1 What is diabetes?

Diabetes is a permanent change in your internal chemistry, which results in your blood containing too much glucose. The cause is a deficiency of the hormone 'insulin'.

> "I just started feeling lousy, losing weight, always thirsty – it seemed like I could never get enough to drink. And there I was – diabetic! I thought my life was ruined. And then I said: 'No, dammit, this is the way I am now and I'd better learn to live with it, 'cos all of those feelings, the anger, the frustration aren't going to take it away.'"

> "One of the most difficult things I found that I had to come to terms with when you are newly diagnosed is that diabetes is for life."

Diabetes is one of the oldest known human diseases. Its full name, 'diabetes mellitus', comes from the Greek words for 'siphon' and 'sugar' and describes the most obvious symptom of uncontrolled diabetes: the passing of large amounts of urine, which is sweet because it contains sugar. A proper understanding of the condition has only developed over the last hundred years or so. In 1921, two Canadian scientists, Frederick Banting and Charles Best, discovered that a mysterious substance was produced in small groups of cells, known as the *islets of Langerhans*, within the pancreas. They named this substance 'insulin' (after the Latin name for 'islet' which is *insula*), and it was probably the most important discovery in the history of diabetes. When insulin became available as a treatment for diabetes after 1922, it was seen as a medical miracle, transforming the lives of many young people who would otherwise have died after a painful 'wasting' illness.

The cause of diabetes is a deficiency of the hormone 'insulin'. A hormone is a chemical messenger that is made in one part of the body (in this case the pancreas; see Figure 1) and has an effect on more distant parts when it is released into the bloodstream. In type 1 diabetes there may be complete failure of insulin production. In type 2 diabetes, however, there is usually a combination of a partial failure of

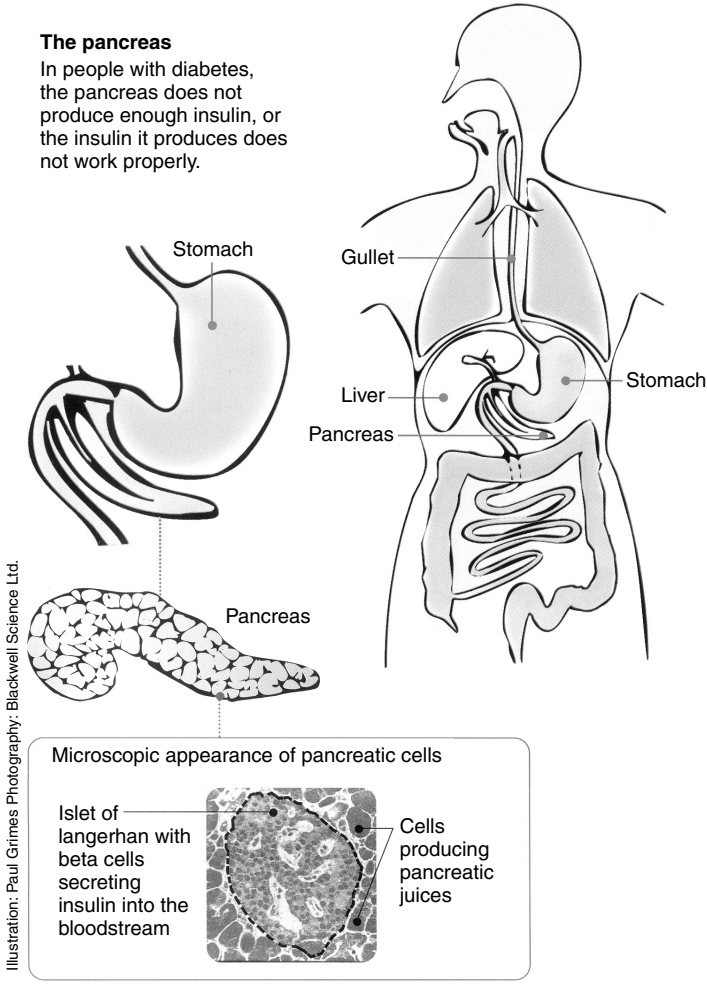

Figure 1. The pancreas. From *Understanding Diabetes: Your Key to Better Health*. Diabetes UK Publications

insulin production and a reduced body response to the hormone. This is known as *insulin resistance*. This chapter will discuss what diabetes is and what goes wrong with normal blood sugar regulation, the different types of diabetes, what causes it, what the main symptoms are, who gets it and how it is diagnosed.

What goes wrong?

The glucose in your blood comes from the digestion of food and the chemical changes made to it by the liver. Some glucose is stored and some is used for energy.

Insulin has a unique shape that plugs into special sockets or receptors on the surface of cells throughout the body, and by plugging into these receptors, insulin not only makes cells extract glucose from the blood but also prevents them from breaking down proteins and fat. It is the only hormone that can reduce blood glucose, and it does this in several ways:

- By increasing the amount stored in the liver in the form of glycogen.
- By preventing the liver from releasing too much glucose.
- By encouraging cells elsewhere in the body to take up glucose.

Other mechanisms in the body work in conjunction with insulin to help to maintain the correct level of blood glucose. However, insulin is the only means available to the body of actually lowering blood glucose levels, and when the insulin supply fails, the whole system goes out of balance. After a meal, there is no brake on the glucose absorbed from what you have eaten, so the level of sugar in your blood continues to rise. When the concentration rises above a certain level, the glucose starts to spill out of the bloodstream into the urine. Infections such as cystitis and thrush can develop more easily when the urine is sweet as the germs responsible can grow more rapidly.

Another consequence of rising blood glucose is a tendency to pass more urine. This is because the extra glucose in the blood is filtered out by the kidneys, which try to dispose of it by excreting more salt and water. This excess urine production is known as *polyuria* and is often the earliest sign of diabetes. If nothing is done to halt this process, the person will quickly become dehydrated and thirsty. As previously mentioned, as well as regulating blood glucose, insulin acts to prevent weight loss and helps to build up body tissue – so a person whose supply has failed or is not working properly will inevitably lose some weight.

Symptoms

The severity of the symptoms and the rate at which they develop may differ, depending on the type of diabetes.

Type 1 (IDDM: Insulin-dependent diabetes mellitus)

This type starts most commonly in younger people who have to have regular injections of insulin to remain well. As the person is not producing any insulin, the symptoms can come on very rapidly as blood glucose control is lost. Insulin has a very important role in maintaining stability in the body by preventing breakdown of proteins (found in muscle) and fats. When insulin fails, the by-products of the

breakdown of fat and muscle build up in the blood and lead to the production of substances called *ketones*. If nothing is done to stop this, the level will rise until eventually it causes the person to go into what's known as a *ketoacidotic coma*. This is much less common these days as diabetes is usually diagnosed long before coma develops. However, when it occurs patients need urgent hospital treatment with insulin and fluids into a vein. This is not the same thing as a coma induced by low blood sugar (or hypoglycaemia) – see page 12.

Type 2 (NIDDM: Non-insulin-dependent diabetes mellitus)

Type 2 diabetes, also sometimes known as age-related or maturity onset diabetes, is more common in middle or later life and can be controlled by tablets or just by dietary modification. As the supply of insulin is reduced or is not quite as effective as normal, the blood glucose level rises more slowly. There is less protein and fat breakdown so ketones are produced in much smaller quantities and the risk of a ketoacidotic coma is low.

Box 1. Main symptoms of diabetes.

- Increased thirst.
- Dehydration.
- Passing large amounts of urine, especially at night.
- Weight loss.
- Extreme tiredness and lethargy.
- Genital itching or regular episodes of thrush.
- Blurred vision.

Who gets it?

Around 2 per cent of people in this country have diabetes, although as many as half of them may not realise it. The vast majority have type 2 diabetes, which affects more men than women. As the age of the population as a whole is rising, type 2 diabetes is likely to become even more common during the coming years. Among schoolchildren, about 2 in 1000 have diabetes.

The prevalence of diabetes is much greater in ethnic minorities, so that, for example, more than 16 per cent of Asians in the UK may be affected.

What causes diabetes?

There are several known reasons why insulin secretion may be reduced, and any individual might be affected by one or more of them. There are many other explanations that people believe, but they are not based upon scientific evidence.

Genetic factors

Researchers studying identical twins and the family trees of patients with diabetes have found that heredity is an important factor in both kinds of diabetes. With type 1 diabetes, there is about a 50 per cent chance of the second twin developing the condition if the first one has it, and a 5 per cent chance of the child of an affected parent doing so. With type 2 diabetes, it is virtually certain that if one of a pair of identical twins develops the condition, the other will also do so.

It is difficult to predict precisely who will inherit the condition. A small number of families have a much stronger tendency to develop diabetes and scientists have identified several genes that seem to be involved. In these circumstances, it may be possible to test family members and determine their risk of developing the condition.

For the most part, however, it is difficult to identify the genes involved and this makes it different from some other conditions such as cystic fibrosis, where a single gene is operating. So even if a close member of your family has diabetes, there is no certainty that other members of the family will develop it, or if you have it, it does not follow that your children will develop it. Some people who inherit a tendency to diabetes never actually contract the condition, so there are obviously other factors at work.

Infection

It has been known for some time that the onset of type 1 diabetes in children and young people is more likely to occur at certain times of the year when lots of coughs and colds are circulating. Some viruses, such as mumps and Coxsackie, are known to have the potential to damage the pancreas, bringing on diabetes. As far as individual patients are concerned, however, it is very rare that doctors can link the onset of their diabetes with a specific bout of infection. A possible explanation for this is that the infection may have begun a process that only comes to light many years later.

Environmental factors

People who develop type 2 diabetes are often overweight and eat an unbalanced diet. It is interesting to note that people who move from a country with a low risk

of diabetes to one where there is a higher risk have the same chance of developing the condition as the locals in their new country. Dramatic changes in lifestyle can also make it more likely that a person will succumb to diabetes.

A good example of this is shown by the Pacific Islanders of Nauru who became very wealthy when phosphates were discovered on their island. As a consequence, their diets changed dramatically, they put on a lot of weight, and became much more prone to developing diabetes.

All this points to important connections between diet, environment and diabetes. However, there is no precise link between developing diabetes and the individual consumption of sugar and sweets.

Secondary diabetes

There are a small number of people who develop diabetes as a result of other diseases of the pancreas. For example, pancreatitis (or inflammation of the pancreas) can bring on the condition by destroying large parts of the gland. Some people suffering from hormonal diseases, such as Cushing's syndrome (the body makes too much steroid hormone) or acromegaly (the body makes too much growth hormone), may also have diabetes as a side-effect of their main illness. It can also be a result of damage to the pancreas caused by chronic over-indulgence in alcohol.

Stress

Although many people relate the onset of their diabetes to a stressful event such as an accident or other illness, it is difficult to prove a direct link between stress and diabetes. The explanation may lie in the fact that people see their doctors because of some stressful event, and their diabetes is diagnosed opportunistically at the same time.

How is diabetes diagnosed?

> "It really scared me. My uncle had diabetes and he died when he was 40..."

> "Finding out I had diabetes was a complete shock. There were times in the beginning when I panicked and thought I would never be able to cope ..."

Diabetes may or may not be accompanied by obvious symptoms. In some cases, a number of symptoms become apparent very rapidly and are impossible to

ignore. For example, when a person complains of going to the loo excessively, a continuous thirst and sudden weight loss, the doctor should immediately suspect diabetes. This, however, is not always the case. Some people who have diabetes do not even suspect it, because they haven't experienced any of the 'obvious' symptoms. In such cases, diabetes is discovered 'by accident' during a routine examination.

The only certain way to determine that a person has diabetes is to have the doctor measure that person's blood sugar levels. This can be done through one of several different blood tests. Some tests require that nothing should be eaten for some hours beforehand, and are usually done in the morning; some tests can be done at any time of the day, even if a meal has been taken. If the blood sugar levels are too high, it's possible that diabetes is the cause. However, the doctor may repeat a blood glucose test or take a different test to confirm a definite diagnosis.

How are blood glucose levels measured?

The amount of sugar concentrated in the blood is measured in units called milligrams of glucose per 100 millilitres of blood. The normal 'fasting' level of sugar in the blood – usually before breakfast or after another length of time when no calories are taken in by eating – ranges from 60 to 115 mg/dl in a person who does not have diabetes. After eating, the concentration of blood sugar increases, although it usually does not rise above 180 mg/dl in a healthy person. Over a period of 2 to 4 hours, blood sugar returns to the body's normal baseline. There is no such thing as a constant blood sugar level; it is normal for the concentration of glucose in the blood to vary. However, the variations that occur in people without diabetes are not as marked as the variations in people with diabetes.

What blood tests are used to diagnose diabetes?

Diagnostic tests are used to confirm a diagnosis of diabetes if there are symptoms or other indicators of the disease. For diagnostic tests, the doctor draws one or more samples of blood and sends them to a laboratory for analysis. Diagnostic tests vary according to cost, accuracy, and ease of administration.

There are a number of different types of blood tests that can be used to diagnose diabetes.

- The *fasting plasma glucose test* (FPG) is given after the patient has fasted for at least 8 hours, usually overnight. 'Fasting' means not taking in any foods or

drinks that contain calories. A blood sample is taken in a laboratory or in the doctor's office to measure blood glucose levels.

- The *random plasma glucose test* – for which the patient does not have to fast – measures blood glucose levels at any given time. This is the simplest test for diabetes because it can be administered whether or not the person has had anything to eat or drink.
- The *oral glucose tolerance test* (OGTT) – which requires fasting and is administered after the patient has ingested a special glucose-containing solution – measures blood glucose levels five times over a period of 3 hours. First, an initial blood sugar is drawn to measure fasting plasma glucose levels, and the person being tested is then given 75 grams of glucose (or 100 grams for pregnant women) in a sweet-tasting solution. Blood sugar levels are measured at 30 minutes and at 1, 2, and 3 hours after the solution is given. In a person who does not have diabetes, blood sugar levels rise after drinking the glucose solution but quickly fall back to normal as insulin enables body cells to absorb glucose from the bloodstream. In a person with diabetes, on the other hand, glucose levels rise higher than normal and take a much longer time to decrease.
- In addition, the *glucose challenge test* is used to determine if a woman has diabetes in pregnancy (known as 'gestational diabetes'). It is given between the twenty-fourth and twenty-eighth weeks of pregnancy. The woman being tested is given a glucose solution to drink, and her blood glucose level is measured 1 hour later. An OGTT is usually required to make a definite diagnosis.

Summary

- Diabetes develops when an individual cannot make enough insulin or the insulin that he or she does make is either insufficient or is ineffective at controlling blood glucose levels.
- Insulin is a hormone (chemical messenger) that is critical for maintaining a healthy life.
- Symptoms of diabetes are weight loss, passing large amounts of urine, thirst and feeling run down.
- There are several causes including genetic predisposition, infections, environmental factors and stress, and any or all of these may be important in each individual case.

- Around 2 per cent of people in this country have diabetes, the vast majority of whom have type 2 diabetes.
- The prevalence of diabetes is much higher in people of Asian or African-Caribbean origin.
- The only certain way to determine if a person has diabetes is to have his or her blood sugar levels measured by a doctor.