Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1232371107

BIOLOGY (PRINCIPAL) **9790/04**

Paper 4 Practical **May/June 2016**

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: As listed in the Confidential Instructions.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Section B
Answer **all** questions.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
Section B	
Total	

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **17** printed pages and **3** blank pages.

CAMBRIDGE International Examinations

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Section A

Answer **all** the questions.

You are advised to spend no more than **90 minutes** on Question 1.

1 You should read through the whole of this question carefully and then plan your use of the time to make sure that you finish all the work that you would like to do.

Betalains are red pigments that are found in some fungi and flowering plants, including beetroot, *Beta vulgaris*.

Betalains are glycosides consisting of a glucose molecule bound to a pigment compound by a glycosidic bond. Betalains are water soluble.

Cells of *B. vulgaris* store molecules of betalain in their vacuoles. The membrane surrounding vacuoles in plant cells is the tonoplast, which has a similar structure to other cell membranes.

(a) Suggest why betalain molecules cannot pass from vacuoles of plant cells into the cytoplasm.

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Various factors influence the permeability of membranes.

You are required to investigate the effect of different concentrations of alcohol on the membrane permeability of root cells of *B. vulgaris*.

To assess the permeability of the membranes of *B. vulgaris* cells you will make standard solutions of betalains (beetroot juice) of known concentration from two stock solutions that have been prepared from beetroot tissue.

Take care not to spill beetroot juice on your skin or clothing as it will stain.

You are provided with:

- 10.0% betalain solution
- 1.0% betalain solution
- distilled water
- 5 ready-prepared discs of root tissue from *B. vulgaris* (beetroot)
- 4 cores cut from the same root tissue, which you can use to prepare more discs
- 100% alcohol containing a mixture of ethanol and methanol
- a supply of boiling water.

Alcohol is highly flammable and harmful. You are recommended to wear eye protection.

Initial procedure

1 Make up a series of standard solutions of betalain using the 10.0% betalain solution, the 1.0% betalain solution and distilled water, as shown in Table 1.1.

You will need to make 10.0 cm^3 of each standard solution in the test-tubes provided. Use two 10 cm^3 syringes and a 1 cm^3 syringe, as appropriate.

Table 1.1

percentage concentration of standard solution of betalain	volume of 10.0% betalain solution / cm^3	volume of 1.0% betalain solution / cm^3	volume of distilled water / cm^3
10.0	10.0	–	0.0
5.0	5.0	–	5.0
1.0	–	10.0	0.0
0.5	–	5.0	5.0
0.1	–	1.0	9.0
0.0	–	–	10.0

You will require these standard solutions for step **4**. If you decide to use additional standard solutions with different concentrations from those in Table 1.1, state this in your answer to **(d)**.

Estimating the concentration of betalain

2 Put the five ready-prepared discs of beetroot into a specimen tube. Half fill the specimen tube with boiling water.

3 Leave the discs for ten minutes. Meanwhile continue with step **5**.

4 After ten minutes, pour off the solution surrounding the discs into a test-tube. Compare it with the standard solutions of betalain that you have prepared. Estimate the concentration of betalain in the solution.

(b) Record the estimated concentration of betalain in the solution.

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Main investigation

5 You are provided with four cores cut from fresh beetroot tissue. The cores are provided in a beaker of distilled water.

Cut the cores into an appropriate number of discs of approximately 4 mm thickness (3–5 mm is acceptable). Wash these discs thoroughly in several changes of washing water. Leave the discs in distilled water while you prepare the solutions of alcohol.

6 Use the 100% alcohol to make solutions of different concentrations of alcohol. Put 5.0 cm^3 of each concentration into a specimen tube for all the tests that you are planning to do.

(c) Use this space to construct a dilution table and to make any other notes about how you prepared the solutions of alcohol.

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7 Place washed discs of beetroot tissue into the specimen tubes containing the different concentrations of alcohol and leave them for at least **twenty minutes** before taking results.

8 After this time, pour off the solution from each specimen tube into an appropriately labelled test-tube and estimate the concentration of betalain in the solution.

(d) State and explain the steps that you took to ensure that you obtained valid results in this investigation.

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(e) Use the space below to present all of your results.

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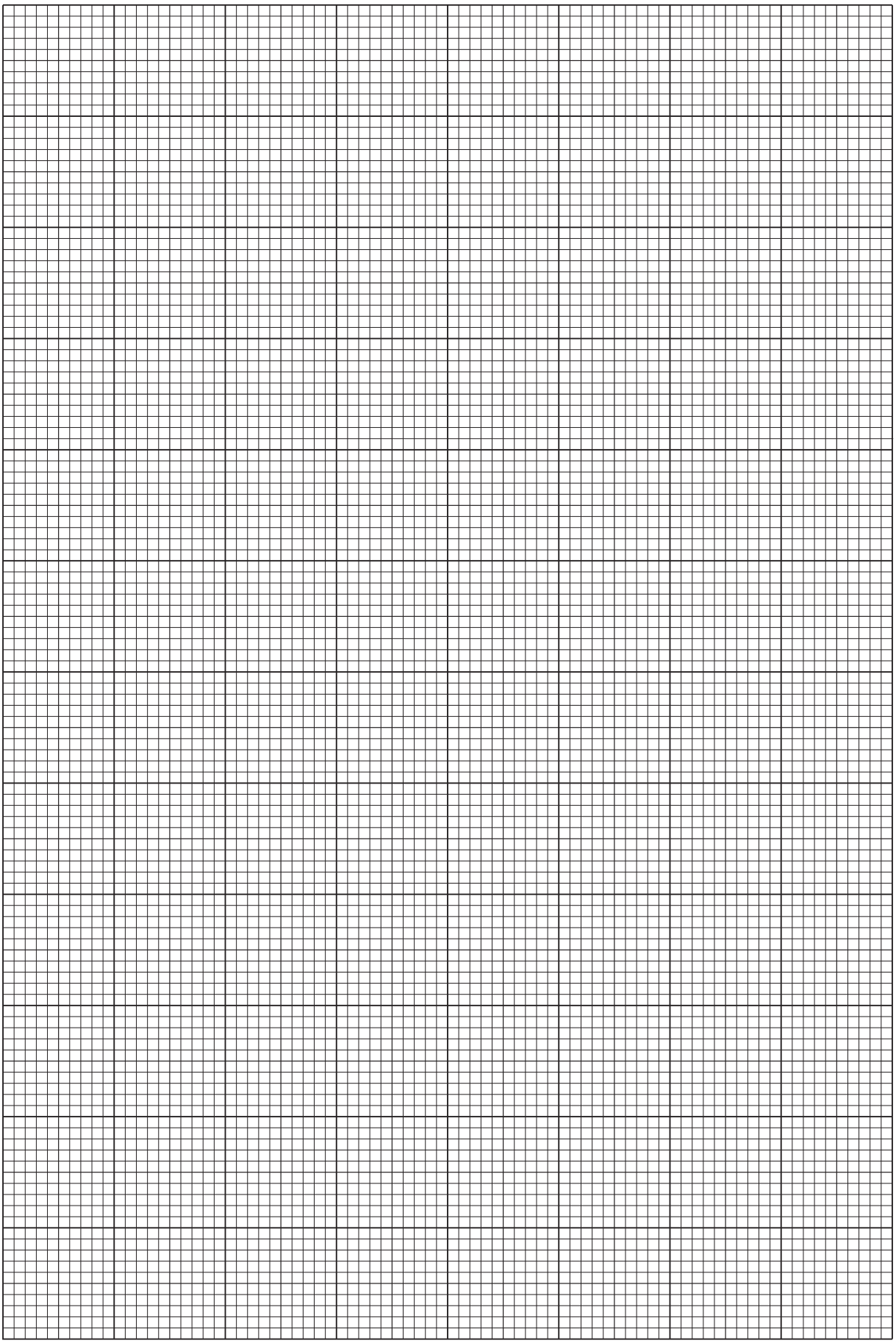
(f) Use the grid opposite to present your results in a suitable format. [5]



(g) Describe **and** explain your results.

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(h) Identify the limitations and sources of error in the investigation that may have affected the quality of the results.

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(i) Explain how you would use a colorimeter to determine the **rate of leakage** of betalains from beetroot tissue treated with 100% alcohol.

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Section B

Answer **all** the questions.

You are advised to spend no more than **60 minutes** on Section B.

You should read through the whole of Question 2 and Question 3 carefully and then plan your use of the time to make sure that you finish all the work that you would like to do.

2 Specimen **K1** is ivy-leaved toadflax, *Cymbalaria muralis*.

(a) Make a labelled drawing to show the features of a single leaf of *C. muralis*.

Indicate the magnification of your drawing.

[6]

(b) The lower epidermis of a leaf of *C. muralis* can be peeled away easily from the rest of the leaf.

Tear the leaf across and use your fingers or a pair of blunt forceps to remove a piece of the lower epidermis.

Place the piece of epidermis with the external surface facing upwards in a drop or two of water on a microscope slide. Cover it with a cover slip.

Observe under the low-power and high-power objective lens of your microscope.

(i) Use the space below to make a high-power drawing to show the characteristic features of the lower epidermis.

Label your drawing.

[6]

(ii) Indicate the magnification of your drawing and explain how you calculated it.

magnification .....

explanation .....

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(c) Fig. 2.1 shows the lower epidermis of a leaf of *Iris* sp.

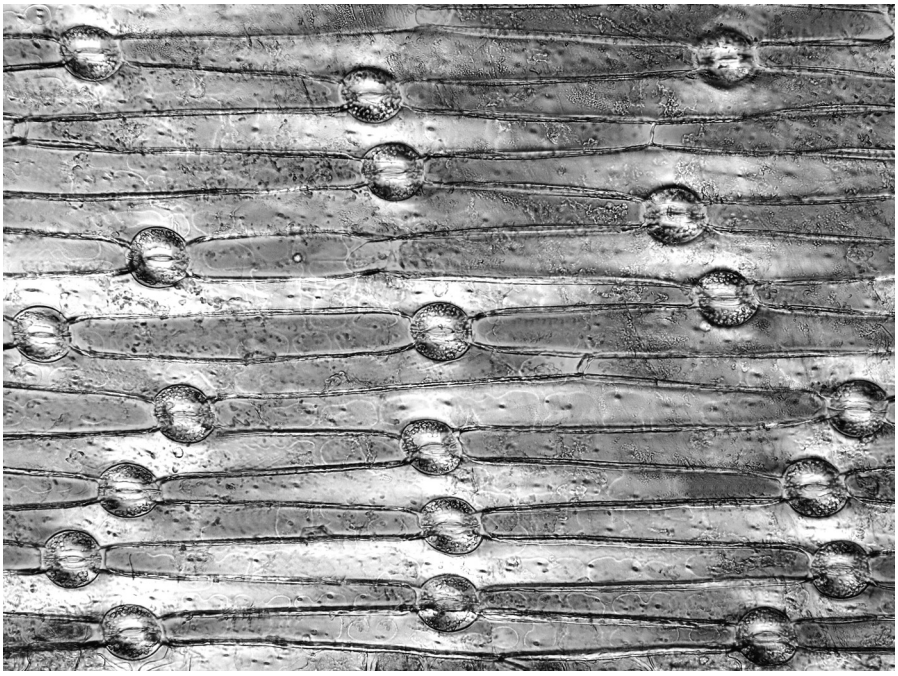

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Fig. 2.1

Describe how the lower epidermis of *Iris* differs from the lower epidermis of *C. muralis*.

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3 *Sordaria fimicola* is a fungus which has haploid and diploid stages in its life cycle.

In this species, as in many fungi, meiosis occurs soon after fertilisation. The zygote divides by meiosis to produce haploid nuclei that each divide immediately by mitosis.

The cytoplasm then divides to form eight spores. The formation of these spores occurs in tube-like structures known as asci, as shown in Fig. 3.1. The spores are lined up inside each ascus in the order in which they form.

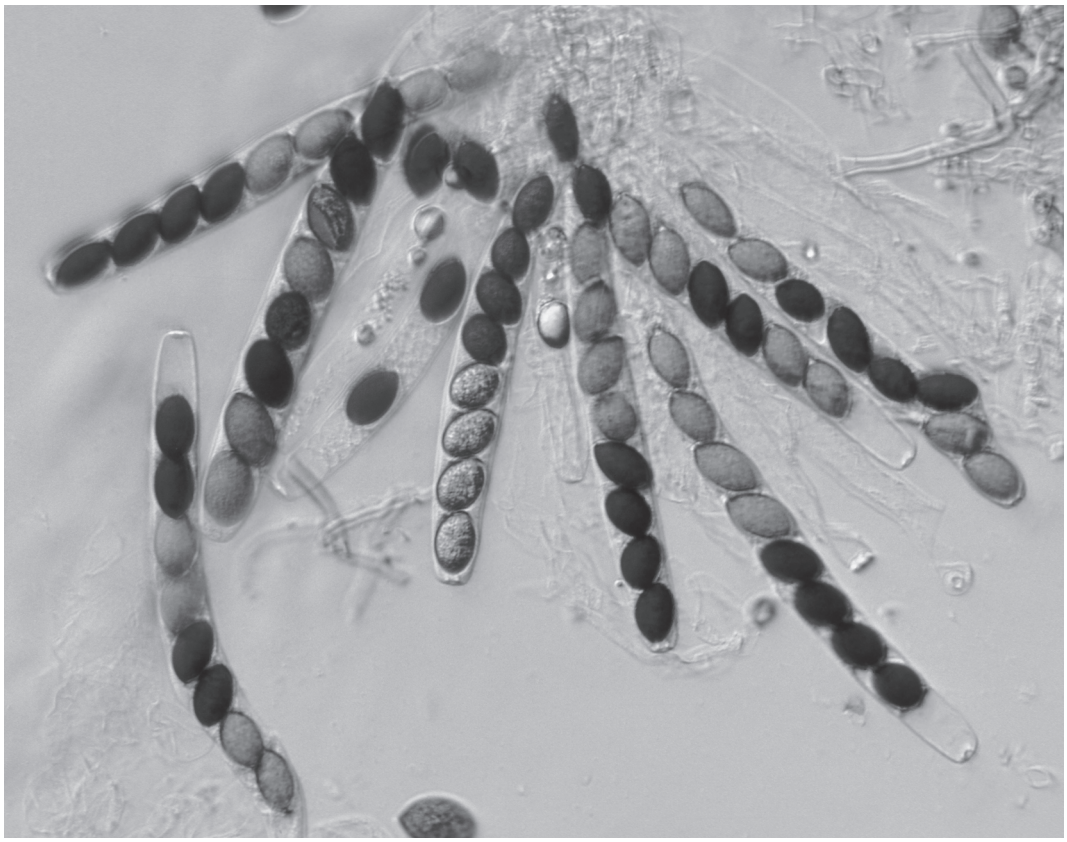

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Fig. 3.1

As shown in Fig. 3.1, the spores can be dark (black) or light (yellow) in colour. The gene controlling the colour of the spores has two alleles: **B** controls the production of a black pigment and gives rise to black spores and **b** gives rise to yellow spores.

When a diploid zygote, **Bb**, divides by meiosis then mitosis, half of the eight spores produced will be black and half will be yellow. The arrangement of black and yellow spores depends on whether or not crossing over occurs during meiosis. Fig. 3.2 shows the possible arrangements of black and yellow spores in asci that result when no crossing over has occurred during meiosis. Any other arrangement of spores is as a result of crossing over.

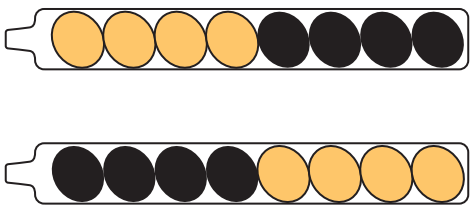

Fig. 3.2

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(a) State why crossing over can only occur during meiosis and not during mitosis.

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(b) A student photographed some asci of *S. fimicola* and made a drawing, as shown in Fig. 3.3.

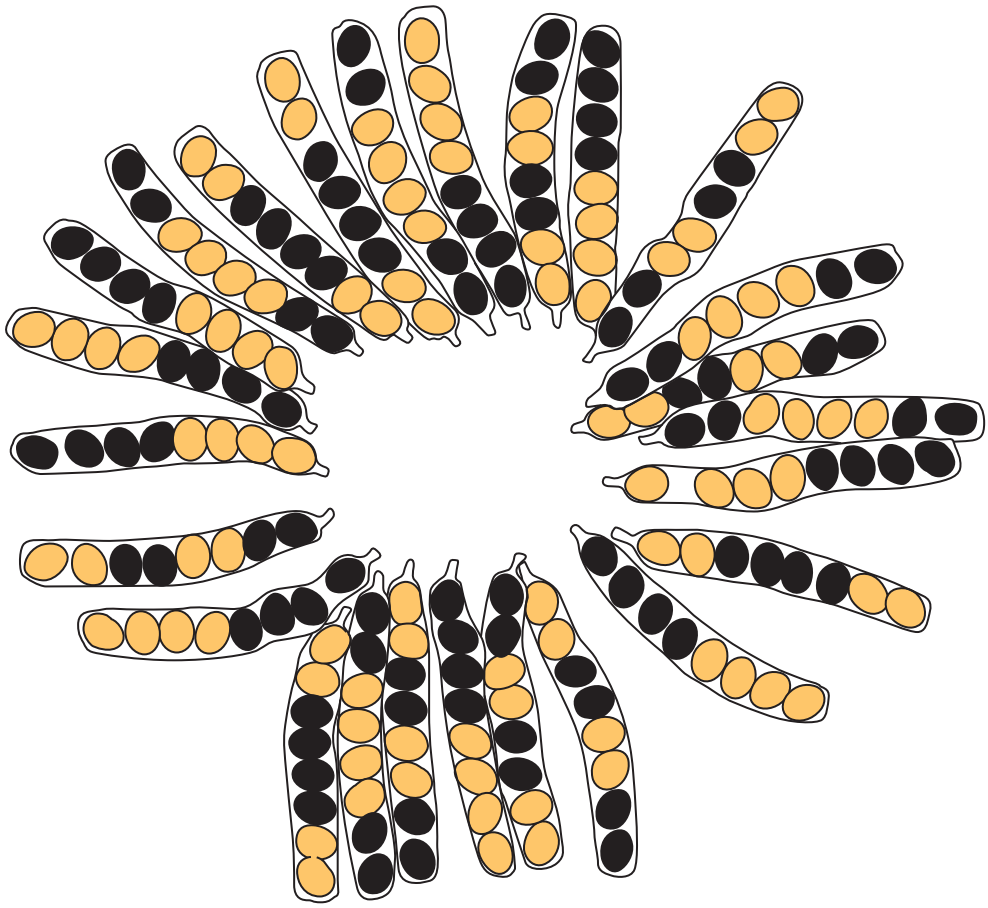

Fig. 3.3

(i) Count the number of asci in which crossing over has occurred.

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Count the number of asci in which crossing over has not occurred.

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From your results, calculate the percentage frequency of crossing over during meiosis in *S. fimicola*.

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[3]

(ii) Published data for *S. fimicola* states that the percentage frequency of asci showing the occurrence of crossing over is 54%.

Calculate the number of asci that would be expected to show crossing over in Fig. 3.3.

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(iii) The chi-squared (χ^2) test can be used to find the level of significance of the difference between the results from **(b)(i)** and the results based on the published data from **(b)(ii)**.

The formula for chi-squared is:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

$\sum$ = sum of…

O = observed value

E = expected value

Complete Table 3.1 and calculate the value of χ^2.

Table 3.1

	no crossing over	crossing over
observed number (O)		
expected number (E)		
$O - E$		
$(O - E)^2$		
$\frac{(O - E)^2}{E}$		

$\chi^2 = \sum \frac{(O - E)^2}{E}$	

[3]

(iv) State the null hypothesis for this investigation.

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(v) State the number of degrees of freedom for this investigation.

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(vi) Table 3.2 is a table of probabilities for values of χ^2 at different degrees of freedom.

Table 3.2

degrees of freedom	probability, p						
	0.90	0.50	0.10	0.05	0.02	0.01	0.001
1	0.02	0.45	2.71	3.84	5.41	6.64	10.83
2	0.21	1.39	4.61	5.99	7.82	9.21	13.82
3	0.58	2.37	6.25	7.82	9.84	11.35	16.27
4	1.06	3.36	7.78	9.49	11.67	13.28	18.47

Using Table 3.2 and the value of χ^2 that you calculated in **(b)(iii)**, state **and** explain the conclusion that can be made from these results.

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