

**Biology**  
**PAPER 1**  
**Higher Tier**

Total Marks
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**Tuesday 16 May 2023 – Morning**

**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 the 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 A bomb calorimeter is used to measure the energy content of a food sample.**

**Look at FIGURE 1 for Question 1(a) in the Diagram Booklet. It shows a bomb calorimeter.**

**The mass of the food sample is measured at the start.**

**The food sample is burnt and the temperature rise of the water is measured.**

- (a) (i) Describe how the temperature rise of the water is measured.  
(2 marks)**

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**1(a)(i) continued.**

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**(ii) The energy content of the food is calculated using the equation:**

$$\text{energy content (J/g)} = \frac{\text{mass of water (g)} \times \text{temperature rise (}^{\circ}\text{C)} \times 4.2}{\text{mass of food (g)}}$$

**The bomb calorimeter was used to find the energy content of a biscuit.**

**The mass of water was 1 000 g, the temperature rise was 69.4°C and the mass of the biscuit was 14.7 g.**

**(continued on the next page)**

**1(a)(ii) continued.**

**Which is the energy content of this biscuit?  
(1 mark)**

☐ **A    291 480 J/g**

☐ **B    19 829 J/g**

☐ **C    69 400 J/g**

☐ **D    4 721 J/g**

**(iii) A different biscuit with the same mass gave a  
temperature rise of 78.2 °C.**

**Give ONE reason why this biscuit gave a  
greater temperature rise.  
(1 mark)**

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**(continued on the next page)**

**1 continued.**

- (b) Look at FIGURE 2 for Question 1(b) in the Diagram Booklet. It shows the equipment used in a school laboratory to measure the energy content of a food sample.**

**Explain why a bomb calorimeter gives a more accurate value than this equipment for the energy content of a food sample.**

**(3 marks)**

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**1(b) continued.**

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

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- 2 (a) Name the type of reproduction that produces genetically identical organisms.  
(1 mark)**
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- (b) Grafting is a technique used to grow some varieties of apple tree.**

**Look at FIGURE 3 for Question 2(b) in the Diagram Booklet. It shows apple tree shoots grafted on to a rootstock.**

**Grafting can be used to produce apple trees that are genetically identical.**

**Give ONE advantage and ONE disadvantage of growing genetically identical apple trees.  
(2 marks)**

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

**advantage**

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**2(b) continued.**

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**disadvantage**

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**(continued on the next page)**

**2 continued.**

**(c) As apples ripen, enzymes convert starch into sugars.**

**Devise a method to find the optimum pH of an enzyme that breaks down starch.**

**You may use standard laboratory equipment and the solutions given below.**

**(4 marks)**

**starch solution**

**enzyme solution**

**iodine solution**

**a range of pH solutions**

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

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**(continued on the next page)**

**Turn over**

**2(c) continued.**

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**2 continued.**

**(d) The optimum pH of an enzyme is pH 6.**

**Explain why this enzyme would not work at pH 10.  
(2 marks)**

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

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- 3 Look at FIGURE 4 for Question 3(a) in the Diagram Booklet. It shows colonies of bacteria growing on an agar plate.**

**Each colony starts as one bacterium.**

**Every time bacteria reproduce, the number of bacteria in each colony doubles.**

- (a) Calculate the number of bacteria in a colony after five hours, if each bacterium reproduces every 30 minutes.  
(2 marks)**

\_\_\_\_\_ bacteria

**(continued on the next page)**

**3 continued.**

**(b) Some bacteria are pathogens.**

**(i) State the meaning of the term pathogen.  
(1 mark)**

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**(ii) Explain why antibiotics can be used to treat  
bacterial infections.  
(2 marks)**

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**Turn over**

**3(b) continued.**

**(iii) A rod-shaped bacterium is 0.005 mm long.**

**A student draws the rod-shaped bacterium.**

**The bacterium in the drawing is 80 mm long.**

**Calculate the magnification of this drawing.  
(2 marks)**

**magnification = \_\_\_\_\_**

**(Total for Question 3 = 7 marks)**

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- 4 Look at FIGURE 5 for Question 4(a) in the Diagram Booklet. It shows a chart used by opticians to test a person's vision.**

**The person's vision is judged by the lowest row of letters they can read.**

- (a) (i) An optician tested the eyesight of 240 people.**

**35% of these people could read the normal vision row without wearing glasses.**

**The rest of the people need glasses to correct their vision.**

**Calculate the number of people who need glasses to correct their vision.**

**(3 marks)**

**\_\_\_\_\_ people**

**(continued on the next page)**

**Turn over**

**4(a) continued.**

- (ii) An optician can use the chart to diagnose short-sightedness.**

**Give ONE reason why people are short-sighted.**

**(1 mark)**

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**(continued on the next page)**

**4(a) continued.**

**(iii) Look at the diagrams for Question 4(a)(iii) in the Diagram Booklet. Which diagram shows how short-sightedness can be corrected?  
(1 mark)**

☐ **Diagram A**

☐ **Diagram B**

☐ **Diagram C**

☐ **Diagram D**

**(continued on the next page)**

**4 continued.**

**(b) Cataracts can affect a person's vision.**

**Look at FIGURE 6 for Question 4(b) in the Diagram Booklet. It shows what a person with normal vision and a person with cataracts can see for the top letter on the optician's chart.**

**(i) Describe why a person with cataracts would see the image shown in Figure 6.  
(2 marks)**

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**4(b) continued.**

- (ii) State the treatment for cataracts.  
(1 mark)**
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**(c) Look at FIGURE 7 for Question 4(c)(i) in the Diagram Booklet. It shows the structure of the brain.**

- (i) Which region of the brain is labelled structure X?  
(1 mark)**

- ☐ **A cerebellum**
- ☐ **B cerebral hemisphere**
- ☐ **C medulla oblongata**
- ☐ **D spinal cord**

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**4(c) continued.**

- (ii) When a person reacts to a stimulus, messages from the brain are sent to their muscles.**

**Describe how messages are sent from the brain to muscles.**

**(2 marks)**

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

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5 (a) Look at FIGURE 8 for Question 5(a) in the Diagram Booklet. It shows a diagram of a mouse sperm cell.

(i) Which row of the table shows the functions of structure A and structure B?  
(1 mark)

	function of structure A	function of structure B
<input type="checkbox"/> A	releases energy	contains the genetic material
<input type="checkbox"/> B	produces glucose	contains digestive enzymes
<input type="checkbox"/> C	releases energy	contains digestive enzymes
<input type="checkbox"/> D	produces glucose	contains the genetic material

(continued on the next page)

**5(a) continued.**

- (ii) The diploid chromosome number for a mouse is 40.**

**State the number of chromosomes in a mouse sperm cell.**

**(1 mark)**

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**(continued on the next page)**



**5 continued.**

**(b) After a mouse egg cell is fertilised, cell division produces a ball of genetically identical stem cells.**

**(i) Which is the correct order for the stages of one cell division?**

**(1 mark)**

- ☐ A    metaphase → prophase → anaphase  
→ telophase
- ☐ B    prophase → metaphase → anaphase  
→ telophase
- ☐ C    anaphase → prophase → metaphase  
→ telophase
- ☐ D    prophase → anaphase → metaphase  
→ telophase

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**5(b) continued.**

- (ii) The genetically identical stem cells produce the cells that develop into an embryo.**

**Describe how stem cells produce the cells of an embryo.**

**(2 marks)**

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**5 continued.**

- (c) Scientific research has made many discoveries and developments allowing stem cells to be used in medical treatments.**

**Look at FIGURE 9 for Question 5(c) in the Diagram Booklet. It shows a timeline for some of these discoveries and developments.**

- (i) Give ONE scientific reason why the bone marrow transplant in 1968 was from a sister to her brother.**  
**(1 mark)**

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**5(c) continued.**

- (ii) Give ONE scientific reason why some people are opposed to the isolation of human embryonic stem cells.  
(1 mark)**

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- (iii) Stem cells, with the properties of embryonic stem cells, can be produced from a patient's own skin cells.**

**Discuss the benefits of using these stem cells to treat the patient.  
(3 marks)**

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**5(c)(iii) continued.**

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**(Total for Question 5 = 10 marks)**

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- 6 (a) In the 19th century the destruction of wetland habitats caused the extinction of the bittern in the UK.**

**Look at FIGURE 10 for Question 6(a) in the Diagram Booklet. It shows a bittern.**

**Restoration of the habitats has led to the birds returning to the UK.**

**Male bitterns make a loud booming sound.**

**This allows the numbers of male bitterns to be counted.**

**In 1997, 11 males were counted and this increased to 221 males in 2021.**

- (i) Calculate the percentage increase in the number of males from 1997 to 2021.  
(3 marks)**

**%**

**6(a) continued.**

**The bitterns are difficult to see in the reeds of the wetland habitat.**

**(ii) Give ONE benefit of this to the bittern.  
(1 mark)**

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**6(a) continued.**

- (iii) There is some concern that the bitterns in the UK are all closely related. This could make them susceptible to extinction.**

**Explain, using your knowledge of natural selection, why being closely related could make the bitterns susceptible to extinction.  
(3 marks)**

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**6(a)(iii) continued.**

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- (b) Describe how selective breeding can be used to produce a large population of animals that are not closely related.  
(2 marks)**

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**6 continued.**

- (c) Sex determination in birds is different from humans.**

**Males are homozygous Z and females are heterozygous ZW.**

**Look at the Punnett square for Question 6(c) in the Diagram Booklet. Complete the Punnett square to show how sex is determined in birds.**

**(2 marks)**

**(Total for Question 6 = 11 marks)**

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**7 Plant growth can be affected by the environment, by pathogens, or both.**

**(a) A farmer found lesions on crop plants growing in one of their fields.**

**Look at FIGURE 11 for Question 7(a) in the Diagram Booklet. It shows lesions on leaves.**

**\*(i) Discuss how the cause of the lesions and their spread through the crops could be investigated.**

**You should refer to distribution analysis in your answer.**

**(6 marks)**

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

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**7(a)(i) continued.**

[illegible]

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**Turn over**

**7(a) continued.**

- (ii) The farmer decides to dig up the affected crop plants.**

**Give ONE precaution the farmer should take when digging up the affected crop plants.  
(1 mark)**

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- (b) The genetic material of some plant viruses is single-stranded RNA.**

**The RNA is copied by the infected host cell and acts as a mRNA molecule.**

**Describe how protein synthesis makes viral proteins from this mRNA.  
(4 marks)**

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**7(b) continued.**

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**(Total for Question 7 = 11 marks)**

- 8 A student investigated the movement of water in potatoes.**

**The student used three identical cubes of potato.**

**Look at FIGURE 12 for Question 8 in the Diagram Booklet. The size of a cube is shown in Figure 12.**

- (a) (i) Calculate the volume of this cube.**

**Include the units in your answer.  
(2 marks)**

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**8(a) continued.**

**One cube was placed in water and each of the other two cubes were placed in solutions with different concentrations of salt.**

**The cubes were left for 20 minutes.**

**Look at FIGURE 13 for Question 8(a) in the Diagram Booklet. It shows the student's results.**

- (ii) Give ONE way the student could ensure the measurement of the mass of the cubes is accurate.**  
**(1 mark)**

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**8(a) continued.**

- (iii) Explain the mass change in the cube in the concentrated salt solution.  
(3 marks)**

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**8(a) continued.**

- (iv) The student wanted to find the concentration of salt solution where the potato cube did not change mass.**

**Describe how the student could modify this investigation to find this concentration.  
(3 marks)**

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**8 continued.**

- (b) Explain why potato cells do not burst when placed in water.  
(2 marks)**

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**(Total for Question 8 = 11 marks)**

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- 9 (a) A person's mass is partially influenced by the alleles they inherit from their parents.

Give TWO other factors that can influence a person's mass.  
(2 marks)

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**9 continued.**

- (b) Look at FIGURE 14 for Question 9(b) in the Diagram Booklet. It shows the data obtained from a patient by a doctor doing a health check.**

**The guidance used by the doctor is also listed in Figure 14.**

**Comment on the data and the health risks to this patient.  
(4 marks)**

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**9(b) continued.**

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**9 continued.**

**\*(c) The doctor also tested the reaction time of the patient.**

**Describe the structure and function of a reflex arc.  
(6 marks)**

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

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**9(c) continued.**

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**9(c) continued.**

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

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**10 (a) Haemophilia is a sex-linked genetic disorder caused by a recessive allele on the X chromosome.**

**(i) Describe the phenotype of a male with the genotype  $X^hY$ .  
(1 mark)**

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**(ii) Look at the Punnett square for Question 10(a) (ii) in the Diagram Booklet. Complete the Punnett square to show the genotypes of a male who is not affected by haemophilia, a female who is a carrier of the haemophilia allele and their possible offspring.**

**Use the letters H and h for the alleles.  
(3 marks)**

**(continued on the next page)**

**10 continued.**

**(b) Some genetic disorders occur because the body does not produce enough of a protein.**

**(i) Describe how a mutation in the non-coding region of a gene can lead to the production of less protein.**

**(2 marks)**

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**(continued on the next page)**

**10(b) continued.**

**(ii) Which describes the cause of a protein folding incorrectly?  
(1 mark)**

- ☐ **A a mutation in the coding region of a gene changes the sequence of the amino acids.**
- ☐ **B a mutation in the non-coding region of the gene changes the sequence of the amino acids.**
- ☐ **C a mutation in the coding region of a gene changes the shape of the tRNA molecule.**
- ☐ **D a mutation in the non-coding region of the gene changes the shape of the tRNA molecule.**

**(continued on the next page)**

**10 continued.**

- (c) Monoclonal antibodies can be used in the diagnosis of genetic disorders and pregnancy testing.**

**Describe how a pregnancy test uses monoclonal antibodies to show that a woman is pregnant.  
(4 marks)**

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10(c) continued.

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(Total for Question 10 = 11 marks)

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