

Biology  
PAPER 1  
Higher tier

Total Marks
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Time: 1 hour 45 minutes

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

Surname					
Other names					
Centre Number					
Candidate Number					

**YOU MUST HAVE**

**Ruler, calculator**

**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 Gregor Mendel studied inheritance in pea plants.**

**Pea plants can produce either yellow pea pods or green pea pods.**

**Mendel crossed plants that always produce yellow pea pods with plants that always produce green pea pods.**

**Symbol **A** represents the dominant allele.**

**Symbol **a** represents the recessive allele.**

**(a) Which is the genotype of the pea pods produced from this cross?**

**(1 mark)**

☐ **A    AA**

☐ **B    aa**

☐ **C    Aa**

☐ **D    YG**

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**1 continued.**

- (b) (i) Mendel grew many plants from the seeds in these pea pods.**

**These plants were then crossed with each other.**

**The seeds from this second cross produced 5496 plants with yellow pea pods and 1832 plants with green pea pods.**

**Give this as a ratio in its simplest form.  
(1 mark)**

**ratio \_\_\_\_\_**

**(continued on the next page)**

**1 continued.**

- (ii) Complete the Punnett square to show the outcome of a cross where both parent pea plants are heterozygous.**

**Show the percentage probability of homozygous recessive offspring in your answer.  
(3 marks)**


**percentage probability of  
homozygous recessive offspring \_\_\_\_\_ %**

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**1 continued.**

**(c) (i) Some plants reproduce sexually.**

**Give ONE advantage of this type  
of reproduction.  
(1 mark)**

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**(ii) Name the process that forms gametes for  
sexual reproduction.  
(1 mark)**

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

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**2 (a) DNA molecules contain base pairs.**

**Describe how the base pairs are bonded together  
in a DNA molecule.**

**(2 marks)**

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**2 continued.**

**(b) Look at FIGURE 1 for Question 2(b) in the Diagram Booklet. It shows part of a DNA molecule.**

**(i) Write the code for the complementary DNA strand in Figure 1.**

**(2 marks)**

**(ii) Three bases code for each amino acid.**

**Which is the maximum number of amino acids coded for by this strand of DNA?**

**(1 mark)**

☐ **A    3**

☐ **B    4**

☐ **C    6**

☐ **D    12**

**(continued on the next page)**

**2 continued.**

**(iii) What is the shape of a DNA molecule?  
(1 mark)**

- ☐ **A triple stranded**
- ☐ **B single stranded**
- ☐ **C single helix**
- ☐ **D double helix**

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**2 continued.**

**(c) A student wanted to extract the DNA from fresh peas.**

**The student crushed the peas and added washing up liquid and water.**

**The enzyme protease was then added to this mixture.**

**(i) Explain why the enzyme protease was added to the mixture.  
(2 marks)**

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**Turn over**

**2 continued.**

**(ii) The mixture was then heated and filtered.**

**Finally, the student poured the filtrate into a test tube and ice cold ethanol was poured down the side of the test tube into the filtrate.**

**State why ice cold ethanol was poured into the filtrate.**

**(1 mark)**

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

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**3 (a) Look at FIGURE 2 for Question 3(a) in the Diagram Booklet. It shows the number of people diagnosed with sexually transmitted infections (STIs) in the UK during 2017.**

**(i) State the sexually transmitted infection that has the median number of people diagnosed. (1 mark)**

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**(ii) The population of the UK in 2017 was 66 million people.**

**Calculate the total number of people diagnosed with chlamydia in the UK in 2017. (2 marks)**

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

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**Turn over**

**3 continued.**

**(iii) State why chlamydia can be described as a communicable disease.  
(1 mark)**

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**(iv) Give ONE way the transmission of chlamydia can be prevented.  
(1 mark)**

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**3 continued.**

- (v) Explain why chlamydia can be treated with antibiotics.  
(2 marks)**

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**3 continued.**

**(b) HIV is another sexually transmitted infection.**

**Explain how HIV can lead to the onset of AIDS.  
(2 marks)**

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

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**4 (a) Look at FIGURE 3 for Question 4(a) in the Diagram Booklet. It shows two light receptor cells from the human eye.**

**(i) Which part of the eye contains light receptor cells?  
(1 mark)**

☐ **A cornea**

☐ **B iris**

☐ **C lens**

☐ **D retina**

**(ii) These cells require energy.**

**The cell organelles labelled X release energy during respiration.**

**Name the organelles labelled X.  
(1 mark)**

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**Turn over**

**4 continued.**

**(iii) The cell organelle labelled Y  
contains chromosomes.**

**Name the organelle labelled Y.  
(1 mark)**

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**(iv) Cell A responds to dim light and is  
responsible for night vision.**

**Name cell A.  
(1 mark)**

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**4 continued.**

- (v) Describe how the role of light receptor cell B is different from the role of light receptor cell A.  
(2 marks)**

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**4 continued.**

- (b) The optic nerve carries information from the back of the eye to the brain.**

**The optic nerve is 47 mm in length.**

**Nerve impulses travel at 75 metres per second.**

- (i) Calculate the time an impulse takes to travel the length of the optic nerve.**

**Use the equation:  $\text{speed} = \frac{\text{distance}}{\text{time}}$**   
**(3 marks)**

**\_\_\_\_\_ seconds**

**(continued on the next page)**

**4 continued.**

- (ii) The impulse travels to the occipital lobe of the brain.**

**Look at FIGURE 4 for Question 4(b)(ii) in the Diagram Booklet. The occipital lobe is labelled.**

**Which part of the brain contains the occipital lobe?  
(1 mark)**

- ☐ **A cerebral hemispheres**
- ☐ **B medulla oblongata**
- ☐ **C cerebellum**
- ☐ **D hypothalamus**

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**4 continued.**

- (iii) State the sense most likely to be affected if the occipital lobe is damaged.  
(1 mark)**

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

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5 (a) In 2017, a new strain of **Klebsiella pneumoniae** bacteria was discovered that was resistant to 26 different antibiotics.

(i) Explain how **Klebsiella pneumoniae** bacteria developed resistance to antibiotics.  
(4 marks)

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- (ii) State how the use of antibiotics could contribute to **Klebsiella pneumoniae** bacteria developing resistance to antibiotics.  
(1 mark)

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- (iii) **Klebsiella pneumoniae** is a prokaryotic cell.

Which is a characteristic feature of a prokaryotic cell?  
(1 mark)

- ☐ A it has chloroplasts
- ☐ B it does not have a nucleus
- ☐ C it does not have ribosomes
- ☐ D it cannot reproduce without a host

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**5 continued.**

(b) New antibiotics are being developed to treat the disease caused by **Klebsiella pneumoniae**.

**Describe the stages of antibiotic development that would occur after the discovery of a new antibiotic. (3 marks)**

This image shows a blank sheet of white paper with ten horizontal black lines. The lines are evenly spaced and run across the width of the page, providing a template for writing or drawing.

**(Total for Question 5 = 9 marks)**

- 6 A student investigated the fat content of two types of milk: milk A and milk B.**

**Look at FIGURE 5 for Question 6 in the Diagram Booklet. Before starting the investigation, the student added a drop of oil from a pipette into a test tube of water as shown.**

**The drop of oil rose to the surface of the water.**

- (a) The student then placed a drop of milk A into one test tube of water and a drop of milk B into a different test tube of water.**

**The drop of milk A sank to the bottom and the drop of milk B rose to the surface.**

**Give ONE reason for the drop of milk B rising to the surface.**

**(1 mark)**

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**6 continued.**

**(b)  $5\text{ cm}^3$  of milk B and  $1\text{ cm}^3$  of lipase were added to a different test tube.**

**The pH of this mixture was pH 7.**

**This test tube was placed in a water bath for 10 minutes.**

**The pH of the mixture changed from pH 7 to pH 5.**

**(i) Explain what caused this change in pH.  
(3 marks)**

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**Turn over**

**6 continued.**

**(ii) This procedure was repeated with milk A.**

**There was no change in the pH of this mixture after 10 minutes.**

**Explain why there was no change in the pH of the mixture containing milk A.  
(2 marks)**

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**Turn over**

**6 continued.**

**(iii) The student repeated this procedure with lipase that had been boiled and left to cool.**

**This was added to another sample of milk B.**

**Describe why the pH did not change in this mixture.**

**(3 marks)**

[illegible]

**(Total for Question 6 = 9 marks)**

- 7 (a) A student was investigating mitosis in the roots of a garlic plant.**

**Describe how the student could prepare a microscope slide to show mitosis in the growing roots of a garlic plant.  
(4 marks)**

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- (b) Describe what is produced when a single cell divides by mitosis.  
(3 marks)**

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**7 continued.**

- (c) The student observed 89 cells on the microscope slide.**

**Look at FIGURE 6 for Question 7(c) in the Diagram Booklet. It shows the number of cells at each stage of the cell cycle.**

**Use this equation to calculate the mitotic index for this slide.**

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}} \times 100$$

**Give your answer to three significant figures.  
(3 marks)**

**Mitotic index \_\_\_\_\_**

**(continued on the next page)**

**Turn over**

**7 continued.**

- (d) The mitotic index is often used in the diagnosis of cancer.**

**State the effect of cancer on cell division.  
(1 mark)**

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

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- 8 Alfred Russel Wallace travelled around Malaysia during the 1800s and wrote to Charles Darwin about the animal species he studied.**

**His main conclusions were very similar to those of Charles Darwin and they both contributed to the current understanding of evolution.**

- (a) Describe the theory of evolution by natural selection.  
(3 marks)**

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**8 continued.**

**(b) Wallace and Darwin did not always agree.**

**Darwin believed that male birds have feathers that are brightly coloured to make them more attractive to female birds.**

**Wallace thought that female birds have feathers that are less brightly coloured so they are more likely to survive.**

- (i) Explain why having feathers that are less brightly coloured increases the survival rate of females.  
(2 marks)**

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**8 continued.**

- (ii) Suggest why it is more important for the survival of the species that the survival rate is higher in female birds than in male birds.  
(2 marks)**

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**8 continued.**

**(c) Look at FIGURE 7 for Question 8(c) in the Diagram Booklet. It shows the limbs of five animals.**

**Describe how the structure of these limbs provides scientists with evidence for evolution.**

**(3 marks)**

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**(Total for Question 8 = 10 marks)**

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**9 There is a shortage of kidneys for organ transplants.**

**Scientists are investigating how to grow kidneys using genetically modified pig embryos.**

**Look at FIGURE 8 for Question 9 in the Diagram Booklet. Figure 8 and the steps below show this process.**

**Step 1. Human stem cells taken from the patient needing a transplant**

**Step 2. Human cells injected into the early stages of the developing pig embryo. This pig embryo is genetically engineered so it does not grow pig kidneys.**

**Step 3. Pig grows the human kidneys rather than pig kidneys**

**Step 4. Kidneys taken from the pig are implanted into the human**

**(a) (i) State why the embryo of the pig must be engineered so it does not grow pig kidneys.  
(1 mark)**

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**9 continued.**

- (ii) Explain why human stem cells are used for this process.  
(2 marks)**

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**9 continued.**

**(b) Look at FIGURE 9 for Question 9(b) in the Diagram Booklet. It shows the number of organ transplants needed and the number of donors available in the USA from 1991 to 2018.**

**(i) Compare the number of donors available with the number of organ transplants needed from 1991 to 2018.**

**Use information from the graph to support your answer.**

**(3 marks)**

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**(ii) State why scientists are genetically engineering animals for organ transplants.  
(1 mark)**

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**9 continued.**

**\*(c) Bacteria have been genetically engineered to produce human insulin since 1978.**

**Explain how bacteria can be genetically engineered to produce human insulin.  
(6 marks)**

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**9 continued.**

[illegible]

**(Total for Question 9 = 13 marks)**

- 10 (a) Figure 10 shows part of a method used to produce a bacterial culture on a Petri dish.

**FIGURE 10**

**Step 1. Sterilise Petri dish and agar before use**

**Step 2. Pass inoculating loop through a flame**

**Step 3. Allow inoculating loop to cool**

**Step 4. Use inoculating loop to collect  
bacterial sample**

**Step 5. Use inoculating loop to spread bacteria  
onto agar**

- (i) **State why step 1 and step 2 are necessary.  
(1 mark)**

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**10 continued.**

**(ii) Give ONE reason why step 3 is included.  
(1 mark)**

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**10 continued.**

- \*(iii) A student wanted to investigate how effective three different antiseptics were at killing bacteria.**

**The student was provided with:**

- an inoculated Petri dish prepared using the method in Figure 10**
- three different antiseptics**
- filter paper discs**
- sticky tape.**

**Devise a plan for the student to complete this investigation.**

**Include a control and any variables that the student would need to consider.  
(6 marks)**

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**10 continued.**

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**Turn over**

**10 continued.**

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**10 continued.**

**(b) Viruses can cause disease.**

**Describe how the lytic pathway is involved in the reproduction of viruses.**

**(4 marks)**

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(Total for Question 10 = 12 marks)

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