1 There are different types of white blood cell in the body. One type is called CD4+ T-Helper cells.

The normal range of these cells in the blood is between 5×10^8 and 1.2×10^9 cells/dm^3

An AIDS patient has a CD4+ T-Helper cell count of 1.5×10^8 cells/dm^3

(a) Explain why the CD4+ count of 1.5×10^8 cells/dm^3 has led to the diagnosis of AIDS.

(2)

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*(b) Some sexually transmitted infections (STIs) can be diagnosed by testing urine samples.

These tests use monoclonal antibodies that bind to an antigen on the pathogen.

Describe how a monoclonal antibody can be developed and used to detect an STI using a urine sample.

(6)

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(c) The antigens on pathogens can be proteins with a specific amino acid sequence.

Explain how the order of amino acids in a protein is determined by the sequence of the gene.

(4)

(Total for Question 1 = 12 marks)

2 A diabetic athlete is advised to estimate the number of grams of carbohydrate in his meals in order to calculate the number of units of insulin he will need to inject to lower his blood glucose concentration.

Each unit of insulin he injects reduces his blood glucose concentration by $1.5\,\text{mmol}\,\text{dm}^{-3}$.

He needs to inject 1 unit for every 10 grams of carbohydrate he consumes.

Figure 12 shows the estimated carbohydrates in the breakfast eaten by the athlete.

food consumed	estimated carbohydrate /grams
orange juice	25
2 slices brown toast	68
350 grams baked beans	38
tea with sugar	25

Figure 12

(a) (i) Calculate how many units of insulin the athlete would need to inject to control the rise in blood glucose levels.

Give your answer to two significant figures.

(2)

..... units of insulin

(ii) The athlete miscalculated his carbohydrate intake to be greater than his actual intake.

Explain how the increase in the number of units injected would affect his blood glucose concentrations.

(2)

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(b) (i) A patient visits his doctor because he is putting on weight but does not think he is increasing his calorie intake.

The patient has a height of 1.9 m and a body mass of 120 kg.

What is his BMI?

(1)

☒ **A** 0.0083

☒ **B** 33.2

☒ **C** 0.016

☒ **D** 66.4

The doctor diagnosed this person with an underactive thyroid gland.

*(ii) Explain why an underactive thyroid could cause this patient to have an increased body mass.

(6)

(Total for Question 2 = 11 marks)

3 Humans regulate the glucose concentration of their blood.

A scientist recorded the blood glucose concentration of an individual over a seven-hour period.

The results are shown in the table.

time of day	blood glucose concentration / mg per 100 cm^3
06.00	76
07.00	77
08.00	124
09.00	91
10.00	83
11.00	81
12.00	79
13.00	130

(a) (i) Describe the trend in blood glucose concentration for this seven-hour period.

(2)

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(ii) Suggest reasons for the changes in blood glucose concentration.

(2)

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(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.

Excess blood glucose is converted into

(1)

☐ **A** glucagon in the liver

☐ **B** glucagon in the pancreas

☐ **C** glycogen in the liver

☐ **D** glycogen in the pancreas

(b) (i) Scientists have discovered that a high body mass index (BMI) is a risk factor that may cause Type 2 diabetes.

Calculate the BMI for a female who has a mass of 67.5 kg and a height of 1.50 m.

$$\text{BMI} = \frac{\text{mass in kg}}{(\text{height in metres})^2}$$

(2)

answer = ...

(ii) Explain how a Type 2 diabetic can regulate their blood glucose concentration.

(3)

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(Total for Question 3 = 10 marks)

4 (a) Athlete's foot fungus is a pathogen.

(i) Describe how athlete's foot fungus is spread.

(1)

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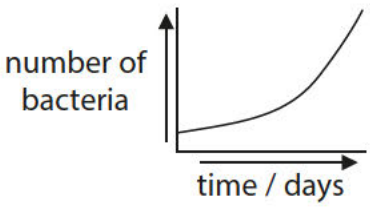
(ii) State the type of medication that can be used to treat this pathogen.

(1)

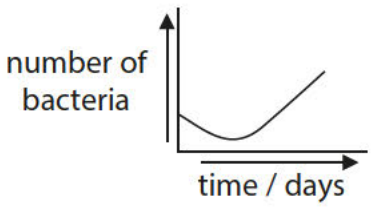
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(b) The graphs show the effect of three different antibiotics on bacterial growth.

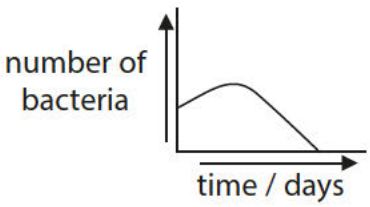
antibiotic A added



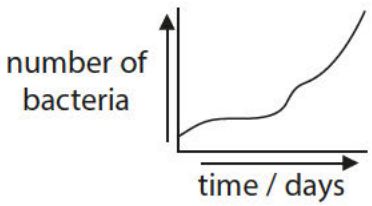
antibiotic B added



antibiotic C added



no antibiotic added



(i) Which of these is most effective at reducing the number of bacteria?

Put a cross (☒) in the box next to your answer.

(1)

☐ **A** antibiotic A

☐ **B** antibiotic B

☐ **C** antibiotic C

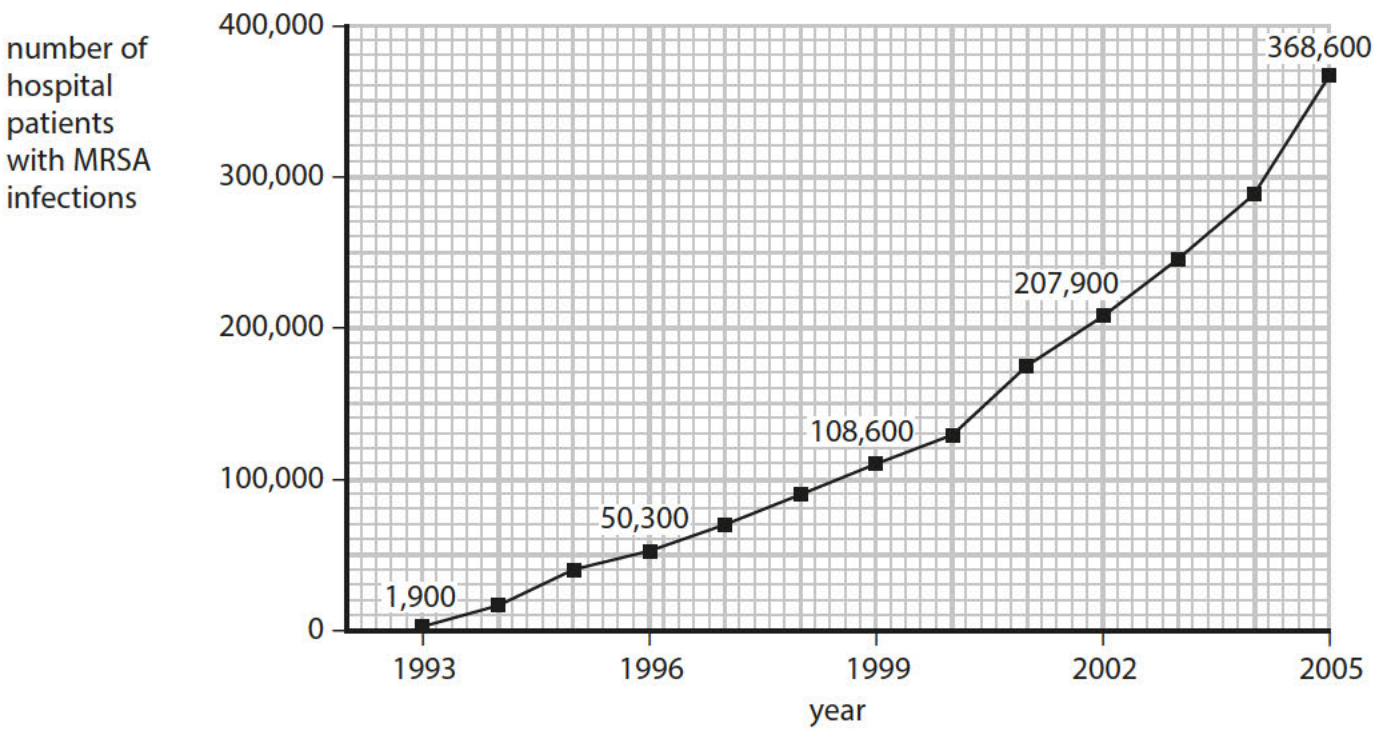
☐ **D** no antibiotic

(ii) Explain how chemical defence mechanisms in the body reduce the chance of infection.

(3)

*(c) MRSA is a bacterial infection.

The graph shows the number of cases of hospital patients with MRSA infections from 1993 to 2005.



Explain the trend in the graph, even though the patients were treated with antibiotics.

(6)

(Total for Question 4 = 12 marks)