Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

A-level
BIOLOGY

Paper 3

Wednesday 18 June 2025 Morning Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A**.
- Answer **one** question from **Section B**.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 78.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
TOTAL	

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ANSWER IN THE SPACES PROVIDED

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Section A

Answer **all** questions in this section.

You are advised to spend no more than 1 hour and 15 minutes on this section.

0 1 . 1 Describe binary fission in bacteria.

[3 marks]

Question 1 continues on the next page

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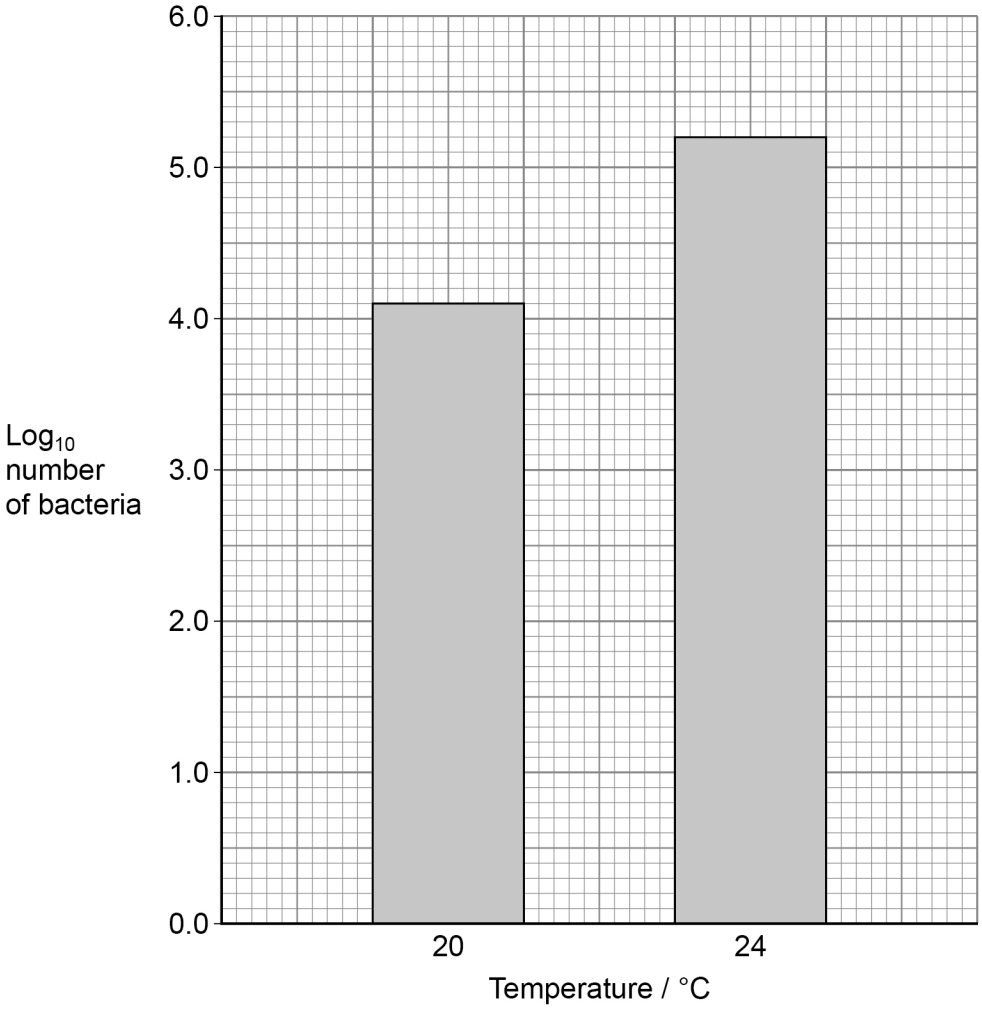
0 1 . 2 Microbiologists investigated the effect of two temperatures on the population growth of a species of bacterium.

They grew separate bacterial cultures in identical nutrient media at 20 °C and 24 °C for 8 hours.

Figure 1 shows the estimated final population size of each culture.

Figure 1



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The bacterial population at 24 °C is larger than that at 20 °C

Calculate this difference as a percentage increase.

The actual number of bacteria can be calculated from the $\log_{10}$ value by using the 10^x button on your calculator.

Give your answer to the nearest whole number.

Show your working.

[2 marks]

Percentage increase = _____

0 1 . 3 Bedaquiline is a drug that inhibits ATP synthase in mycobacteria by stopping hydrogen ion (proton) movement.

Explain how bedaquiline can kill these bacteria.

[3 marks]

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8

Turn over ►

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0 2 . 1 **Table 1** shows four statements and the names of four parts of a nephron.

Put a tick (✓) in each box where the statement is true for that part of the nephron.

[2 marks]

Table 1

Statement	**Part of the nephron**			
	Glomerulus	Proximal convoluted tubule	Distal convoluted tubule	Collecting duct
ADH receptors are present				
Water can be absorbed from the filtrate				
Blood is under high pressure				
Glucose is absorbed from the filtrate				

0 2 . 2 Protein is **not** normally present in the urine of a person.

Explain why.

[2 marks]

Do not write outside the box

0 2 . 3 Glomerular sclerosis (GS) is a type of kidney damage that can cause protein to be present in the urine.

High-protein diets are linked to GS in adults.

Scientists investigated the development of GS in underweight, 5-day-old rats.

They fed:

- 14 rats a high-protein milk diet
- 14 rats a normal-protein milk diet.

From day 21, they fed both groups of rats the **same** diet of solid food. At 160 days old, they examined nephrons in the rats' kidneys for GS.

They identified the number of nephrons with GS for each group of rats.

Rats fed a high-protein diet had a larger number of nephrons with GS than rats fed a normal-protein diet. The scientists performed a statistical test on these data and they calculated $P < 0.01$

A journalist reported on this investigation and stated 'feeding high-protein milk to underweight human babies could cause kidney damage in adults'.

Use all of the information provided to evaluate this statement.

[5 marks]

9

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0 3 Tansy, *Tanacetum vulgare*, is a plant that grows in dense patches. The tansy beetle, *Chrysolina graminis*, feeds on, and completes its life cycle on *T. vulgare.*

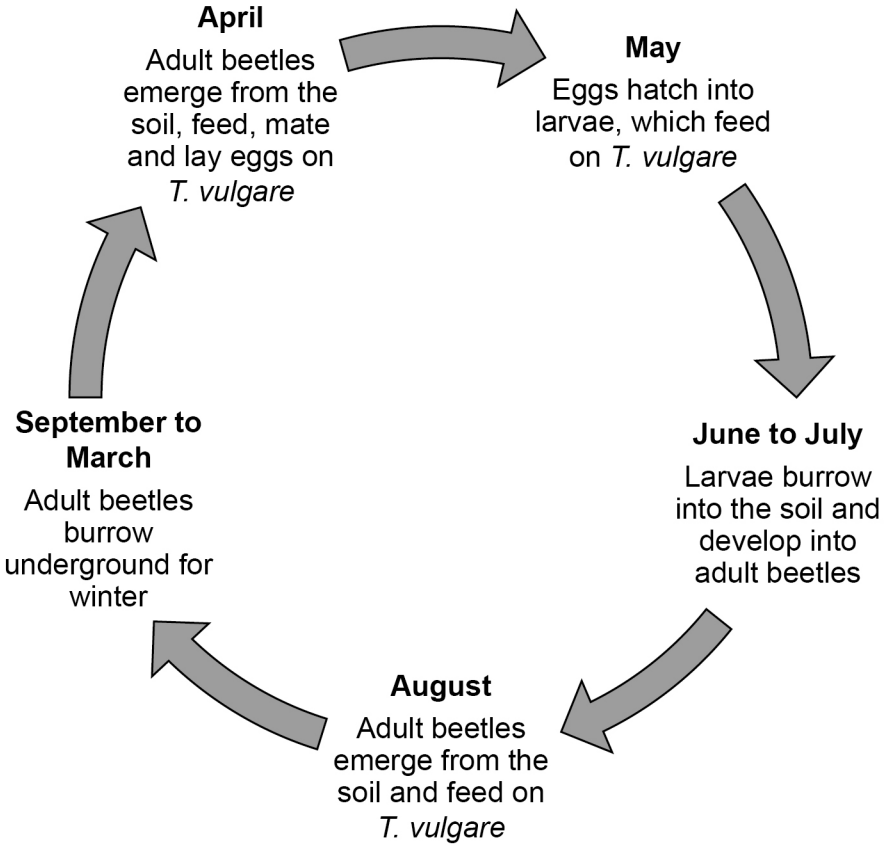
C. graminis is 8–10 mm long and green in colour.

Two other green beetles can also be found in the same habitat.

- The dock beetle, *Gastrophysa viridula,* which is 4–7 mm long.
- The mint leaf beetle, *Chrysolina herbacea,* which is 6–10 mm long.

Figure 2 shows the life cycle of *C. graminis*.

Figure 2



0 3 . 1 How many different genera of beetles are there in the information provided?

[1 mark]

_____

Question 3 continues on the next page

Do not write outside the box

Ecologists investigated the population size of *C. graminis* using the mark-release-recapture method.

Table 2 shows the ecologists' results.

Table 2

Number of *C. graminis* captured and marked in first sample	Number of unmarked *C. graminis* captured in the second sample	Number of marked *C. graminis* captured in the second sample
405	248	124

0 3 . 2 The ecologists captured and marked the first sample of beetles during the second week of August. They identified the species of beetle before marking them.

Use the information provided to suggest:

[3 marks]

two reasons why the first sample of beetles was captured during the second week of August

1 _____

_____

_____

2 _____

_____

_____

one reason why the beetles had to be identified before being marked.

1 _____

_____

_____

Do not write outside the box

0 3 . 3 Use the data provided in **Table 2** to estimate the population size of *C. graminis*.

Show your working.

[2 marks]

Answer = _____ beetles

0 3 . 4 The ecologists repeated the investigation over a five–year period to monitor the population size of *C. graminis*.

State **two** precautions they would have taken each year to obtain comparable data.

[2 marks]

1 _____

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2 _____

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8

Turn over for the next question

Do not write outside the box

0 4 . 1 Draw the **general** structure of an amino acid.

[1 mark]

0 4 . 2 Which statement describing protein structure is correct?

Tick (✓) **one** box.

[1 mark]

- Proteins with a quaternary structure have one or more polypeptide chains. ☐
- Disulfide bridges are present in all proteins with a tertiary structure. ☐
- The secondary structure of a protein is maintained by ionic and hydrogen bonds. ☐
- The primary structure of a protein is the sequence of amino acids joined by peptide bonds. ☐

Do not write outside the box

0 4 . 3 Antibodies are proteins produced and secreted by plasma cells.

Once activated, a single B cell divides and produces 4000 plasma cells.

Each one of these plasma cells produces 2000 molecules of antibody **Q** per second.

A human male has a blood volume of 5.4 dm^3

Calculate the total number of molecules of antibody **Q** per cm^3 of blood 24 hours after the production of these plasma cells.

[2 marks]

Answer = _____ molecules of antibody **Q** per cm^3 of blood

Question 4 continues on the next page

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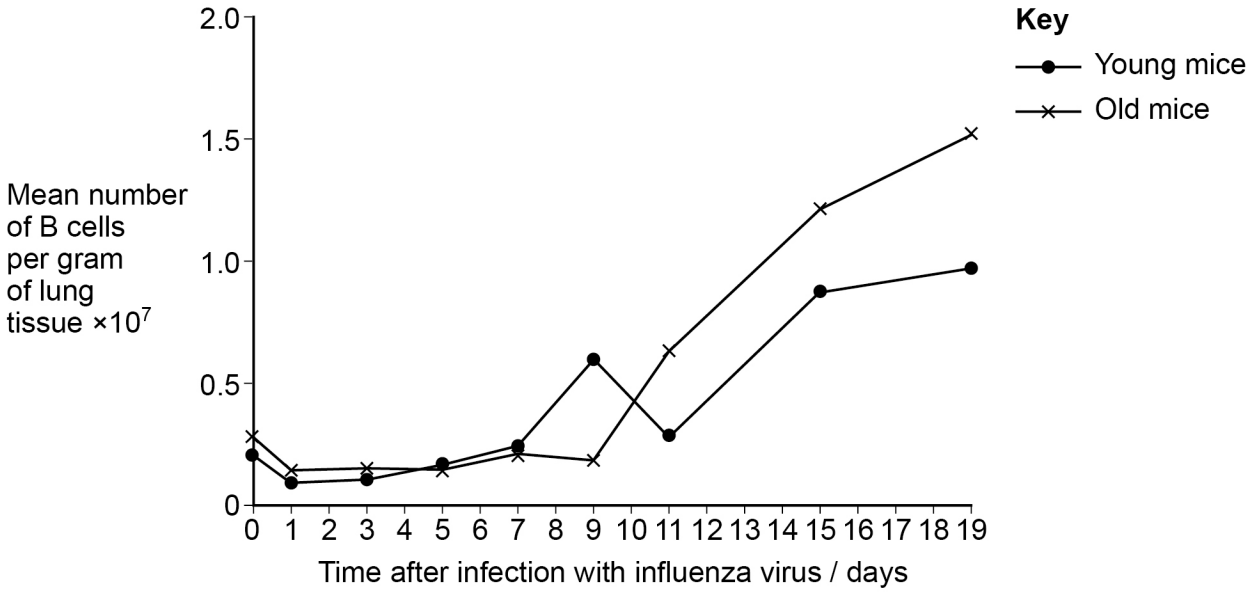
0 4 . 4 Scientists investigated the effect of age on the immune response in healthy female mice.

The scientists used the following method.

1. Infected a large number of young and old mice with the same strain of influenza virus.
2. Removed the lungs from 6 young and 6 old mice on the day of infection (day 0).
3. Repeated step 2 on 8 different days after infection.
4. Determined the mean number of B cells present per gram of lung tissue for young and old mice.

Figure 3 shows the scientists' results.

Figure 3



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The scientists decided that further investigations would be required to conclusively determine the effect of age on the immune response in healthy female mice.

Using all the information provided, suggest **three** reasons for the scientists' decision.

Do **not** refer to statistical tests, repeats or sample size in your answer.

[3 marks]

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7

Turn over for the next question

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0 5 Cleft lip and palate (CLP) is a split in the upper lip and/or the roof of the mouth. CLP is present from birth.

CLP can be caused by various genetic and environmental factors.

CDH1 is a gene involved in lip and mouth development in a fetus before a baby is born.

Scientists hypothesised that CLP is caused by a 'two-hit' model:

- a 'genetic hit' through loss of *CDH1* function
- an 'environmental hit' leading to *CDH1* methylation caused when inflammation affects a fetus.

Inflammation can result from the mother having an infection or diabetes.

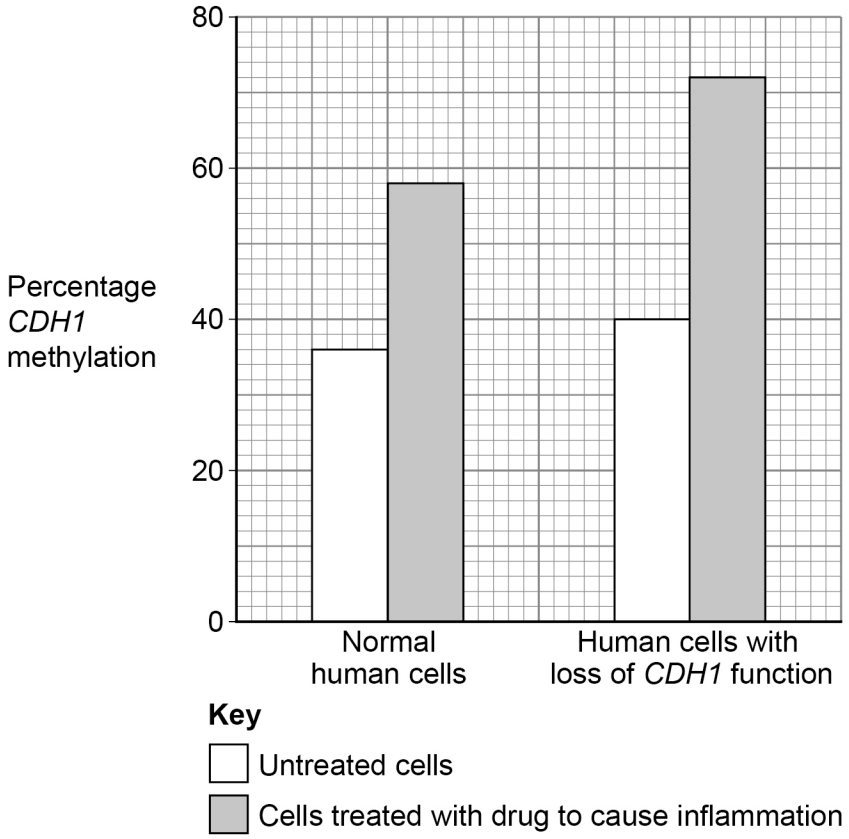
Scientists investigated the 'two-hit' model using human cells grown *in vitro*.

They:

- grew normal cells and cells with a loss of *CDH1* function
- treated some of each type of cell with a drug to cause inflammation and left some of each type of cell untreated
- measured the percentage *CDH1* methylation of the cells.

Figure 4 shows the scientists' results.

Figure 4



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0 5 . 1 The frequency of live births with CLP is 1 in 700

Despite knowing this frequency, the Hardy–Weinberg equation **cannot** be used to estimate **any** allele frequencies for CLP.

Suggest **two** reasons why.

[2 marks]

1 _____

_____

_____

2 _____

_____

_____

0 5 . 2 Describe **one** effect methylation could have on *CDH1*

[1 mark]

_____

_____

_____

0 5 . 3 Suggest **and** explain **three** reasons why the data in **Figure 4** might **not** provide evidence for the 'two-hit' model.

[3 marks]

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3 _____

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6

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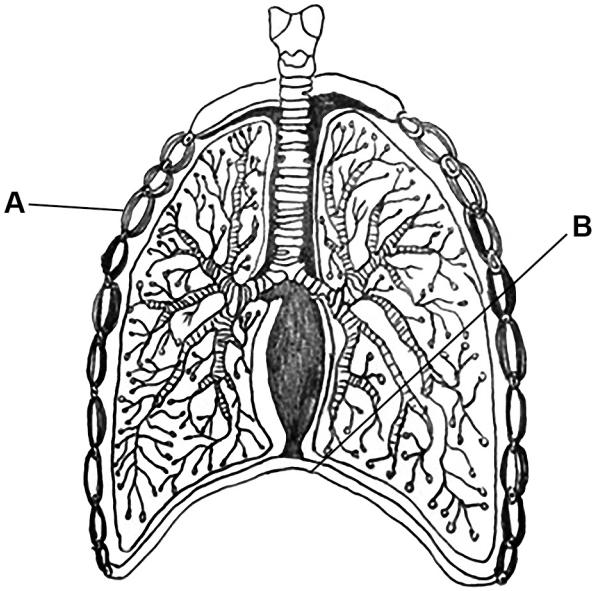
0 6 A student completed a dissection of an animal gas exchange system.

Figure 5 shows the scientific drawing he produced from his observations.

Figure 5



0 6 . 1 Suggest **two** ways the scientific drawing in **Figure 5** could be improved.

Do **not** refer to adding labels or using a sharp pencil in your answer.

[2 marks]

1 _____

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2 _____

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0 6 . 2 Describe the role of structures **A** and **B** in increasing the volume in the thoracic cavity.

[2 marks]

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0 6 . 3 Lung volume can be determined with a spirometer using the helium dilution method.

The lung volume (V2) is calculated using the equation:

$$V2 = \frac{V1(C1 - C2)}{C2}$$

where

C1 = the initial concentration of helium in the spirometer
C2 = the helium concentration in the spirometer when equal with the lungs
V1 = volume of gas in the spirometer.

A student used a spirometer with a volume of 3250 cm^3 and an initial concentration of 10% helium. They found C2 was 3.78%

Use the equation to calculate this student's lung volume in dm^3

Show your working.

[2 marks]

Lung volume = _____ dm^3

Question 6 continues on the next page

Do not write outside the box

Asbestos is a fibrous mineral. If asbestos is inhaled, it can cause a lung disease called asbestosis.

The latency period of a disease is the time between exposure to the cause of the disease and the symptoms occurring. The latency period for asbestosis is 15 to 40 years.

Asbestosis can be diagnosed using a biopsy. This is where a sample of lung cells is removed from a patient and examined with a microscope.

Asbestosis can also be diagnosed without a biopsy. To diagnose asbestosis without a biopsy, five conditions must be met. Three of these are given below.

1. A scan of the lungs showing fibrous scar tissue.
2. Reduced gas exchange.
3. Shortness of breath.

These three conditions are also present in many other lung diseases.

0 6 . 4 Using the information provided, suggest the other **two** conditions that must be met before a diagnosis of asbestosis can be made.

[2 marks]

1 _____

_____

_____

2 _____

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_____

0 6 . 5 Suggest **two** advantages of diagnosing asbestosis **without** a biopsy.

[2 marks]

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2 _____

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Question 6 continues on the next page

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Idiopathic pulmonary fibrosis (IPF) is a lung disease similar to asbestosis. Both diseases cause:

- the death of alveolar epithelial cells due to DNA damage
- dead cells to be replaced by inelastic, fibrous scar tissue.

Currently, there is no cure for asbestosis and no effective treatment to slow its progression. There is also no cure for IPF. However, the drugs nintedanib and pirfenidone can slow the formation of scar tissue and slow the progression of IPF.

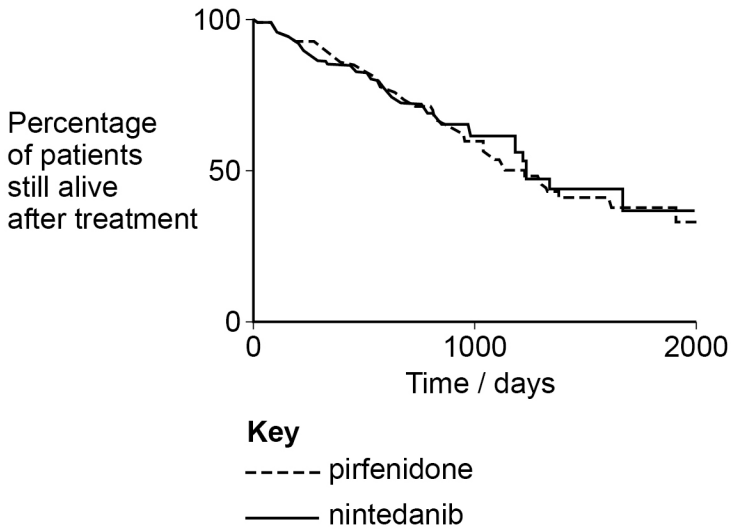
In two **separate** clinical trials, doctors investigated the effect of nintedanib and pirfenidone on 263 IPF patients.

- 124 patients were treated with nintedanib. 7 of these patients had to stop treatment due to side effects.
- 139 patients were treated with pirfenidone. 14 of these patients had to stop treatment due to side effects.

The doctors recorded how many days each patient lived after treatment.

Figure 6 shows their results.

Figure 6



0 6 . 6 Suggest why neither clinical trial had a control group.

[1 mark]

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0 6 . 7 The doctors concluded that both drugs increased life expectancy in patients with IPF compared with survival data for previous patients with IPF.

Using all the information, evaluate whether nintedanib and pirfenidone should be considered as treatments for **asbestosis**.

[4 marks]

15

Turn over for Section B

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Section B

Answer **one** question.

You are advised to spend no more than 45 minutes on this section.

0 7 Write an essay on **one** of the topics below.

Either

0 7 . 1 The importance of condensation and hydrolysis reactions in biological systems.

[25 marks]

Or

0 7 . 2 The importance of responses to changes in the internal and external environment of organisms.

[25 marks]

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END OF QUESTIONS

25

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