

Please write clearly in block capitals.

Centre number

Candidate number

Surname \_\_\_\_\_

Forename(s) \_\_\_\_\_

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	
<b>TOTAL</b>	



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

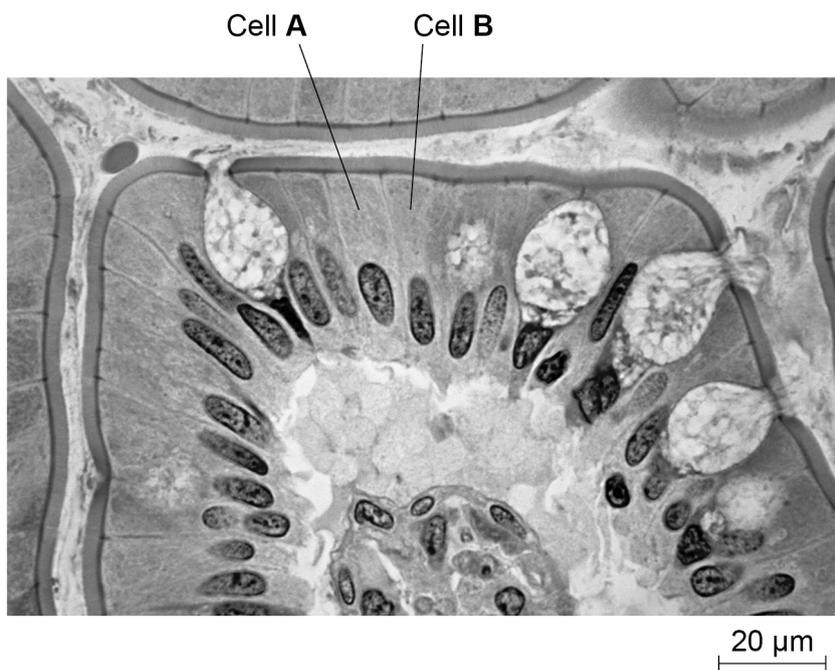
0 1

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  $\mu\text{m}$

**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  $20\ \mu\text{m}$

Calculate the length of cell **A**.

Give your answer in micrometres to the nearest whole micrometre.

**[2 marks]**

Length of cell **A** = \_\_\_\_\_  $\mu\text{m}$

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

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

**[1 mark]**

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**0 1 . 4** A typical mitochondrion measures  $2\ \mu\text{m} \times 1\ \mu\text{m}$

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]**

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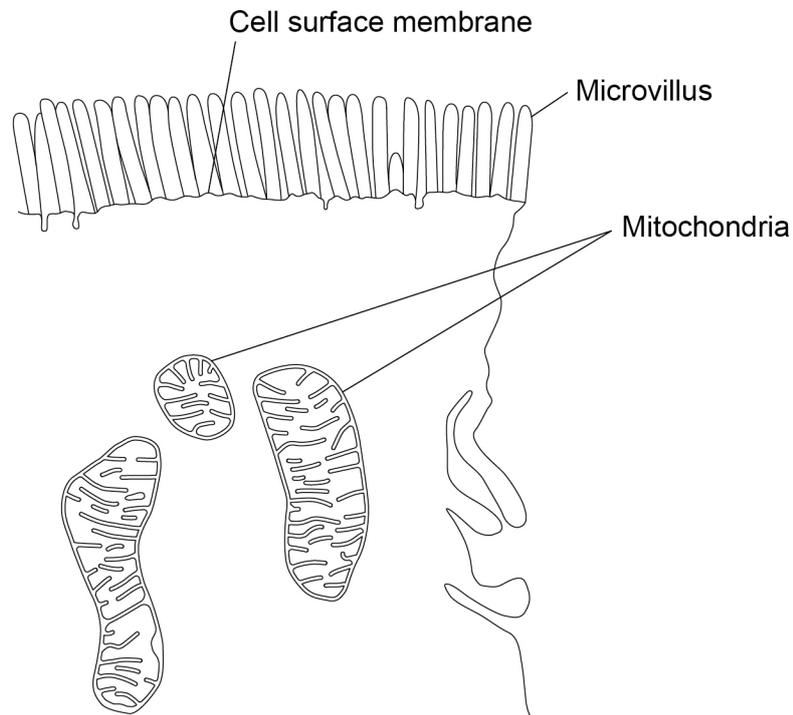
**Question 1 continues on the next page**

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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  $1.5 \mu\text{m}$  and a width of  $0.25 \mu\text{m}$

If there were no microvilli, the cell-surface membrane on the free edge of cell **A** would have a length of  $8 \mu\text{m}$

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]**

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**Question 1 continues on the next page**

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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**

Monosaccharide	Relative rates of absorption	
	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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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

Turn over ►



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]

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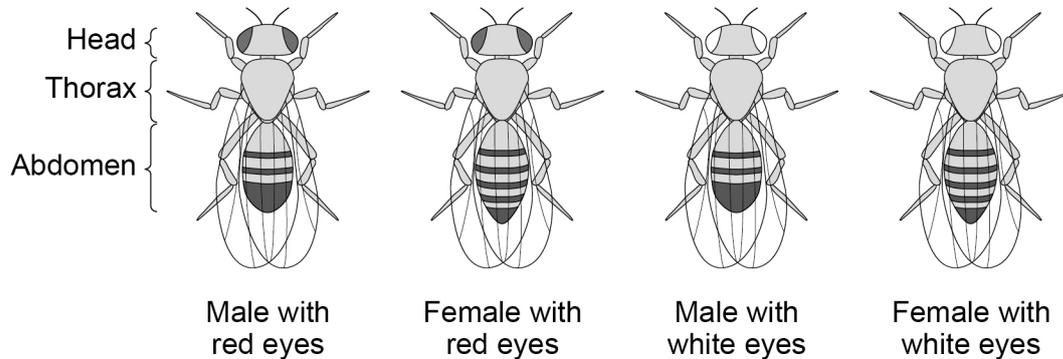
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Figure 3 shows male and female red-eyed and white-eyed *Drosophila*.

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 \_\_\_\_\_

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2 \_\_\_\_\_

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

The results are different, depending on whether:

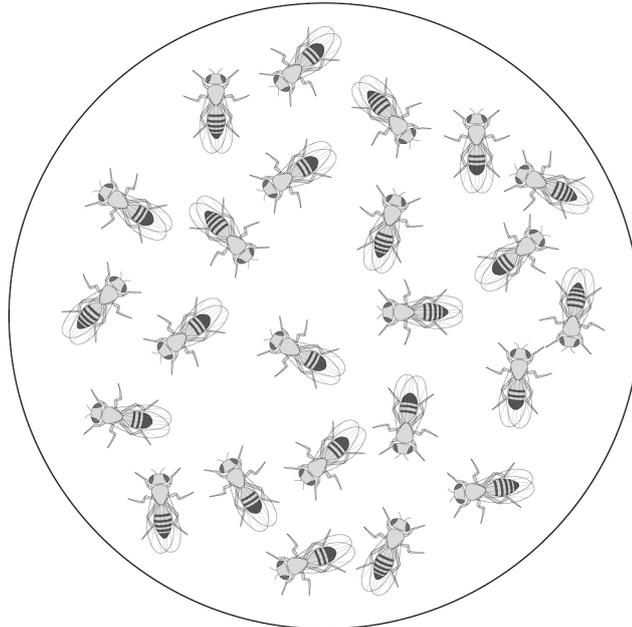
- a white-eyed male is crossed with a red-eyed female
- a red-eyed male is crossed with a white-eyed female.

**Figure 4** shows the offspring produced in each cross.

**Figure 4**

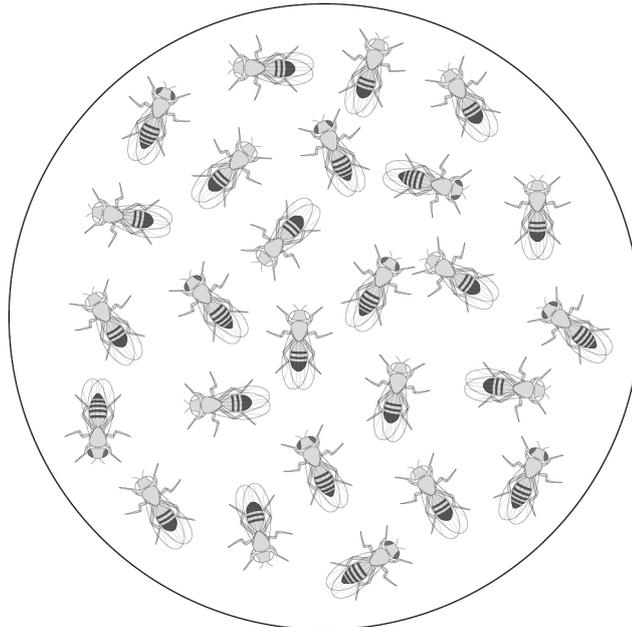
**Experiment 1**

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**

Phenotype of fly	Number of flies	
	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:

$X^R$  = an X chromosome carrying the allele for red eyes

$X^r$  = 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**

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**0 3 . 5** The students used the  $\chi^2$  (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  $\chi^2$ .

**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]**

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**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]**

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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]**

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0	4	4
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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]**

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**Table 4** shows the students' results.

**Table 4**

Animal	Total number of animals	
	Site P	Site Q
<i>Tubifex tubifex</i>	80	2
<i>Chironomus thummi</i>	35	8
<i>Asellus aquaticus</i>	10	55
<i>Gammarus pulex</i>	5	75
<i>Baetis fuscatus</i>	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:

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

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**

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0 5 . 3

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

[3 marks]

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**Quality of written communication [2 marks]**

**END OF QUESTIONS**



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