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 19 June 2024 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	

Do not write outside the box

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 In the following passage, each numbered space can be filled with a biological term.

Each type of cell has specific molecules on its _____(1)_____ that identify it. An antibody is a _____(2)_____ with two _____(3)_____ binding sites. Antibodies are made and released by _____(4)_____ cells.

Vaccines can provide protection for individuals and populations against disease. The response to a vaccine is an example of _____(5)_____ immunity.

_____(6)_____ immunity occurs when a large proportion of a population becomes immune to a disease.

Write the correct biological term beside each number below that matches the space in the passage.

[3 marks]

1 _____

2 _____

3 _____

4 _____

5 _____

6 _____

0 1 . 2 There is currently no effective vaccine available for HIV.

Suggest **one** reason why.

[1 mark]

_____

_____

_____

Do not write outside the box

0 1 . 3 **Table 1** shows the action of two antibiotics.

Table 1

Antibiotic	**Action of antibiotic**
Ciprofloxacin	Causes double-stranded DNA to break apart
Penicillin	Prevents formation of crosslinks between murein chains

Using the information in **Table 1**, explain why each antibiotic is **not** effective against HIV.

[2 marks]

Ciprofloxacin _____

_____

_____

Penicillin _____

_____

_____

6

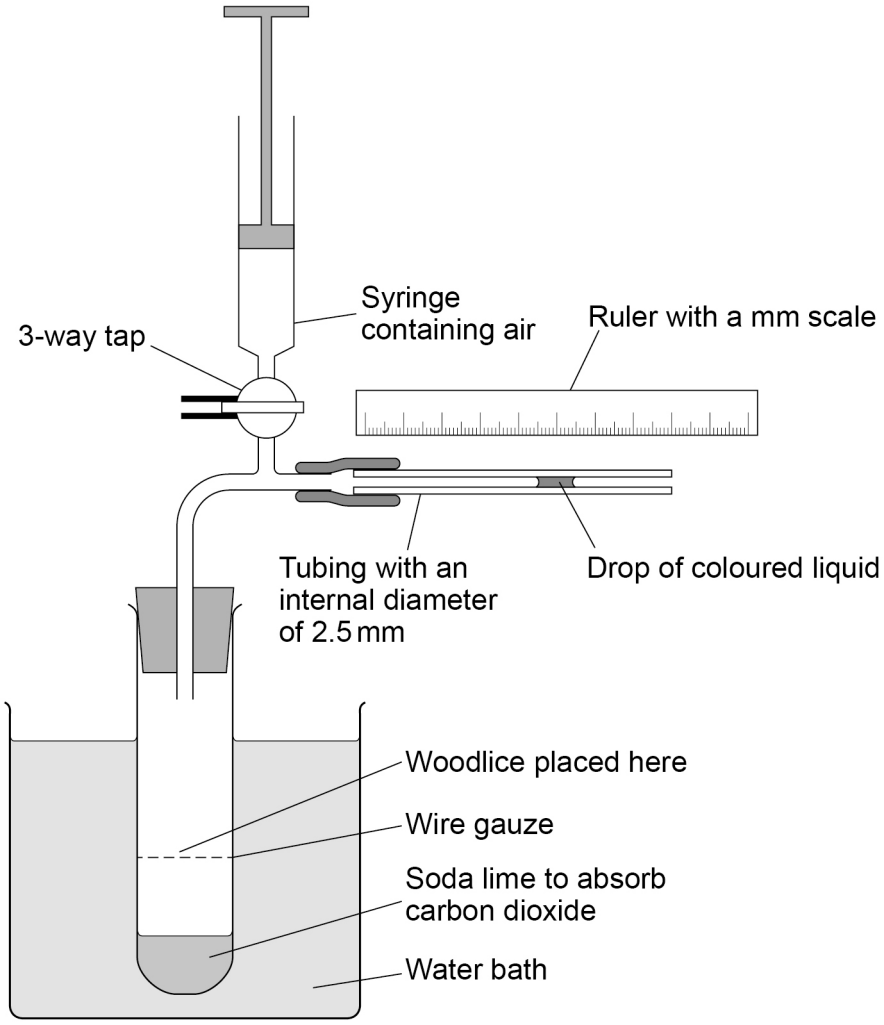
Turn over for the next question

Do not write outside the box

0 2 A student investigated the effect of temperature on the rate of aerobic respiration in woodlice.

Figure 1 shows the apparatus they used.

Figure 1



The student altered the temperature of the water bath and measured how far the drop of coloured liquid moved every minute for 5 minutes.

0 2 . 1 Other than those stated, suggest **two** variables the student should have kept constant in this investigation.

[1 mark]

1 _____

_____

2 _____

_____

Do not write outside the box

0 2 . 2 Describe how the student used the apparatus in **Figure 1** to reset the drop of coloured liquid back to the **right-hand** end of the tubing.

[2 marks]

0 2 . 3 The student also set up a control experiment.

Suggest a suitable control experiment **and** explain why it was necessary.

[2 marks]

Control experiment

Explanation

Question 2 continues on the next page

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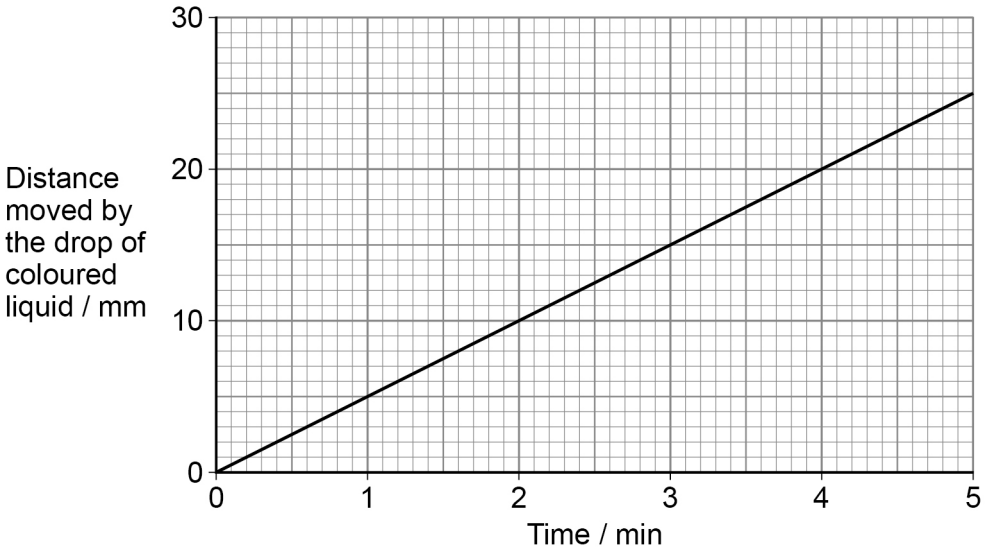
0 2 . 4 **Figure 2** shows the student's results at 25 °C

The mass of the woodlice in the tube was 3.78 g

Figure 2



Use **Figure 1** (on page 4) and **Figure 2** to calculate the mean rate of oxygen uptake by the woodlice in $mm^3\ s^{-1}\ g^{-1}$

The formula for the volume of the capillary tubing is $\pi r^2 l$.

Use π = 3.14 in your calculation.

Show your working **and** give your answer to 2 decimal places.

[3 marks]

Answer _____ $mm^3\ s^{-1}\ g^{-1}$

8

Do not write outside the box

0 3 . 1 Describe **and** explain the relationship between surface area to volume ratio of the human body and metabolic rate.

[3 marks]

Question 3 continues on the next page

Do not write outside the box

Table 2 shows the height and mass of two adults.

Table 2

Person	Height / cm	Mass / kg
A	181	90.90
B	149	62.62

The surface area of a person is estimated using the following formula:

$$\text{Surface area in m}^2 = \sqrt{\frac{\text{height in cm} \times \text{mass in kg}}{3600}}$$

The volume of a person is estimated using the following formula:

$$\text{Volume in m}^3 = \frac{\text{mass in kg}}{1010}$$

0 3 . 2 Using suitable calculations, deduce which person has the smaller surface area to volume ratio.

Show your working **and** complete the sentence below.

Give your answer to 3 significant figures.

[3 marks]

Person _____ has the smaller surface area to volume ratio which = _____

Do not write outside the box

0 3 . 3 Which is **not** a possible explanation for the difference in surface area to volume ratio between person **A** and person **B**?

Tick (✓) **one** box.

[1 mark]

Person **A** and person **B** have different body shapes. ☐

Person **A** has a higher mass than person **B**. ☐

Person **A** is taller than person **B**. ☐

0 3 . 4 Name **two** structural features of the gills of a fish that increase their surface area.

[1 mark]

1 _____

_____

2 _____

_____

8

Turn over for the next question

Do not write outside the box

0 4 Osteoarthritis (OA) is a disease resulting in joint damage which causes stiffness.

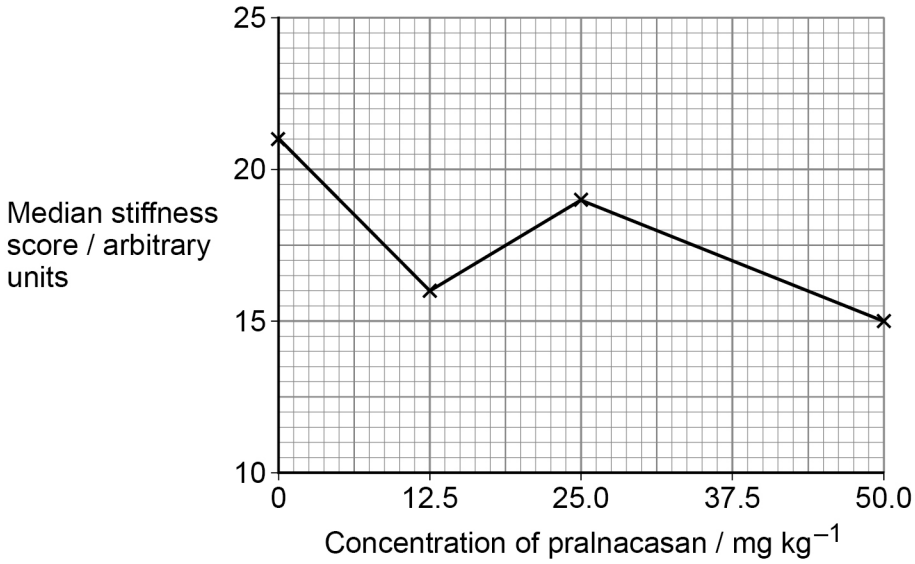
Scientists investigated the use of a drug called pralnacasan to treat OA in 80 mice.

The scientists:

- injected the knee joints of mice with an enzyme to cause joint damage
- split the mice randomly into 4 equal groups
- fed each group with food containing a different concentration of pralnacasan
- after 6 weeks, assessed the stiffness of the knee joints of the mice and scored them using an arbitrary scale.

Figure 3 shows their results.

Figure 3



0 4 . 1 Describe how the scientists determined the median of the stiffness scores.

[1 mark]

Do not write outside the box

0 4 . 2 Using all the information, evaluate the use of pralnacasan as an effective treatment for OA in humans.

[5 marks]

6

Turn over for the next question

Do not write outside the box

0 5 Leigh syndrome (LS) is a rare, recessive, inherited condition.

LS is caused by a mutation in any one of more than 75 different genes coding for proteins involved in oxidative phosphorylation.

In 80% of people with LS, these mutations occur in nuclear DNA. In 20% of people with LS, these mutations occur in mitochondrial DNA (mtDNA).

15% of the nuclear DNA mutations that cause LS occur in the *SURF1* gene. A mutated *SURF1* gene codes for a shorter polypeptide than a non-mutated *SURF1* gene.

0 5 . 1 Name **one** type of *SURF1* gene mutation and explain how this mutation could lead to production of a shorter polypeptide.

[2 marks]

Type of mutation _____

Explanation _____

_____

_____

_____

_____

Do not write outside the box

Globally, the frequency of LS is 1 in 40 000

In the Faroe Islands, which are 18 isolated islands, the frequency of LS is 1 in 1700

0 5 . 2 The population of the Faroe Islands is 49 053

Estimate the number of people in the Faroe Islands with LS caused by a mutation in the *SURF1* gene.

Use information in this question and the information on page 12.

Give your answer to the nearest whole number.

Show your working.

[3 marks]

Answer _____ people

0 5 . 3 The frequency of LS is higher in the Faroe Islands than globally.

Suggest and explain **one** reason why.

[2 marks]

_____

_____

_____

_____

_____

_____

Do not write outside the box

0 5 . 4 LS usually causes death within the first three years of life.

Using all the information in this question, evaluate whether all people should be genetically screened for LS.

[3 marks]

10

Do not write outside the box

0 6 . 1 Define the biological term **population**.

[2 marks]

Question 6 continues on the next page

Do not write outside the box

Ecologists monitored the biodiversity of birds in a protected woodland.

They recorded the number of bird species breeding in the woodland on the same day, every year for a 30-year period.

Figure 4 shows their results.

Figure 4

Figure 4 not reproduced here due to third-party copyright restrictions

The figure is taken from the following website:

Figure 1a. Anne E. Magurran, Stephen R. Baillie, Stephen T. Buckland, Jan McP. Dick, David A. Elston, E. Marian Scott, Rognvald I. Smith, Paul J. Somerfield, Allan D. Watt, Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time, Trends in Ecology & Evolution, Volume 25, Issue 10, 2010, Pages 574-582, ISSN 0169-5347, https://doi.org/10.1016/j.tree.2010.06.016.

0 6 . 2 Which statement correctly represents the species richness of the woodland?

Tick (✓) **one** box.

[1 mark]

- The number of all species present in the woodland ☐
- The number of all species present in the woodland and their habitats ☐
- The number of animal and plant species present in the woodland ☐
- The number of bird species present in the woodland ☐

Do not write outside the box

0 6 . 3 A student studying the information in this question concluded that all woodlands should be protected to increase the biodiversity of birds.

Evaluate the student's conclusion.

[4 marks]

0 6 . 4 It is **not** possible to extrapolate the data for the number of bird species recorded breeding each year beyond 1979.

Explain why.

[1 mark]

Do not write outside the box

In this woodland, the ecologists measured the similarity in the bird community by comparing each year to 1949 using an index of similarity.

This index ranges from 1.0 for total similarity to 0.0 for total dissimilarity.

Figure 5 shows their results.

Figure 5

Figure 5 not reproduced here due to third-party copyright restrictions

The figure is taken from the following website:

Figure 1b, Anne E. Magurran, Stephen R. Baillie, Stephen T. Buckland, Jan McP. Dick, David A. Elston, E. Marian Scott, Rognvald I. Smith, Paul J. Somerfield, Allan D. Watt,
Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time,
Trends in Ecology & Evolution, Volume 25, Issue 10, 2010, Pages 574-582, ISSN 0169-5347, https://doi.org/10.1016/j.tree.2010.06.016.

0 6 . 5 Suggest how the changes in the index of similarity in the bird community provide evidence for the process of succession.

[2 marks]

Do not write outside the box

0 6 . 6 In **Figure 5**, the index of similarity for the last 10 years remains fairly constant.

Name the stage of a succession this represents.

Suggest **one** reason why the index of similarity is **not** absolutely constant.

[2 marks]

Stage of succession _____

Reason why the index of similarity is not absolutely constant _____

_____

_____

_____

_____

Question 6 continues on the next page

Do not write outside the box

The Living Planet Index (LPI) is an index designed to monitor the state of the world's biodiversity.

The LPI is arbitrarily scaled to be 1.0 in 1970, the baseline year.

Figure 6 shows the LPI from the Living Planet Report, 2008. The dotted lines represent ± 2 standard deviations from the mean, which includes over 95% of the data.

Figure 7 shows an alternative version of **Figure 6** published on a news website.

Figure 6 **Figure 7**

Figures 6 and 7 not reproduced here due to third-party copyright restrictions

The figures are taken from the following website:

Figure 2a and 2b, Anne E. Magurran, Stephen R. Baillie, Stephen T. Buckland, Jan McP. Dick, David A. Elston, E. Marian Scott, Rognvald I. Smith, Paul J. Somerfield, Allan D. Watt,
Long-term datasets in biodiversity research and monitoring: assessing change in ecological communities through time,
Trends in Ecology & Evolution, Volume 25, Issue 10, 2010, Pages 574-582, ISSN 0169-5347, https://doi.org/10.1016/j.tree.2010.06.016.

Do not write outside the box

0 6 . 7 The news website published the headline:

The LPI shows human activities cause significant decrease in biodiversity.

Suggest **three** reasons why this headline is **not** valid.

Use all the information provided.

[3 marks]

1 _____

_____

_____

_____

2 _____

_____

_____

_____

3 _____

_____

_____

_____

15

Turn over for Section B

Do not write outside the box

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 Phosphorus-containing substances and their importance in biological systems.

[25 marks]

Or

0 7 . 2 The mechanisms and importance of transport within organisms.

[25 marks]

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END OF QUESTIONS

25

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ANSWER IN THE SPACES PROVIDED

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Question number	**Additional page, if required.** **Write the question numbers in the left-hand margin.**

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