OXFORD
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Please write clearly in block capitals.

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Candidate signature _____
I declare this is my own work.

INTERNATIONAL A-LEVEL
BIOLOGY (9610)

Unit 5 Synoptic paper

Thursday 21 January 2021 07:00 GMT Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
- a pencil
- a ruler with millimetre measurements
- a scientific calculator, which you are expected to use where appropriate.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- 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).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.
- In Question 6, 2 marks will be awarded for the quality of your written communication. You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use specialist vocabulary where appropriate.

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

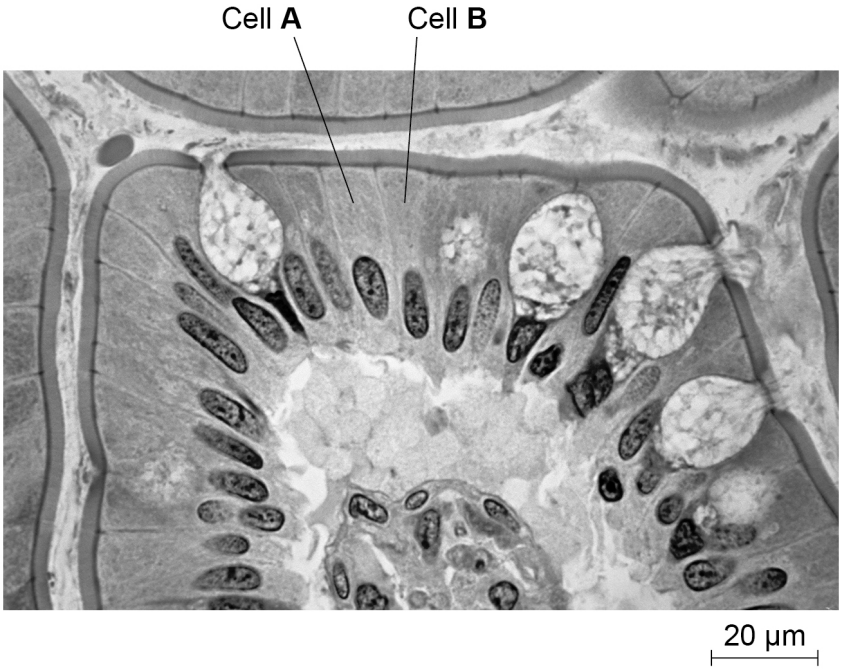
Answer **all** questions in the spaces provided.

0 1 The inner surface of a mammal's small intestine is covered in villi.

Figure 1 shows the tip of a villus in the ileum, viewed through the high power objective lens of a light microscope.

The scale bar represents a distance of 20 μm

Figure 1



0 1 . 1 Draw a diagram of cells **A** and **B** from **Figure 1**.

[2 marks]

0 1 . 2 The scale bar in **Figure 1** represents 20 μm

Calculate the length of cell **A**.

Give your answer in micrometres to the nearest whole micrometre.

[2 marks]

Length of cell **A** = _____ μm

The resolution of the light microscope is approximately 250 nanometres (nm).

0 1 . 3 Define the term **resolution**.

[1 mark]

_____

_____

_____

0 1 . 4 A typical mitochondrion measures 2 μm × 1 μm

In theory, mitochondria should be visible when viewing these cells with this light microscope.

Suggest **one** reason why **no** mitochondria are visible in cells **A** and **B** in **Figure 1**.

[1 mark]

_____

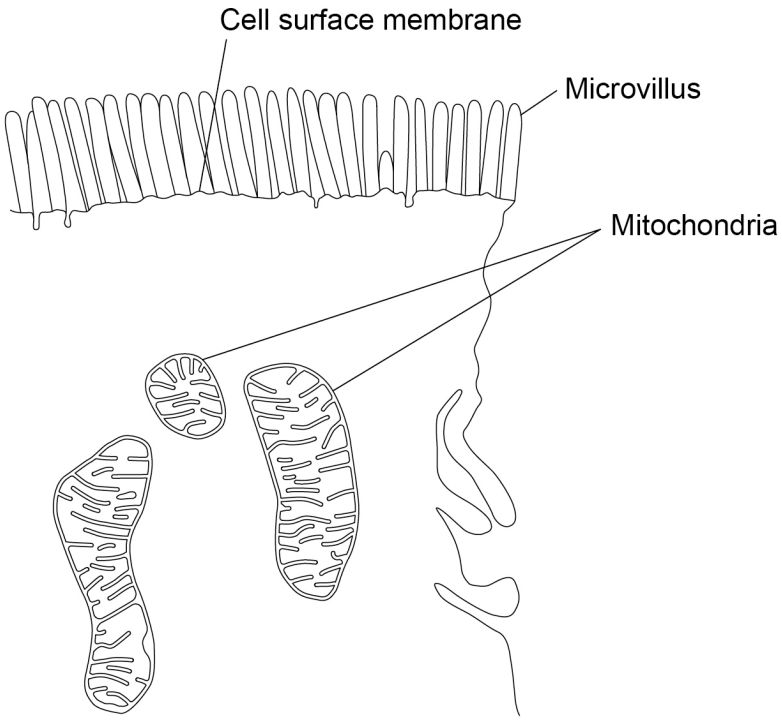
_____

_____

Question 1 continues on the next page

Figure 2 shows part of cell **A** from **Figure 1** in more detail.

Figure 2



The microvillus labelled in **Figure 2** has a length of 1.5 μm and a width of 0.25 μm

If there were no microvilli, the cell-surface membrane on the free edge of cell **A** would have a length of 8 μm

There are 28 microvilli visible on the free edge of cell **A**.

0 1 . 5 Calculate by how many times the free surface of cell **A**, as shown in **Figure 2**, is increased by having microvilli.

Assume that each microvillus is a rectangle and that all the microvilli are the same size.

Give your answer to **2** significant figures.

[2 marks]

Surface of cell **A** is increased _____ times

One function of the cells lining the ileum is to absorb the products of digestion.

Cell **A** has many microvilli and many mitochondria.

0 1 . 6 The increase in surface area produced by many microvilli helps the ileum to absorb large amounts of digested food.

Give the reason why.

[1 mark]

_____

_____

_____

Question 1 continues on the next page

0 1 . 7 Cyanide is a poison that prevents the transfer of electrons to oxygen in mitochondria.

Scientists investigate the rates of absorption of monosaccharides by the ileum of rats with or without treatment with cyanide.

Table 1 shows the scientists' results.

Table 1

	Relative rates of absorption	
Monosaccharide	**Without cyanide**	**With cyanide**
Glucose	1.00	0.33
Galactose	1.10	0.53
Xylose	0.30	0.31
Arabinose	0.29	0.29

Discuss the relative importance of diffusion and active transport in the absorption of each of the different monosaccharides.

Use information from **Table 1**.

[3 marks]

_____

_____

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_____

12

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

0 2 Most adults have a resting heart rate between 60 and 100 beats per minute.

A student made the hypothesis

'Fitter people have lower resting heart rates.'

0 2 . 1 Plan an investigation to find out if the student's hypothesis is correct.

[5 marks]

0 2 . 2 Draw a sketch graph to show the pattern of results you would expect from the investigation you planned in Question **02.1**.

Assume the student's hypothesis is correct.

Give **one** reason for the type of graph you have drawn.

[3 marks]

Reason _____

_____

_____

_____

0 2 . 3 Name a statistical test you could use to analyse your results.

Give a reason for your choice.

[2 marks]

Statistical test _____

_____

Reason _____

_____

_____

10

0 3 In fruit flies (*Drosophila melanogaster*), eye colour is an inherited characteristic.

Wild-type *Drosophila* have red eyes. A mutation causes the flies to have white eyes.

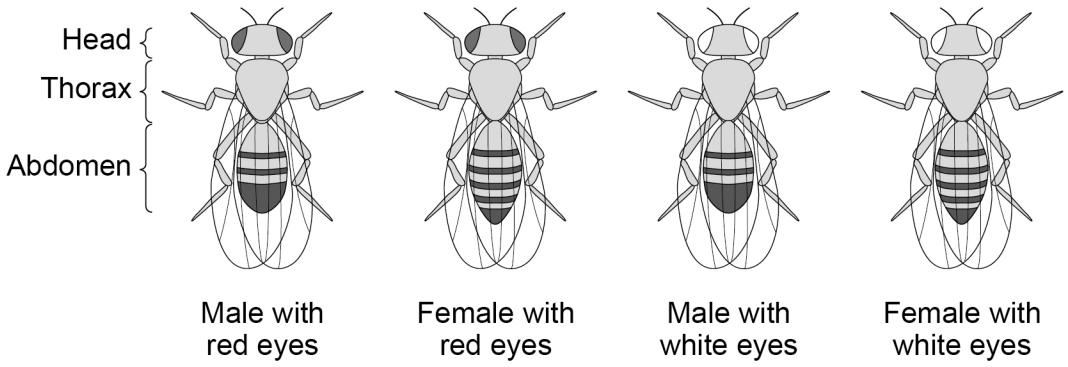
Drosophila are easy to breed in the laboratory as they are small, have a life cycle of only 14 days and produce large numbers of offspring.

0 3 . 1 Explain why the production of large numbers of offspring is useful in genetic investigations.

[2 marks]

Figure 3 shows male and female red-eyed and white-eyed *Drosophila*.

Figure 3



0 3 . 2 When choosing *Drosophila* for a genetic cross, it is important to identify which flies are males and which flies are females.

Use information from **Figure 3** to describe **two** ways that the abdomen of the male is different from the abdomen of the female.

[2 marks]

1

2

Question 3 continues on the next page

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ANSWER IN THE SPACES PROVIDED

Students cross red-eyed *Drosophila* with white-eyed *Drosophila*.

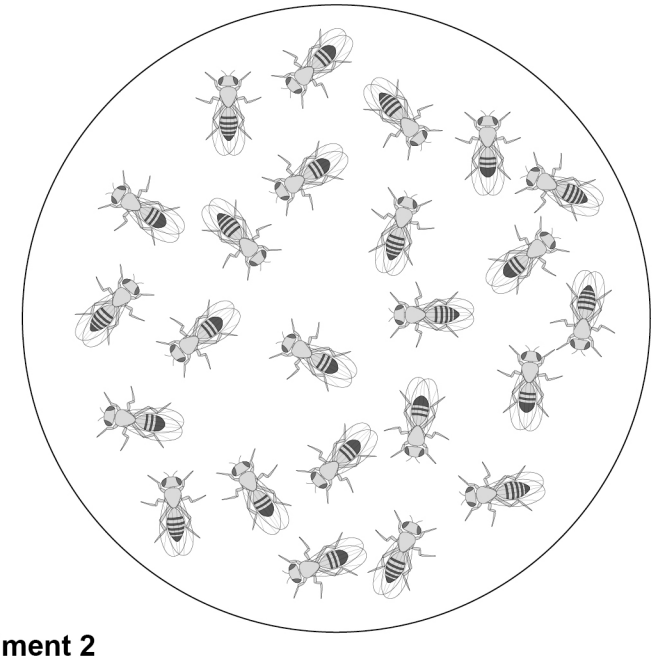
The results are different, depending on whether:

- a white-eyed male is crossed with a red-eyed female
- a red-eyed male is crossed with a white-eyed female.

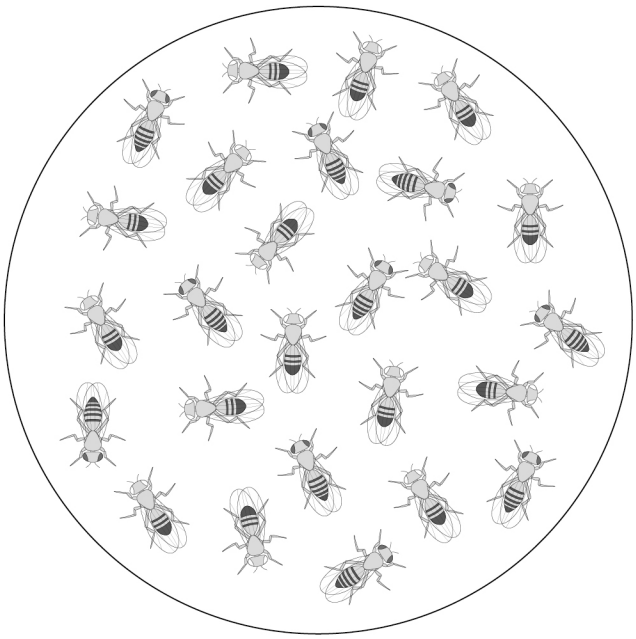
Figure 4 shows the offspring produced in each cross.

Figure 4

Experiment 1
White-eyed male × red-eyed female



Experiment 2
Red-eyed male × white-eyed female



0 3 . 3 Complete **Table 2** to show the numbers of each type of fly in **Figure 4**.

[2 marks]

Table 2

	Number of flies	
Phenotype of fly	**Experiment 1**	**Experiment 2**
Red-eyed male		
Red-eyed female		
White-eyed male		
White-eyed female		

In *Drosophila*, sex is determined in the same way as in humans.

0 3 . 4 Draw **two** genetic diagrams to explain the results in **Table 2**.

Include expected ratios of phenotypes for the offspring in each of experiments **1** and **2**.

[4 marks]

Use the following symbols:

$\mathbf{X^R}$ = an **X** chromosome carrying the allele for red eyes

$\mathbf{X^r}$ = an **X** chromosome carrying the allele for white eyes

Y = a **Y** chromosome.

Experiment 1

White-eyed male × red-eyed female

Ratio of offspring phenotypes _____

Experiment 2

Red-eyed male × white-eyed female

Ratio of offspring phenotypes _____

Question 3 continues on the next page

0 3 . 5 The students used the χ^2 (chi-squared) test to analyse their results.

The students calculated a value of $\chi^2 = 1.38$ for experiment **2**.

Table 3 gives probability values for different values of χ^2.

Table 3

Degrees of freedom	**Probability value**					
	0.99	**0.95**	**0.10**	**0.05**	**0.01**	**0.001**
1	0.0002	0.0039	2.71	3.84	6.63	10.83
2	0.020	0.103	4.61	5.99	9.21	13.82
3	0.115	0.352	6.25	7.81	11.34	16.27
4	0.297	0.711	7.78	9.49	13.28	18.47

Explain if the students' results fit the expected ratio for experiment **2**.

Use the calculated value of $\chi^2 = 1.38$ and data from **Table 3**.

[3 marks]

0 3 . 6 A red-eyed female *Drosophila* could be homozygous or heterozygous for eye colour.

Describe how you could find out if a red-eyed female *Drosophila* was homozygous or heterozygous for eye colour.

[3 marks]

16

Turn over for the next question

0 4 Some parts of the human body, such as the skin and the lining of the digestive system, have cells that continue to divide to replace damaged cells.

Cell division requires DNA replication.

Mistakes are sometimes made when the DNA replicates. Some of these mistakes in DNA replication occur in genes that control the rate of cell division.

A gene called MLH1 codes for a DNA-repair protein.

The MLH1 gene contains 57 496 base pairs.

0 4 . 1 Calculate the number of amino acids you would expect the MLH1 protein to have.

[1 mark]

Number of amino acids = _____

0 4 . 2 The actual number of amino acids in the MLH1 protein is 756.

State what causes the difference between this number of amino acids and the number you calculated in Question **04.1**.

[1 mark]

_____

_____

Methylation of the promoter region of the MLH1 gene can cause uncontrolled cell division and the formation of a tumour.

The promoter region of a gene is the point where RNA-polymerase attaches to the gene.

0 4 . 3 Explain how methylation of the promoter of the MLH1 gene could cause the formation of a tumour.

[3 marks]

_____

_____

_____

_____

_____

_____

0 4 . 4 Doctors can treat tumours using surgery and chemotherapy. Chemotherapy uses chemicals that inhibit DNA replication.

A man has a large tumour in his colon.

The man's doctor considers **two** options:

1. Use chemotherapy to reduce the size of the tumour and then remove the tumour surgically.
2. Remove the tumour first and then use chemotherapy to destroy any remaining tumour cells.

Suggest why the doctor chooses option **2**.

[3 marks]

8

0 5 Students investigate the diversity of small animals that live among stones at the bottom of a shallow river.

The students collect samples of the animals at two sites:

Site **P** 50 metres downstream from a sewage outlet.
Site **Q** 800 metres downstream from the sewage outlet.

The students:

- use square quadrat frames, 50 cm × 50 cm, and nets to take their samples
- put the samples of the small animals into shallow trays of water
- identify and count each different type of animal.

0 5 . 1 Describe how the students could collect a representative sample of the small animals living at each of sites **P** and **Q**.

[4 marks]

Table 4 shows the students' results.

Table 4

Animal	Total number of animals	
	Site P	Site Q
Tubifex tubifex	80	2
Chironomus thummi	35	8
Asellus aquaticus	10	55
Gammarus pulex	5	75
Baetis fuscatus	0	15
Index of diversity	2.20	

The students calculate an index of diversity for the animals at each of sites **P** and **Q**.

The students use the following equation:

$$d = \frac{N(N-1)}{\Sigma n(n-1)}$$

where d = index of diversity
N = total number of animals at the site
n = number of animals of each species

0 5 . 2 **Table 4** gives the index of diversity for site **P**.

Calculate the index of diversity for site **Q**.

[2 marks]

Index of diversity, **d**, for site **Q** = _____

Question 5 continues on the next page

0 5 . 3 Suggest why the index of diversity at site **Q** is larger than the index of diversity at site **P**.

[3 marks]

9

Turn over for the next question

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ANSWER IN THE SPACES PROVIDED

You are reminded that **2** marks will be awarded
for the quality of your written communication in **Question 6**.

0 6 Life would not be possible without water and enzymes.

0 6 . 1 Describe how plants and animals use water.

[6 marks]

0 6 . 2 Explain how enzymes can act as specific catalysts of metabolic reactions.

[6 marks]

0 6 . 3 Different varieties of maize produce grains (fruits) that store different forms of starch.

Waxy maize grains store starch that is 98% amylopectin.

Non-waxy maize grains store starch that is over 90% amylose.

The enzyme α-amylase catalyses the complete hydrolysis of amylose to reducing sugars. α-amylase will only partially hydrolyse amylopectin.

Design an experiment, using α-amylase, to investigate whether a new variety of maize has waxy or non-waxy grains.

[6 marks]

20

Quality of written communication [2 marks]

END OF QUESTIONS

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