

**Biology**  
**PAPER 2**  
**Higher Tier**

Total Marks
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**Friday 9 June 2023 – Afternoon**

**Time: 1 hour 45 minutes**

**In the boxes below, write your name, centre number and candidate number.**

<b>Surname</b>					
<b>Other names</b>					
<b>Centre Number</b>					
<b>Candidate Number</b>					

**YOU MUST HAVE**

**Calculator, ruler**

**YOU WILL BE GIVEN**

**Diagram Booklet**

**INSTRUCTIONS**

**Answer ALL questions.**

**Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – there may be more space than you need.**

**INFORMATION**

**The total mark for this paper is 100.**

**The marks for EACH question are shown in brackets – use this as a guide as to how much time to spend on each question.**

**In questions marked with an ASTERISK (\*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.**

**There may be spare copies of some diagrams.**

**ADVICE**

**Read each question carefully before you start to answer it.**

**Try to answer every question.**

**Check your answers if you have time at the end.**

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**Answer ALL questions. Write your answers in the spaces provided.**

**Some questions must be answered with a cross in a box ☐. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☐.**

- 1 Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows a stream flowing near a fertiliser factory.**

**The factory burns coal as a source of energy.**

**The factory releases waste into the stream and sulfur dioxide into the air.**

**Samples of water were taken at five points, A, B, C, D and E, as shown on Figure 1.**

**Look at Figure 2 for Question 1(a) in the Diagram Booklet. It shows the oxygen concentration in the water at the five points along the stream.**

**(continued on the next page)**

**1 continued.**

- (a) (i) Calculate how many times greater the oxygen concentration is at point E than at point A.  
(1 mark)**

\_\_\_\_\_ times greater

- (ii) State how the oxygen concentration changes from point A to point E.  
(1 mark)**

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**(continued on the next page)**

**1(a) continued.**

**(iii) Which indicator species would be most likely to be seen in the water at point A?  
(1 mark)**

☐ **A**    freshwater shrimp

☐ **B**    lichen

☐ **C**    sludgeworm

☐ **D**    stonefly

**(iv) Explain where the biodiversity will be highest in the stream.  
(3 marks)**

**Answer space continues on the next page.**

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**Turn over**

**1(a)(iv) continued.**

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- (b) Look at Figure 3 for Question 1(b) in the Diagram Booklet. It shows rose leaves infected with blackspot fungus.**

**State why rose plants growing near this factory are not infected with blackspot fungus.**

**(1 mark)**

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**(Total for Question 1 = 7 marks)**

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- 2 People with diabetes cannot always control the concentration of glucose in their blood.**

**(a) Two people eat identical meals.**

**One person has diabetes, the other person does not have diabetes.**

**Look at Figure 4 for Question 2(a) in the Diagram Booklet. It shows the concentration of glucose in the blood of these two people after eating the meals.**

- (i) Calculate the maximum increase in the concentration of glucose in the blood of the person with diabetes.  
(1 mark)**

\_\_\_\_\_ mmol per dm<sup>3</sup>

**(continued on the next page)**

**Turn over**



**2(a) continued.**

- (ii) Water moved out of the red blood cells of the person with diabetes when the concentration of glucose in the blood was above 15 mmol per dm<sup>3</sup>.**

**Explain why water moved out of the red blood cells of the person with diabetes.**

**(2 marks)**

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**(continued on the next page)**

**2 continued.**

**(b) The pancreas produces a hormone that causes the concentration of glucose in the blood to decrease.**

**(i) Name this hormone.  
(1 mark)**

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**(ii) State how this hormone is transported from the pancreas to its target organs.  
(1 mark)**

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**(iii) Which is the target organ for the hormone that controls the concentration of glucose in the blood?  
(1 mark)**

- ☐ **A kidney**
- ☐ **B pancreas**
- ☐ **C liver**
- ☐ **D lung**

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**Turn over**

**2 continued.**

- (c) Explain how type 2 diabetes can be controlled.  
(3 marks)**

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**(Total for Question 2 = 9 marks)**

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**3 Respiration occurs in cells.**

**(a) Why do cells respire?**  
**(1 mark)**

☐ **A to produce nitrogen**

☐ **B to release oxygen**

☐ **C to produce glucose**

☐ **D to release energy**

**(b) An athlete runs every day as part of their training.**

**(i) Explain why the breathing rate of the athlete increases when running.**  
**(2 marks)**

**Answer space continues on the next page.**

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**3(b)(i) continued.**

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**(continued on the next page)**

**3(b) continued.**

- (ii) When the athlete is running, their muscle cells use both aerobic respiration and anaerobic respiration.**

**State TWO differences between aerobic respiration and anaerobic respiration.  
(2 marks)**

**1** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
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**2** \_\_\_\_\_  
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**Turn over**

**3 continued.**

- (c) Bromothymol blue (BTB) solution is an indicator of pH.**

**Look at Figure 5 for Question 3(c) in the Diagram Booklet. It shows the colour of BTB at different pH levels.**

**When air is passed through green BTB, for one minute, the solution stays green.**

**When a person breathes out through a straw into BTB for one minute the solution turns yellow.**

- (i) Explain why the air breathed out turns the BTB solution yellow.  
(2 marks)**

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**Turn over**

**3(c) continued.**

- (ii) A scientist placed pondweed into two sealed test tubes containing green BTB solution.**

**Test tube A was kept in the dark.**

**Test tube B was kept in the light.**

**All other conditions were kept the same.**

**Look at Figure 6 for Question 3(c)(ii) in the Diagram Booklet. It shows these test tubes at the start of the investigation.**

**Look at Figure 7 for Question 3(c)(ii) in the Diagram Booklet. It shows the colour of the BTB solution after 5 hours.**

**Explain the results for tube A and tube B shown in Figure 7.**

**(2 marks)**

**Answer space continues on the next page.**

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**Turn over**



**3(c)(ii) continued.**

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**(Total for Question 3 = 9 marks)**

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- 4 (a) A student wanted to make a jacket to wear in cold weather.**

**The student compared the insulation properties of wool as a natural material with polyester as a synthetic material.**

**Each material was wrapped around a beaker containing hot water as shown in Figure 8. Look at Figure 8 for Question 4(a) in the Diagram Booklet.**

**The temperature was recorded every 2 minutes for 12 minutes.**

- (i) Which part of the body controls the regulation of body temperature?  
(1 mark)**

- ☐ **A kidney**
- ☐ **B pituitary gland**
- ☐ **C hypothalamus**
- ☐ **D pancreas**

**(continued on the next page)**

**4(a) continued.**

**(ii) State ONE variable that should be controlled in this investigation.**

**(1 mark)**

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**(iii) Describe a control that could be used for this investigation.**

**(2 marks)**

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**(continued on the next page)**

**4 continued.**

**(b) Look at Figure 9 for Question 4(b) in the Diagram Booklet. The results for this investigation are shown in Figure 9.**

- (i) Compare and contrast the temperature changes for wool and polyester in this investigation.  
(2 marks)**

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**4(b) continued.**

- (ii) State ONE improvement to this investigation that would make the results more comparable. (1 mark)**

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- (c) (i) Wearing an insulated jacket may cause a person to sweat.**

**Explain how sweating helps to regulate temperature in humans. (2 marks)**

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**4(c) continued.**

**(ii) Sweat contains urea.**

**State where and how urea is produced in the human body.**

**(2 marks)**

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**(Total for Question 4 = 11 marks)**

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- 5 A student investigated the effect of light intensity on the photosynthesis of pondweed.**

**A light source was placed at different distances from the pondweed.**

**The bubbles produced were counted for 2 minutes.**

**Look at Figure 10 for Question 5 in the Diagram Booklet. It shows the apparatus that was used.**

- (a) (i) State why the student included a water bath in the apparatus.  
(1 mark)**

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**(continued on the next page)**

**5(a) continued.**

- (ii) State TWO variables that should be controlled when completing this investigation.  
(2 marks)**

**1** \_\_\_\_\_

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**2** \_\_\_\_\_

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\_\_\_\_\_

**(continued on the next page)**



**5 continued.**

**(b) Look at Figure 11 for Question 5(b) in the Diagram Booklet. It shows the results of this investigation.**

**(i) The light intensity was calculated using the inverse square law for photosynthesis.**

**Calculate the light intensity at a distance of 25 cm from the lamp.**

**Include the equation for the inverse square law in your answer.**

**(3 marks)**

\_\_\_\_\_ arbitrary units

**(continued on the next page)**

**Turn over**

**5(b) continued.**

- (ii) Explain how the student could improve this investigation to get a more accurate measurement of the gas produced.  
(2 marks)**

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- (c) Look again at Figure 10 for Question 5 in the Diagram Booklet. Devise a plan to show that temperature is a limiting factor in photosynthesis.**

**Use the apparatus shown in Figure 10.  
(3 marks)**

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**5(c) continued.**

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**(Total for Question 5 = 11 marks)**

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**6 Gas exchange happens in the alveoli in the lungs.**

**Look at Figure 12 for Question 6(a) in the Diagram Booklet. It shows an alveolus and a capillary.**

**(a) (i) Name the gas used in respiration that moves from the alveolus into the capillary.**

**(1 mark)**

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**(ii) Name the gas produced by respiration that moves from the capillary into the alveolus.**

**(1 mark)**

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**(continued on the next page)**

**6(a) continued.**

**(iii) The capillary wall is only one cell thick.**

**Explain how gases move from the alveolus to the capillary.**

**(3 marks)**

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**Turn over**

**6(a) continued.**

- (iv) Explain the advantages of red blood cells passing one at a time through this narrow capillary.  
(3 marks)**

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**6 continued.**

- (b) The average number of alveoli in each human lung is 280 million.**

**The surface area of 1 million alveoli is  $0.25\text{m}^2$ .**

**Calculate the total surface area of a human lung.  
(2 marks)**

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**(Total for Question 6 = 10 marks)**

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- 7 Look at Figure 13 for Question 7 in the Diagram Booklet. It shows part of a food web of organisms found in the cold Antarctic Ocean.**

**(a) Which term describes phytoplankton in this food web?**  
**(1 mark)**

☐ **A consumer**

☐ **B producer**

☐ **C predator**

☐ **D prey**

**(b) Humans are removing large numbers of cod from the Antarctic Ocean.**

**(i) State why the removal of cod could lead to a decrease in the numbers of squid and penguins.**  
**(1 mark)**

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**7(b) continued.**

- (ii) Explain why the removal of cod could lead to an increase in the numbers of squid and penguins.  
(2 marks)**

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**(continued on the next page)**

**7 continued.**

- (c) Look at Figure 14 for Question 7(c) in the Diagram Booklet. It shows information about the biomass of some organisms in one part of the Antarctic Ocean.**
- (i) Look at the blank grid for Question 7(c)(i) in the Diagram Booklet. On the grid, draw and label a pyramid of biomass for this food chain. (2 marks)**
- (ii) Seals are mammals.**

**Explain why the conversion of biomass from phytoplankton to shrimps is more efficient than the conversion of biomass from cod to seals.**  
**(2 marks)**

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**(continued on the next page)**

**Turn over**

**7 continued.**

**(d) Cod are being overfished in the Antarctic Ocean.**

**Suggest TWO actions that could be taken by humans to increase the number of cod in the Antarctic Ocean.**

**(2 marks)**

**1** \_\_\_\_\_

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**2** \_\_\_\_\_

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**(Total for Question 7 = 10 marks)**

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- 8 Look at Figure 15 for Question 8(a) in the Diagram Booklet. It shows the changes in the levels of the hormones of the menstrual cycle.**

**(a) (i) The maximum concentration of oestrogen is just before ovulation.**

**Which is the maximum concentration of oestrogen?  
(1 mark)**

- ☐ **A 8 ng/ml**
- ☐ **B 210 pg/ml**
- ☐ **C 320 pg/ml**
- ☐ **D 900 ng/ml**

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**8(a) continued.**

- (ii) Explain how TWO of the hormones shown in Figure 15 cause ovulation.  
(3 marks)**

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**(continued on the next page)**

**8(a) continued.**

- (iii) State the number of days for the first menstruation shown in Figure 15.  
(1 mark)**

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**8(a) continued.**

**(iv) Explain how the levels of each hormone in the woman shown in Figure 15 would be different, if she was pregnant.**  
**(4 marks)**

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**Turn over**

**8(a)(iv) continued.**

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**(Total for Question 8 = 9 marks)**

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**9 Look at Figure 16 for Question 9(a) in the Diagram Booklet. It shows a photomicrograph of two stomata in a leaf.**

**(a) (i) The length of one guard cell in this image is 6 mm.**

**Convert the length of this guard cell into micrometres ( $\mu\text{m}$ ).  
(1 mark)**

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**(continued on the next page)**

**9(a) continued.**

**(ii) The image has been magnified 150 $\times$ .**

**Calculate the actual size of the guard cell.**

**Give your answer in standard form in mm.  
(3 marks)**

\_\_\_\_\_mm

**(continued on the next page)**

**9 continued.**

- (b) Explain the role of denitrifying bacteria in the nitrogen cycle.  
(2 marks)**

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**9 continued.**

**\*(c) Describe how carbon is cycled through the biotic and abiotic components of an ecosystem.**  
**(6 marks)**

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**9(c) continued.**

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**Turn over**

**9(c) continued.**

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**(Total for Question 9 = 12 marks)**

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**10 Blood is filtered in the kidney.**

**Look at Figure 17 for Question 10 in the Diagram Booklet. It shows the diameter of some molecules found in human blood.**

- (a) (i) Which part of the nephron is the site of ultrafiltration?  
(1 mark)**

- ☐ **A distal convoluted tubule**
- ☐ **B collecting duct**
- ☐ **C glomerulus**
- ☐ **D loop of Henle**

**(continued on the next page)**

**10(a) continued.**

**(ii) Molecule Z is a protein.**

**Explain why protein is not usually found  
in urine.**

**(2 marks)**

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**(continued on the next page)**



**10(a) continued.**

**(iii) Haemolytic anaemia is a disease that causes red blood cells to burst.**

**Haemoglobin is not found in the urine of people who do not have haemolytic anaemia.**

**The diameter of a haemoglobin molecule is 5.5 nm.**

**Explain why haemoglobin can be found in the urine of people with haemolytic anaemia.  
(3 marks)**

**Answer space continues on the next page.**

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**10(a)(iii) continued.**

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**\*(b) Describe how the water content of the blood is controlled in the nephron.  
(6 marks)**

**Answer space continues on the next 2 pages.**

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**10(b) continued.**

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**10(b) continued.**

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**(Total for Question 10 = 12 marks)**

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**TOTAL FOR PAPER = 100 MARKS**  
**END OF PAPER**