars in their urine. Patients kept their carbohydrate intake below this level. Cooks even boiled vegetables three times to remove as much carbohydrate as possible.[1,2,3] Of course, this also removed many valuable nutrients.

One of these patients, Elizabeth Hughes, the 11-year-old diabetic daughter of an American presidential candidate and New York Governor, controlled her blood sugar levels by eating just 500 to 800 calories a day. She also fasted for 1 day a week. If doctors detected even a trace of sugar in her urine she ate 250 calories a day or less. Her weight fell from 34 kg in 1919 (average for her age and height) to 20 kg in the summer of 1922. Fortunately, in the August of that year Elizabeth was among the first people treated with insulin. Elizabeth recovered, travelling widely and working with numerous charities. She died in 1981.[1,2]

As we will see during this book, a healthy, balanced diet remains a foundation of diabetic care, almost a century after insulin's introduction. Watching your diet helps control blood glucose levels and so can reduce the risk of complications. But, ironically, unhealthy, unbalanced diets also contribute to most cases of diabetes.

The dangers of a poor diet

Humans did not evolve to chomp on junk food high in sugar and fat, and low in essential nutrients: sweets, cakes, takeaway food, ready meals and so on. We evolved to eat, essentially, a hunter–gatherer diet – one that is rich in complex carbohydrates (such as starch from fruit and vegetables) and low in animal fats. Our hunter–gatherer ancestors also kept moving searching for food and water. Inevitably, most members of these societies were physically fit and relatively lean.

By contrast, the typical modern Western diet produces an overabundance of energy. If you do not burn this energy off, the body stores the surplus in fat cells as a precaution against famine. But in industrialized nations we can easily access food. So, we never use these stores. As a result we gain weight, especially around the middle (central obesity). This excess weight causes around 90 per cent of cases of T2DM in the UK. Obesity also increases the risk of stroke, heart disease and some cancers.

Excess weight is not the only cause of diabetes. For example, diabetes can arise from 'biological civil war' when the body mistakenly destroys insulin-producing cells. And certain medicines, operations, diseases and even pregnancy can trigger diabetes.

Nevertheless, our expanding waistbands are responsible for most of the rise in diabetes that experts expect will emerge over the next few years. The upward trend is already clear: according to government statistics, the number of drugs prescribed for diabetes in England increased by 41 per cent between 2005/6 and 2010/11. And while the number of new cases diagnosed each year is already frightening, it will probably get worse. In 2008, doctors diagnosed 145,000 new cases of diabetes, which Diabetes UK points out is more than the population of Middlesbrough. Diabetes UK also predicts that by 2025, 4.2 million people will have diabetes, up from 2.6 million in 2009. Meanwhile, increasing numbers of overweight and obese children and adolescents will develop T2DM.

Now the good news

Now some good news. Healthy eating – alongside other lifestyle changes and, if necessary, drugs – dramatically reduces the risk of diabetic complications. If you are already taking insulin or antidiabetic tablets, diet alone will not control your blood glucose levels. Nevertheless, eating a healthy, balanced diet will reduce the risk of complications, both long-term (e.g. heart disease, amputations and blindness) and short-term (e.g. hypoglycaemic attacks caused by dangerously low blood sugar levels). Indeed, a healthy diet helps people with diabetes live fulfilled, active, satisfying lives.

If you've not yet developed full-blown T2DM, but are at risk – so-called prediabetes or impaired glucose tolerance – improving your eating habits can go a long way towards slowing the progression to diabetes and, in some cases, may reverse the gradual increase in blood glucose levels that ends in your doctor diagnosing diabetes. So, if T2DM runs in your family, your doctor has diagnosed prediabetes, or you are overweight and inactive, you should try hard to eat a healthy diet, exercise, quit smoking and follow the other suggestions in this book. A healthy diet and lifestyle will also help reduce your risk of developing many other serious diseases.

This book begins by looking at the causes and consequences of diabetes. We will consider the place of diet in diabetes management, alongside other treatments. Unlike a century ago, doctors now suggest that most people with diabetes can choose from a wide range of foods. With some planning you should be able to find a healthy diet that reduces your risk of diabetes-related complications, while satisfying your taste buds. We wish you all the best in your endeavours to eat yourself back to much better health and peace of mind.

Authors' note to the reader

This book aims to help you improve your control of blood glucose levels, avoid short- and long-term complications, and enhance your general health and well-being. The NHS now recommends that everyone with diabetes should take part in 'structured education' to help manage his or her disease. These courses cover lifestyle changes (including diet), medications and monitoring blood glucose. For example, DAFNE (Dose Adjustment For Normal Eating) and DESMOND (Diabetes Education and Self-Management for Ongoing and Newly Diagnosed diabetes) help people with types 1 and 2 diabetes, respectively. If you want to know more or want a refresher, speak to your GP or diabetes team. The advice in this book supports and expands on, rather than replaces, these self-management courses and suggestions from your healthcare professionals, which are tailored to your particular problems and circumstances.

If you think you are at risk of diabetes or you develop symptoms (see page 21) you must see your GP as soon as possible. Finally, although changing your diet can help improve your blood glucose levels you should never adjust or stop any medicine (for diabetes or any other disease) without speaking to your doctor or diabetes nurse first.

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1

The pancreas – controlling glucose levels

Diagnosing disease has never been easy. Medieval doctors regularly inspected their patients' urine by holding a sample in a bulbous glass flask to the light. Some went further: they took a swig. Indian texts from the fifth century BCE and the Islamic philosopher–scientist Avicenna, writing around the start of the eleventh century, commented that the urine of people with diabetes tasted sweet. In 1674, Thomas Willis, a leading English doctor, used the sweet taste to distinguish diabetes from other diseases that caused frequent urination, such as infections or bladder stones. Willis coined the term diabetes mellitus – the latter term from the Greek word for honey or sweet.[1]

As mentioned in the introduction, cells use glucose for fuel. Glucose is the most common sugar in the human body. Carbohydrates are long chains of sugars; starch, for example, consists of long chains of glucose. Sucrose (table sugar) contains glucose joined to another sugar called fructose. Digestion breaks carbohydrates into single sugars, which travel around your body in your blood.

A hormone called insulin stimulates cells to take glucose from the blood. Cells then use the glucose to generate energy. Without insulin, most cells (there are some important exceptions) cannot use glucose so, in people who do not produce enough insulin, glucose levels in the blood rise. In other people with diabetes, insulin does not work properly when it reaches the cells – so-called insulin resistance (some people have both problems). Again, the cells do not absorb glucose and the amount in the blood (the concentration) rises.

In response, the body tries to flush the excess sugar out of the body. As a result, people with diabetes urinate more – and their urine tastes sweet. Diabetes derives from another Greek word that means siphon. The second century Greek doctor Aretus the Cappadocian described patients passing urine 'like a siphon'.[1]

To understand what goes wrong in diabetes and why a healthy, balanced diet helps, we need to look at how the body normally controls blood sugar levels. In this chapter we will discuss the pancreas, insulin's actions and how the body tightly regulates blood glucose levels. Some of this section may seem a little complicated at first. But it is important to understand the basic principles of glucose control. So take your time, and, if need be, discuss individual points further with your doctor, nurse or a helpline such as that run by Diabetes UK. See the list of useful addresses, beginning on page 121, for the contact details of all the organizations mentioned in this book.

The pancreas

The pancreas, which is about 15 cm (6 inches) long, lies behind your stomach about level with the inverted V where your ribs meet at the front of your chest (see Figure 1). The rounded 'head' of the pancreas is next to the first part of your bowel after your stomach – called the duodenum. Biologists distinguish two other parts of the pancreas: the middle 'body' and the narrow 'tail', which lies on the left side of your body (Figure 2).

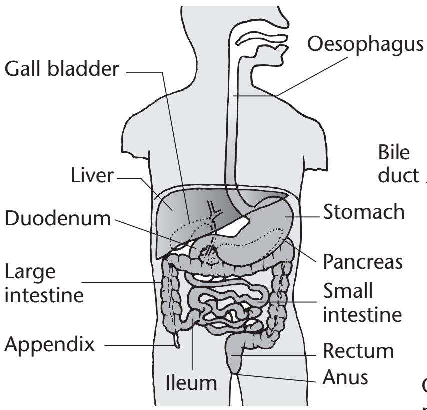

Figure 1 The digestive system

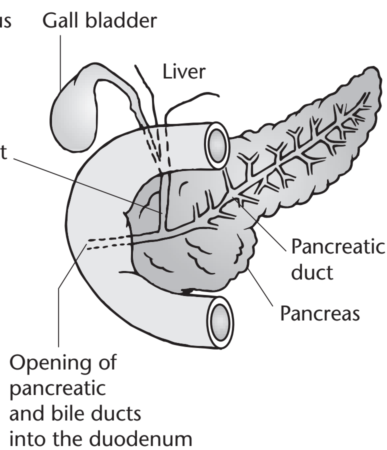

Figure 2 The pancreas

Your pancreas has two vital roles, producing:

- pancreatic juice, a cocktail of chemicals that helps you digest food, and
- several important hormones, including insulin.

Pancreatic juice

When you eat, food travels from your mouth, down your oesophagus and into your stomach. Acid produced by the stomach sterilizes, and starts digesting, food. From the stomach, food flows into the duodenum (see Figure 1).

Specialist cells in the pancreas (acinar cells) pump pancreatic juice into small ducts. These tubes feed into a larger duct running the length of the organ – the pancreatic duct (see Figure 2). Meanwhile, the liver and gall bladder (a small pouch under the liver) release a greenish-yellow fluid called bile, which helps digest fats. The gall bladder stores bile made earlier. Bile flows along ducts from the liver and gall bladder, which join to form the common bile duct and enter the head of the pancreas. The common bile duct and pancreatic duct converge, then join the duodenum.

The composition of pancreatic juice

Pancreatic juice contains:

- water;
- enzymes that digest proteins (proteases), fat (pancreatic lipase) starch (amylase) and several other constituents of food;
- bicarbonate to neutralize the acid that arrives in the small intestine from the stomach. Cells lining the pancreatic duct add the bicarbonate, which acts as a natural antacid.

Islands in a pancreatic sea

Doctors recognized millennia ago that the urine of people with diabetes tasted sweet. However, the cause of the sweet taste remained a mystery. Nineteenth-century doctors discovered that many people who died from diabetes had damaged pancreases. Then, between 1867 and 1869, a German medical student called Paul Langerhans scrutinized the pancreas under a microscope. In a 'sea' of acinar cells, Langerhans saw small, pale 'islands'. But doctors still did not know what these 'Islets of Langerhans' did.[2]

Another piece of the jigsaw fell into place in 1889, when German researchers found that if they surgically removed a dog's pancreas, the unfortunate canine developed diabetes. However, when they tied the pancreatic duct, the dog experienced minor digestive problems but not diabetes. So, researchers realized that the pancreas controlled blood sugar levels.

We now know that the Islets of Langerhans produce hormones, including insulin and glucagon, which work together to maintain the proper level of sugar in the blood. Each of the million or so islets contain three major types of cell:

- Beta cells produce insulin and make up about 60–80 per cent of the islets. The term insulin comes from the Latin for island: insula.
- Alpha cells produce glucagon, which essentially has the opposite actions to insulin.
- Delta cells secrete the hormone somatostatin. This, in turn, controls the release of other hormones, including glucagon.

Pancreatic islets also produce several minor hormones. We won't consider somatostatin or these other hormones any further.

Cells from your big toe to your scalp need insulin to ensure they generate sufficient energy to survive. So, a dense network of blood vessels carries hormones secreted by the pancreas around the body. Indeed, while the Islets of Langerhans account for about 1–2 per cent of the weight of the pancreas, they receive around 10–15 per cent of the organ's blood flow.

Insulin

Insulin is one of the most important hormones released by the pancreas. It's so important that evolution ensured the protein differs little between mammals (see box opposite). Even dung beetles produce insulin. So why is insulin so important?

Proteins, amino acids and insulin

When you eat meat or another protein, your digestive system breaks protein into its building blocks – called amino acids. Humans use 20 different amino acids to build proteins as varied as the muscles in your heart, the nerves in your brain and the hairs on your head. The sequence of amino acids determines the size, shape and function of each protein.

Your body rearranges the amino acids in food into the proteins that your body needs. That's why you can convert a steak into your hair, nails, skin, blood and so on. Our bodies can make only about half of the 20 amino acids we need. We need to get the rest – the so-called essential amino acids – from food. Think of a protein as a tower of Lego bricks. Digestion pulls the tower apart into separate bricks. Your body rejoins the bricks to form a new tower with a different order, shape and size.

Insulin contains 51 amino acids (the bricks). Cow (bovine) insulin differs by three amino acids and pig (porcine) insulin by just one. The resemblance is so close that people with diabetes can control blood sugar levels by injecting insulin extracted from pigs, cows and even fish. A once widely used insulin contained 70 per cent beef insulin and 30 per cent pork insulin, for example. Nevertheless, pharmaceutical companies needed to process 8000 lbs of animal pancreases to extract 1 lb of insulin (3,600 kg to produce 1 kg).

Over the years, animal insulin saved countless lives. Today, people with diabetes tend to use genetically engineered insulin that exactly reproduces the human sequence. This is available in almost unlimited amounts and avoids any potential infections and other risks (such as triggering immune reactions) associated with proteins derived from animals. We'll look at therapeutic insulin again in Chapter 5.

Glucose from food

Next time you pick up a potato look at all that white flesh inside the skin. The potato plant stores energy as starch in the flesh, which it uses to support growth. And that's why potatoes became a staple food worldwide: they are packed with energy and nutrients. Indeed, we obtain most of our daily glucose from starchy carbohydrates such as rice, pasta, potatoes and bread as well as from the sugars in, for example, fruit and sweet foods. Digestion breaks starch and sugars into glucose. So, after we eat, blood glucose levels rise. But to what extent and for how long depends on whether we ate a baked potato or drank a bottle of sugary soft drink.

Blood glucose levels shoot up within a few minutes of swallowing a sugary drink. Some people find this provides a short-lived lift. However, they then report feeling a little tired and maybe a bit downcast as blood sugar levels fall. The body takes longer to convert starchy carbohydrates (such as in the baked potato) into sugars. This slow release of glucose helps smooth out the peaks and troughs in blood sugar. That's good news for everyone; it helps stop you snacking between meals and so controls weight, for example. And it helps people with diabetes avoid potentially dangerous declines in their blood sugar level – hypoglycaemic attacks (see page 38).

After you eat...

Your cells need glucose all day, not just after you eat. So, you have various stores around your body. Before a meal, your liver and, to a lesser extent, kidneys release glucose from their stores. When you wake in the morning, your liver has produced about 80 per cent of the glucose in your blood. Your kidneys have released the other 20 per cent. Indeed, when insulin levels are low, production of glucose from your liver and kidney can double.[3]

After a meal, levels of glucose in the blood rise rapidly, triggering beta cells to release insulin. In response, the amount of glucose released from the liver declines by almost 80 per cent. The sight and taste of food can also trigger insulin release, which helps your body prepare for the expected surge in glucose after a meal. Several other food molecules, such as amino acids and fats, can also stimulate insulin release.

Measuring blood glucose levels

Doctors can report blood glucose levels using several different units. In the UK, doctors usually use millimoles of glucose per litre of blood (mmol/l). Clinicians in the USA typically use milligrams (mg) of glucose per 100 ml (dl) of blood. A blood sugar level of 80 mg/dl is around 4.4 mmol/l. To convert mg/dl to mmol/l, multiply by 0.0555. To convert mmol/l to mg/dl, multiply by 18.0182.

Before a meal, the fasting blood glucose concentration (12–16 hours after you last ate) in a healthy person is around 4.4–5.0 mmol/l. At these levels of glucose, insulin secretion is very low. Blood glucose levels peak between 60 and 90 minutes after eating a meal and can reach around 9 mmol/l. Insulin secretion rises in parallel with the increasing blood glucose levels.

In healthy people blood glucose levels return to premeal concentrations after around 3 hours, and insulin secretion drops. Nevertheless, insulin controls sugar levels throughout the day. So, only about half the insulin released by the pancreas follows the spike in blood glucose levels after a meal. You slowly release the remaining insulin over the rest of the day.

Insulin's actions

Insulin stimulates cells to absorb enough glucose from the blood to make the energy needed to keep us alive and active. To do this, insulin binds to specific receptors on the surface of the muscle, fat and other cells.

When insulin binds to the receptor, special proteins called glucose transporters move from the inside of the cell to the membrane that surrounds each cell. The transporter picks up a molecule of glucose, which it carries to the inside of the cell. When blood levels of insulin fall, glucose transporters remain inside the cell waiting for the next meal. Meanwhile, cells switch to alternative energy sources, such as fat.

Some organs – of which the brain is the most important – do not store glucose, and its cells, unlike those of many other organs, can't effectively use fatty acids as a fuel (see below). So, the brain depends on a constant supply of glucose from your blood. And it's always hungry. Indeed, your brain uses around a quarter of all the glucose in your body.

So that the body can supply the brain and other vital organs with glucose during times of famine, insulin stimulates the liver to store some of the glucose in a meal. Most of the blood supply from your gut, which carries the nutrients you've ingested from your food, goes through the liver before reaching the rest of the body. Between 25 and 30 per cent of the glucose you absorbed from the food is removed from the blood on its way through the liver. The liver uses about 60 per cent of this glucose to fuel its activities and sticks the rest together into a long chain called glycogen. Muscles can also store glycogen, which holds the energy ready for future use – a bit like a biological battery.

The liver and muscle can store about 2,000 calories-worth of energy in a 70 kg person. A moderately active person needs about 35 calories a day for each kg of body weight to keep their weight stable. Sedentary people and those who exercise vigorously need about 29 and 40 calories, respectively, for each kg of body weight. In other words, glycogen stores are enough to keep an average woman going for a day.

The liver's storage capacity is limited. Once glycogen stores make up more than about 5 per cent of the weight of the liver, the body strongly suppresses glycogen production. But all that glucose in the diet is too valuable to waste. So, liver cells use the additional glucose to make fatty acids, which are released into the circulation and used by other tissues as a source of energy when there's not enough glucose.

To further bolster our energy reserves, insulin inhibits the breakdown of fat and encourages fat cells (adipocytes) to take up glucose. Fat cells use glucose to make another chemical called glycerol. Usually about 5 per cent of the glucose in a meal ends up as glycerol. Fat cells join glycerol with fatty acids to form a fat called triglyceride – yet another energy store. In a 70 kg adult the body stores around 100,000 calories as triglycerides, especially in layers of fat around the stomach. Unfortunately, high levels of triglycerides in the blood increase the risk of heart disease and pancreatitis (where the pancreas becomes inflamed [page 20]).

So many energy stores may seem superfluous – biological belt and braces – when we can just pop down to the supermarket. But people living in developed countries have been able to rely on secure food sources for a relatively short time. Previous generations endured times of feast and times of famine. The winters of even good years often proved tough. These diverse energy stores increased our ancestors' chances of survival when food was scarce.

Insulin has yet another action that helps us survive food shortages – to stimulate cells to take up amino acids. You can see its effects in people with anorexia – they seem little more than skin and bones. In particular they lack muscle. When insulin levels are low and we have depleted our other energy stores, cells start breaking down protein in our muscle. This releases amino acids into the bloodstream. The liver can convert some of these amino acids into glucose, a process called gluconeogenesis.

Glucagon: insulin's partner

Almost all biological actions have an opposite and equal reaction. This fundamental process (homeostasis) means that the vital biological mechanisms we rely on to remain healthy stay within relatively narrow limits.

For example, another hormone, glucagon, has the opposite effect to insulin and increases blood glucose levels. As blood levels of glucose rise, glucagon secretion declines. The interplay between insulin and glucagon determines and, in healthy people, tightly controls blood glucose concentrations. So, when blood glucose levels fall, glucagon secretion increases, which:

- triggers liver cells to break down glycogen stores, thus releasing glucose into the blood;
- activates gluconeogenesis, in which the liver converts other substances, such as certain amino acids, into glucose; and
- stimulates the breakdown of triglycerides into fatty acids. Most cells can use the released fatty acids as fuel, which helps conserve dwindling glucose levels for organs (such as the brain) that cannot use fatty acids.

Exercise also triggers glucagon release, at least in part because working out burns up glucose.

A healthy pancreas has around a million Islets of Langerhans. So, we can lose a relatively large proportion – often more than 90 per cent – of our beta cells before the pancreas produces insufficient insulin to control swings in blood glucose levels. Essentially, diabetes arises when insulin production is no longer adequate to tightly control blood glucose concentrations.

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