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LEVEL 2 CAMBRIDGE NATIONAL IN SCIENCE

R072/02/RB How scientific ideas have developed

PRE-RELEASE RESOURCE BOOKLET

JANUARY 2014

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INSTRUCTIONS TO CANDIDATES

- This Pre-release Resource Booklet contains the article required to answer Question 1.
- Take this booklet away and read it through carefully.
- Spend some time looking up any technical terms or phrases you do not understand.
- For the examination on **8 January 2014** you will be given a fresh copy of this booklet, together with a question paper.
- You will **not** be able to take your original copy into the examination with you.

INFORMATION FOR CANDIDATES

- This document consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

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Insulin as a treatment for diabetes

One hundred years ago, before the discovery of insulin, diabetes usually caused an early death. Doctors knew that sugar made patients with diabetes worse. The most effective treatment was to put the patients on a very strict diet. This treatment could mean that patients with diabetes survived for a few extra years, but it never made them well. Some patients even died of starvation because of the strict diet.

Figure 1 shows how the average blood glucose concentration changes over 24 hours for two groups of people. One group has diabetes, the other group does not.

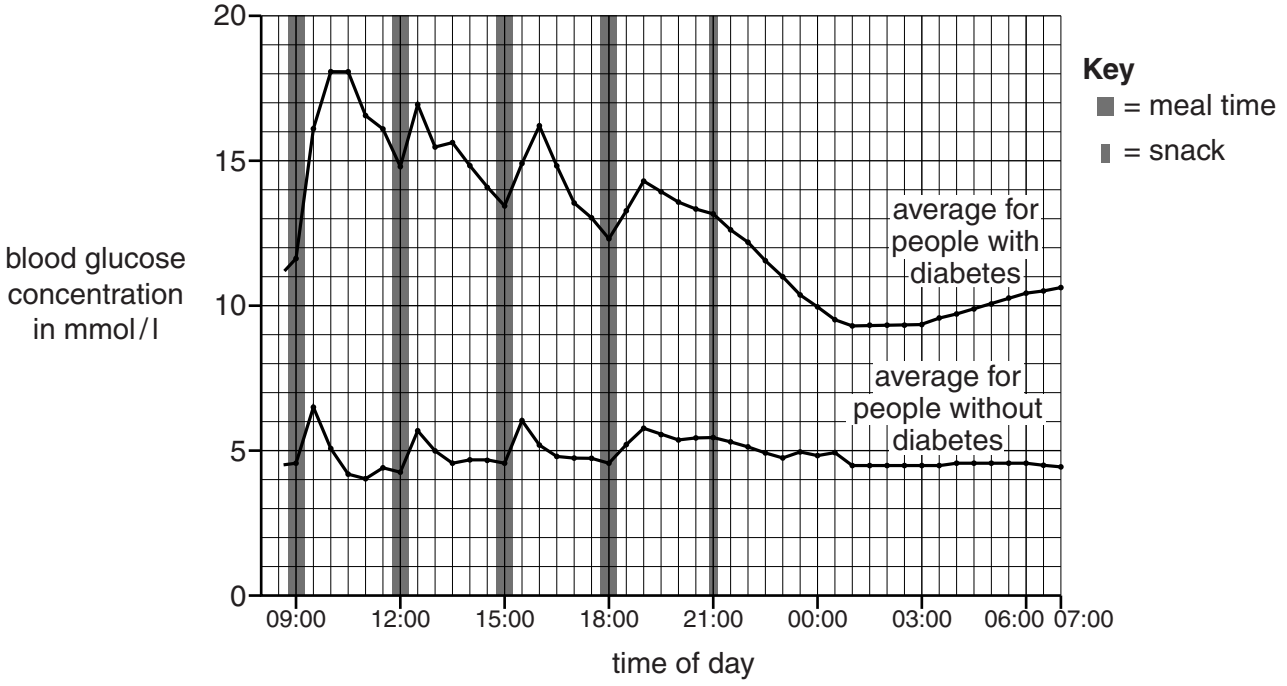

Figure 1

It is recommended that the blood glucose concentration just before a meal should be about 4 mmol/l. Two hours after a meal, it should be no higher than 8 mmol/l. When the concentration is above 33 mmol/l, the person is likely to get severely dehydrated and may become unconscious.

Figure 2 shows the percentage of people who have been diagnosed with diabetes at different ages.

Age in years	Diabetic men (%)	Diabetic women (%)
16–34	1.8	2.1
35–54	9.4	6.6
55–64	11.1	8.0
65–74	15.2	12.2
75+	15.9	13.2

Figure 2

Developing a treatment for diabetes

In 1920, Dr Frederick Banting thought that a chemical from the pancreas might be linked to diabetes. He worked with Charles Best. They began their experiments by removing the pancreas from a dog. This dog became ill.

- The dog's blood glucose concentration rose.
- It became thirsty and drank lots of water.
- It urinated more often.
- It became weaker and weaker.

The dog had developed diabetes.

Banting and Best then took a 'pancreatic extract' from a healthy dog. The extract was injected into the dog with diabetes. If the dog had several injections a day, it stayed healthy and free of symptoms. The extract contained insulin. They had discovered how to control diabetes, but not how to cure it. Later, they found that they could obtain the extract from a cow which had just been slaughtered. This provided enough insulin to keep several dogs with diabetes healthy.

In January 1922, a 14-year-old boy, Leonard Thompson, was chosen as the first person with diabetes to receive insulin. He had been near to death before being given the insulin injection but he rapidly regained his strength and appetite, so the treatment was a success. The team now expanded their testing to other volunteers with diabetes, who mostly reacted just as well to the insulin extract.

Many patients were safely treated with insulin extracted from cows (bovine insulin). This could help keep their blood glucose concentration close to the normal range. Bovine insulin is a protein which is almost identical to human insulin. A few people produced antibodies to bovine insulin, which prevented it working properly. Some people were also concerned about possible long term complications from the regular injection of a foreign substance.

At this time, scientists did not understand that insulin is a protein made from 51 amino acids. We now know that human DNA includes a gene which codes for the insulin protein.

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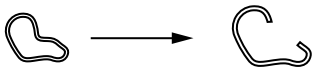
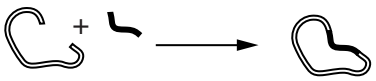
Genetic engineering of human insulin

Figure 3 shows the steps involved in using bacteria to make human insulin.

Step 1:
Bacteria contain a circular piece of DNA called a plasmid. In 1975, researchers used an enzyme to cut into this plasmid from a common bacterium.



Step 2:
They could then insert a copy of the code for human insulin. Rejoining (recombining) the DNA chain means that the plasmid can be put back into the bacterium.



Step 3:
The bacterium has been genetically modified so that it produces proteins exactly like human insulin. In the right conditions, the bacterium grows quickly and multiplies, making lots of human insulin.

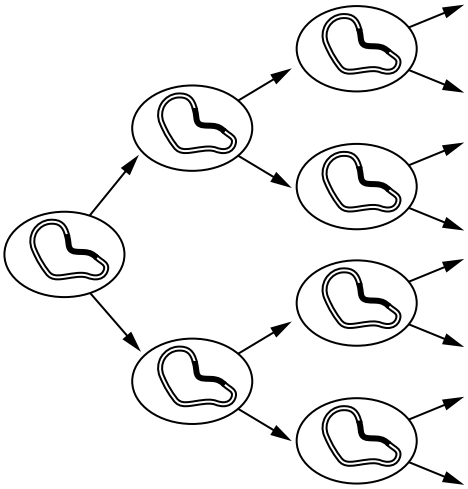


Figure 3