

A level Diabetes case study

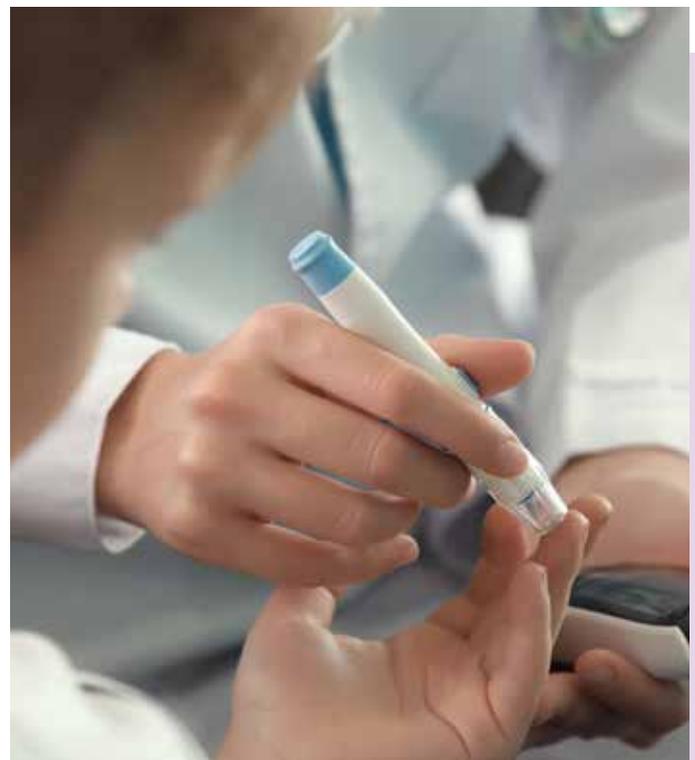
Heinrich is 6 years old. His mother has taken him to the GP as he has experienced weight loss, tingling in his hands and feet and muscle cramps. The GP suspects Heinrich may have diabetes, so further blood tests are carried out and the results are as follows:

Test	Heinrich's Results	Healthy levels
Fasting venous plasma glucose levels	8.1 mmol/l	≤ 7 mmol/l
Oral glucose tolerance test	11.7 mmol/l	≤ 11.1 mmol/l
HbA1c blood levels*	51.1 mmol/mol	≤ 48 mmol/mol

Based on these results and the symptoms described, Heinrich was diagnosed with type 1 diabetes.

Tasks:

- Describe the causes of Heinrich's diabetes and compare it with the causes of type 2 diabetes.
- Discuss the treatment options available for Heinrich and other sufferers of type 1 diabetes.
- Type 1 diabetes is far less common than type 2, type 2 accounts for approximately 90% of all diabetes in the UK¹. Describe how the symptoms of type 2 diabetes might be controlled or improved.
- Discuss how Heinrich and other diabetics monitor glucose levels and outline the importance of monitoring this.
- Insulin is not the only hormone that can affect blood glucose levels – briefly discuss two other key hormones that will influence Heinrich's blood glucose levels.



* HbA1c refers to glycated haemoglobin, glucose in the blood naturally attaches to haemoglobin. The higher the level of HbA1c, the higher the level of glucose in the blood.

¹ <https://www.diabetes.org.uk/diabetes-the-basics/differences-between-type-1-and-type-2-diabetes>

Answers:

- Despite the similarities in symptoms of type 1 and type 2 diabetes, the underlying causes are very different. Heinrich has type 1 diabetes, which is characterised as an autoimmune disease that targets the β cells in the islets of Langerhans. This results in inflammation and cell destruction. However, in type 2 diabetes, there is no autoimmune response. Type 2 diabetes is caused by either an inadequate amount of insulin being produced, or insulin is produced but the receptor cells are unable to recognise and respond to it.
- Heinrich will be treated with the hormone insulin. This would have originally been in the form of cow or pig insulin, but Heinrich would be prescribed human insulin, which is produced in *Escherichia coli*. There are two classes of insulin; rapid acting and long acting. Long acting insulin is the preferred type as this is only required once every 24 hours.
- As type 2 diabetes is caused by a reduced response to insulin by specialised insulin receptors on the cell membrane, treating with insulin may help by increasing the amount of insulin present. However, the best way to control the symptoms of type 2 diabetes is to eat a healthier diet and take more exercise – reducing BMI is the most effective way of improving the symptoms of type 2 diabetes. Sometimes additional treatment may be required, there are medications that can improve sensitivity of cells to insulin.
- Heinrich and other individuals with diabetes have to monitor their blood glucose levels regularly. One way this can be done is by using a traditional home blood glucose monitoring kit. Alternatively, a continuous glucose monitoring system (CGMS), implanted under the skin of the abdomen, can be used. The advantage of the CGMS is that it takes continuous readings, making it more accurate than the home kit. It is important to monitor the levels of glucose in the blood because if the levels drop too low then an individual may lose consciousness as a result of hypoglycemia. Hypoglycemia can be a problem if the amount of insulin administered is not correct, resulting in the depletion of glucose from the blood. This is particularly detrimental to the brain, as the brain can only metabolise glucose and is unable to use other stores of energy. If the brain is unable to get enough energy it will start to shut down, resulting in loss of consciousness. On the other hand, if the levels of glucose are too high then it is known as hyperglycemia. Hyperglycemia results in increased frequency of urination, this results in dehydration and in severe cases coma.
- The two other key hormones that influence blood glucose levels are glucagon and adrenaline. Glucagon is a protein hormone released from the α cells of the pancreas; it is produced when the levels of glucose in the blood are too low. Glucagon is responsible for returning the blood glucose levels to optimum by activating enzymes involved in glycogenesis and gluconeogenesis. Adrenaline is a steroid hormone released by the adrenal glands and is important for increasing blood glucose levels. Adrenaline works by binding adrenergic receptor which activate adenyl cyclase which converts ATP into cyclic AMP (cAMP). cAMP then activates protein kinases which are involved in converting glycogen into glucose, the glucose is then released into the blood stream.

GCSE

diabetes worksheet

1) Answer the following:

a) What is the definition of a hormone?

b) What is the primary function of glucose in the body?

c) What is the primary hormone associated with diabetes?

d) What is glycogen?

2) Outline how the hormone from question 1c regulates blood glucose levels.

3) Diabetes is a disease that occurs when blood glucose levels are not regulated correctly, outline the causes of the two different types of diabetes.

4) Describe how the two types of diabetes might be treated.

Answers:

- 1)
 - a) A hormone is a chemical substance, produced by a gland and carried by the blood which alters the activity of specific target organs.
 - b) Glucose is used for cellular respiration (the conversion of glucose and oxygen into carbon dioxide and water in order to release energy).
 - c) Insulin
 - d) Glycogen is made up of many connected glucose molecules and is used by animals as a store of glucose.
- 2) If the levels of blood glucose are too high, then the pancreas secretes insulin into the blood. In the liver and the muscle cells the excess glucose is converted into glycogen reducing the blood glucose level to normal. If the blood glucose is too low, then no insulin is secreted, and glucose is not converted into glycogen.
- 3) Type 1 diabetes is a disorder where the pancreas fails to produce enough insulin leading to increased blood glucose levels. Type 2 diabetes is a disorder where the cells of the body no longer respond to insulin – resulting in increased blood glucose levels.
- 4) The main treatment for type 1 diabetes is to inject insulin. A carefully controlled carbohydrate intake is also recommended. For type 2 diabetes there is a link between obesity and the disease. The best way to manage type 2 diabetes is to eat a carbohydrate-controlled diet and to implement an exercise regime.

Key Stage 3 diabetes activity

Diabetes is a disease where the body is unable to use the _____ that it has absorbed into the blood after a meal. When the body is working properly, it takes the sugar from the _____ and uses it for _____, providing the body with energy. When we eat a big meal, our body makes a molecule called _____.

This is very important as it tells the body that we have just eaten a big meal so there will be lots of sugar in the blood. It can be _____ to have lots of sugar in the blood, it is required in the rest of the body where it can be used for _____.

So, when insulin is made it tells parts of the body, like the _____, to take up the sugar from the blood and store it or use it for _____.

When the body stops working properly and someone develops _____, there are two main problems; either the body no longer makes the molecule _____, or the body stops _____ it. In both cases, the sugar stays in the blood and can't be used or stored, this results in tiredness, _____ and weight loss.

There are two ways diabetes can be managed, if the body can no longer make _____ then it can be _____, and this will work the same as if the body had made it itself.

Or if the body stops recognising insulin then this is probably because of poor diet and a generally _____ lifestyle. The best way to manage this is by eating more _____ and doing _____ exercise.

Fill in the missing spaces using the words in the table below. These words could be used multiple times or not at all.

injected	healthy	sleepiness	recognising	unhealthy
less	good	insulin	respiration	sugar
bad	blood	more	muscles	diabetes

Answers:

Diabetes is a disease where the body is unable to use the **sugar** that it has absorbed into the blood after a meal. When the body is working properly, it takes the sugar from the **blood** and uses it for **respiration**, providing the body with energy. When we eat a big meal, our body makes a molecule called **insulin**.

This is very important as it tells the body that we have just eaten a big meal so there will be lots of sugar in the blood. It can be **bad** to have lots of sugar in the blood, it is required in the rest of the body where it can be used for **respiration**. So, when insulin is made it tells parts of the body, like the **muscles**, to take up the sugar from the blood and store it or use it for **respiration**.

When the body stops working properly and someone develops **diabetes** there are two main problems; either the body no longer makes the molecule **insulin**, or the body stops **recognising** it. In both cases the sugar stays in the blood and can't be used or stored, this results in tiredness, **sleepiness** and weight loss.

There are two ways diabetes can be treated, if the body can no longer make **insulin** then it can be **injected**, and this will work the same as if the body had made it itself. Or if the body stops recognising insulin then this is probably because of poor diet and a generally **unhealthy** lifestyle. The best way to treat this is by eating more **healthily** and doing **more** exercise.