Cambridge Pre-U

Cambridge International Examinations
Cambridge Pre-U Certificate

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

2308850209

BIOLOGY (PRINCIPAL) **9790/02**

Paper 2 Data Analysis and Planning **May/June 2018**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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 the question.
Write your answer in the space 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	

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

This document consists of **16** printed pages.

DC (LK/SW) 146144/4

CAMBRIDGE International Examinations

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Answer **all** the questions.

Section A – Data Analysis

1 The European honey bee, *Apis mellifera*, is a social insect that lives in colonies. Each colony contains one active egg-laying adult queen, many non-reproductive adult workers that collect food, and many larvae. Only a few of these larvae are able to develop into new queens. Fig. 1.1 shows an adult worker honey bee.

Fig. 1.1

Recently, in many countries the number of European honey bees has decreased. In order to conserve this species, efforts have been made to discover the reasons for this decrease. The decrease has been linked to several causes, one of which is greater use of pesticides. Two pesticides that are suspected of causing harm are:

- chlorpyrifos (CPF), which is an organophosphate insecticide
- Pristine®, which is a fungicide.

These are sprayed onto crop plants before flowering. When the crops flower, the honey bees visit the flowers to collect food (nectar and pollen) and then take it back to the hive. They store nectar as honey and store a mixture of pollen and honey as 'bee bread'.

These pesticides either kill the honey bees directly or may have these effects:

- damage the immune system of the honey bees, increasing the risk of infection by viruses
- prevent the development of replacement queens to take over the hive and form new colonies.

In an investigation into the effects of pesticides, several colonies of European honey bees were fed pollen treated in one of three different ways:

- **A** – pollen with CPF
- **B** – pollen with CPF + Pristine®
- **C** – pollen free from pesticide.

For each treatment, the researchers recorded the:

- pesticide concentration in the pollen
- pesticide concentration in the bee bread
- pesticide concentration in the honey bees.

Samples of pollen, bee bread and honey bees were analysed for CPF and Pristine®. The results, expressed as mean concentrations ±SD (standard deviation), are shown in Table 1.1.

Table 1.1

type of pollen fed to honey bees	pesticide concentration in pollen / parts per billion		pesticide concentration in bee bread / parts per billion		pesticide concentration in honey bees / parts per billion	
	CPF	Pristine®	CPF	Pristine®	CPF	Pristine®
A – pollen with CPF	967 ± 12	0	310 ± 12	0	80 ± 27	0
B – pollen with CPF + Pristine®	942 ± 35	529 ± 84	293 ± 13	381 ± 21	73 ± 33	23 ± 23
C – pollen free from pesticide	0	0	0	0	0	0

(a) Describe the results shown in Table 1.1, including reference to the standard deviations.

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(b) Queen larvae from colonies that had never been exposed to pesticide were placed in colonies supplied with pollen **A**, **B** or **C**. The number of queen larvae that completed development into adults and the number that died during development were counted for each treatment. A chi-squared test (χ^2) was performed to test the assumption that CPF has no effect on whether queen larvae complete their development. This was done using the data from the treatment with pollen **A** and the treatment with pollen **C**. The χ^2 value was 21.0, which corresponded to $p < 0.0001$.

The percentage of queen larvae that completed development into adults was also calculated for each treatment. The results are shown in Fig. 1.2.

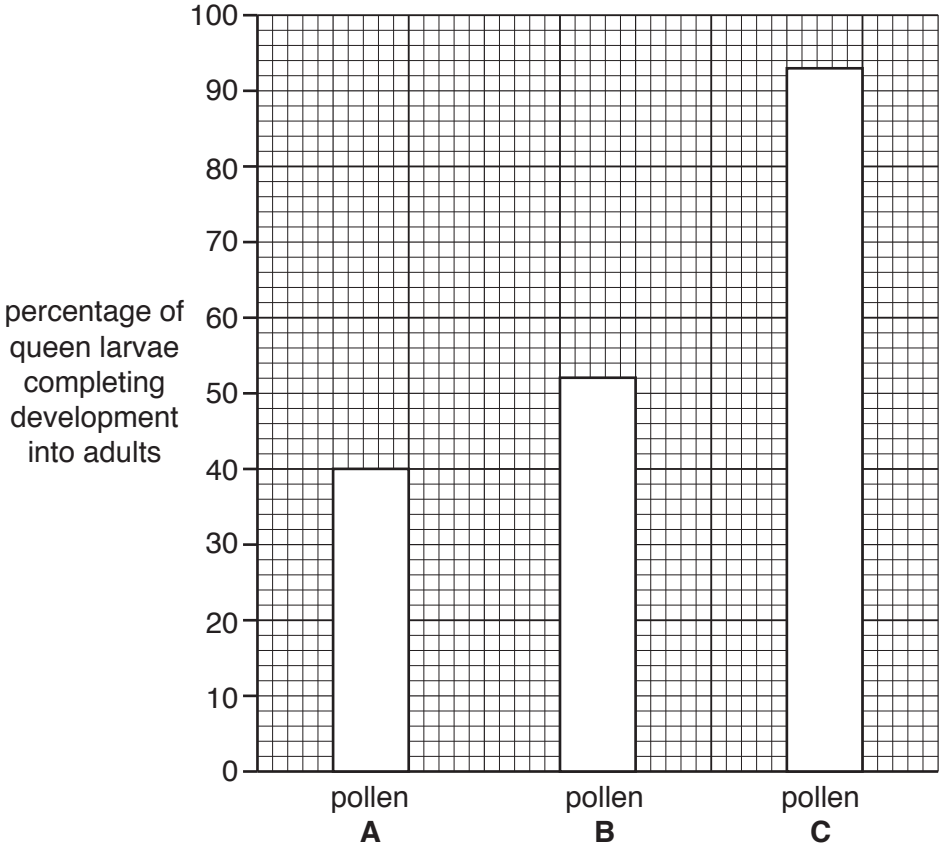

Fig. 1.2

Comment on these results, including reference to the χ^2 value and its corresponding *p* value.

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A further investigation involved newly hatched queen larvae from colonies supplied with either pollen **A** or pollen **B**. The larvae were fed either pollen **A** or pollen **B** for 36 hours before being transferred to a colony supplied with either pollen **A**, pollen **B** or pollen **C**. The larvae were observed for four weeks, after which time all larvae had either completed development into adults or died.

Fig. 1.3 summarises this investigation.

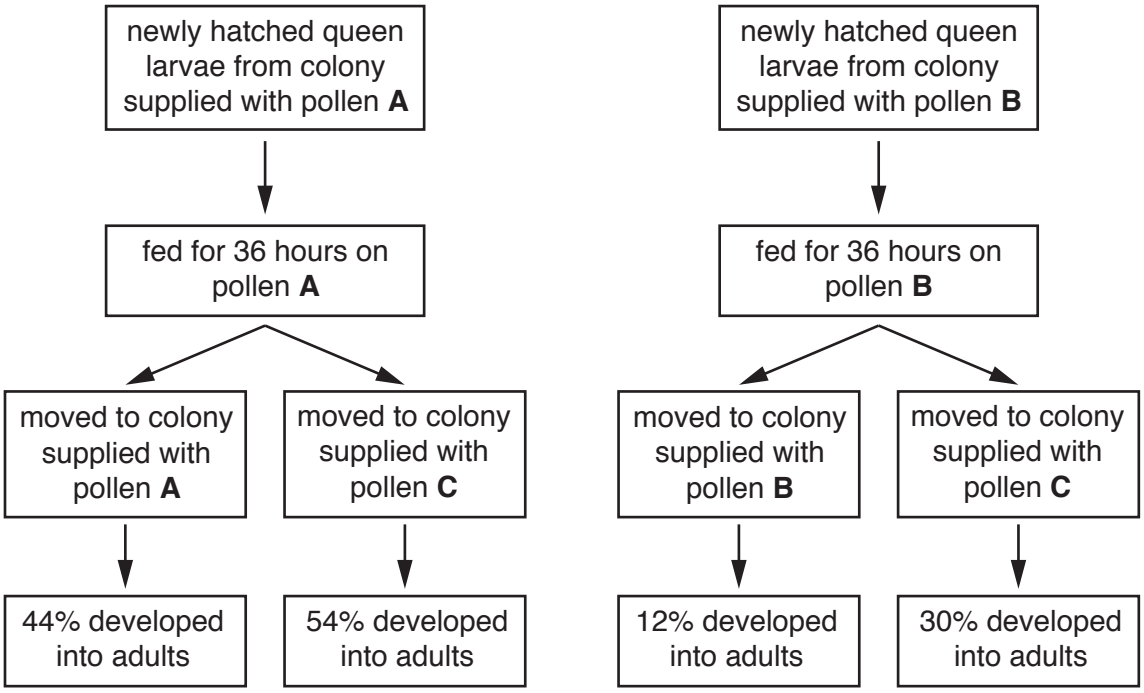

Fig. 1.3

(c) Describe **and** compare the effects of the different feeding treatments on the development of queen larvae, as shown in Fig. 1.3.

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Newly emerged adult queens from colonies fed pollen **A**, **B** or **C** were analysed for the presence of the deformed wing virus (DWV).

The results are shown in Fig. 1.4.

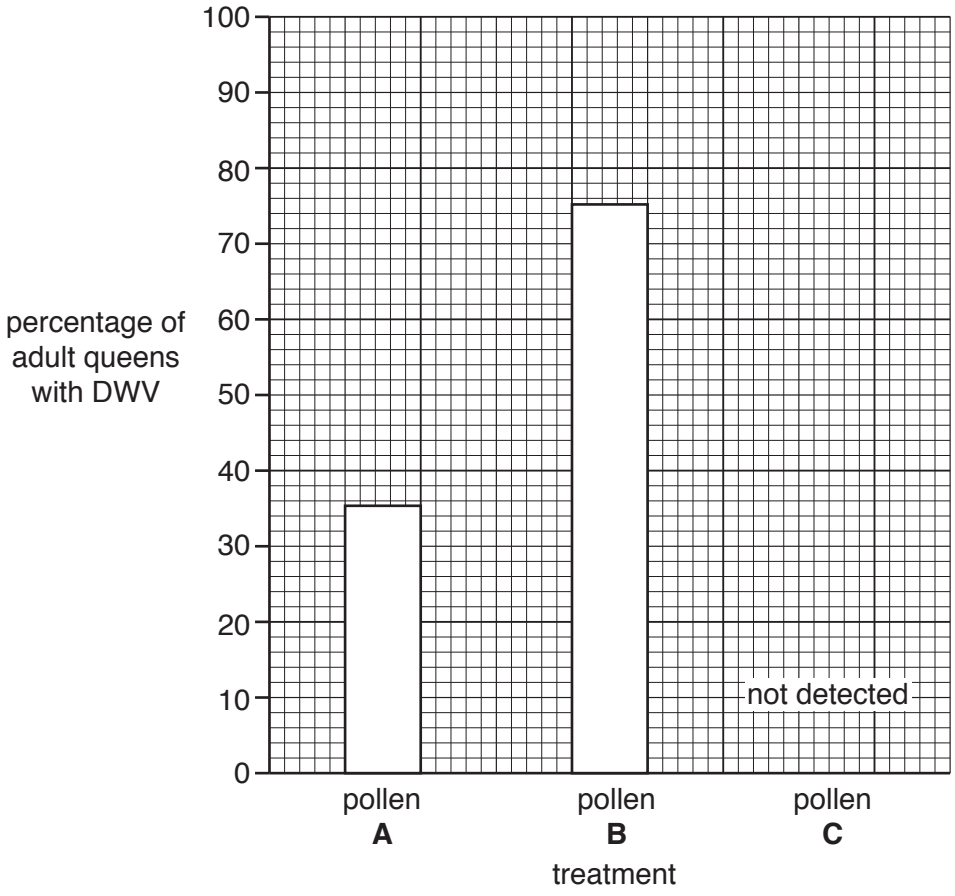

Fig. 1.4

The investigators hypothesised that increased infection with DWV in the bees fed with CPF and Pristine® resulted from reduced effectiveness of the immune system.

Organophosphates such as CPF block G-protein receptors.

The fungicide Pristine® inhibits the electron transport chain on the cristae of mitochondria.

(d) Suggest **and** explain how blocking G-protein receptors and inhibiting the electron transport chain will reduce the effectiveness of the immune system.

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inhibiting the electron transport chain .....

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(e) The European honey bee is important in the pollination of food crops. It has been described as a keystone species. Its conservation is considered a high priority.

(i) Explain what is meant by a *keystone species*.

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(ii) Outline the environmental and economic implications of the results from this study.

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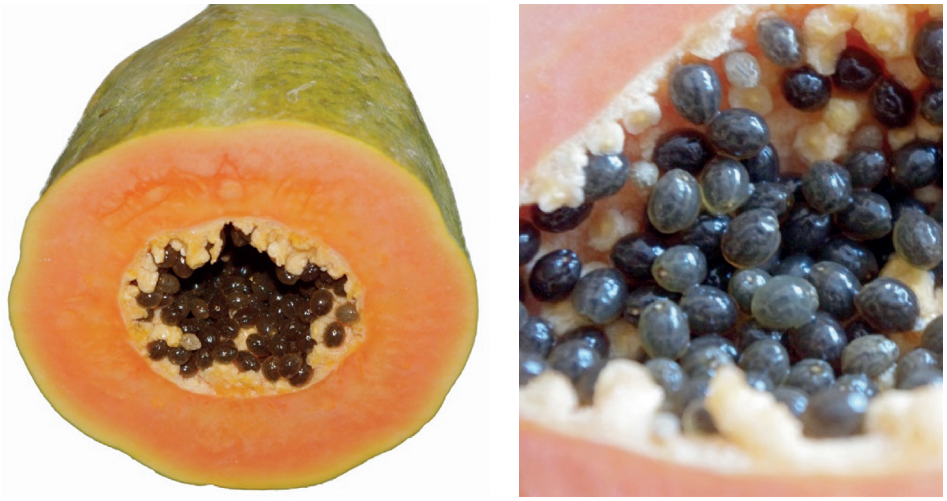
2 Papaya fruit have been investigated for their unusual biological properties.

(a) Fig. 2.1a shows a cut fruit of the papaya plant, *Carica papaya*. Its seeds are covered with a gelatinous protective layer known as a sarcotesta, shown in Fig. 2.1b.



a **b**

Fig. 2.1

Some students investigated the effect of sarcotesta extract on papaya seed germination. Germination is when the seed begins development into a plant.

The students prepared an extract of the sarcotesta from the seeds of a papaya fruit. They diluted the sarcotesta extract with distilled water to make ten solutions of different concentrations, **A** to **J**. The students took ten papaya seeds and removed the sarcotesta. One seed was then placed into each solution in separate Petri dishes.

The results are shown in Table 2.1.

Table 2.1

solution	percentage concentration of sarcotesta extract	germination after two weeks
A	0	yes
B	5	yes
C	10	yes
D	15	yes
E	20	no
F	25	no
G	30	no
H	35	no
I	40	no
J	45	no

(i) Suggest **two** limitations of the method described in this investigation.

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(ii) Use the results shown in Table 2.1 to suggest **and** explain a possible advantage to the plant of having a sarcotesta around its seeds.

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(b) Scientists have investigated the effect of papaya peel extract on the ability of human tumour cells to divide.

Different concentrations of papaya peel extract were added to cultures of human liver tumour cells, which were then incubated at 37 °C.

Table 2.2 shows the percentage of tumour cells still able to divide after incubation for 48 hours.

Table 2.2

papaya peel extract concentration / $\mu g\,cm^{-3}$	percentage of tumour cells able to divide
0	100
5	63
10	58
20	46
40	40
80	37

(i) Use the grid provided in Fig. 2.2 to plot a graph showing the effect of papaya peel extract concentration on the percentage of tumour cells able to divide.

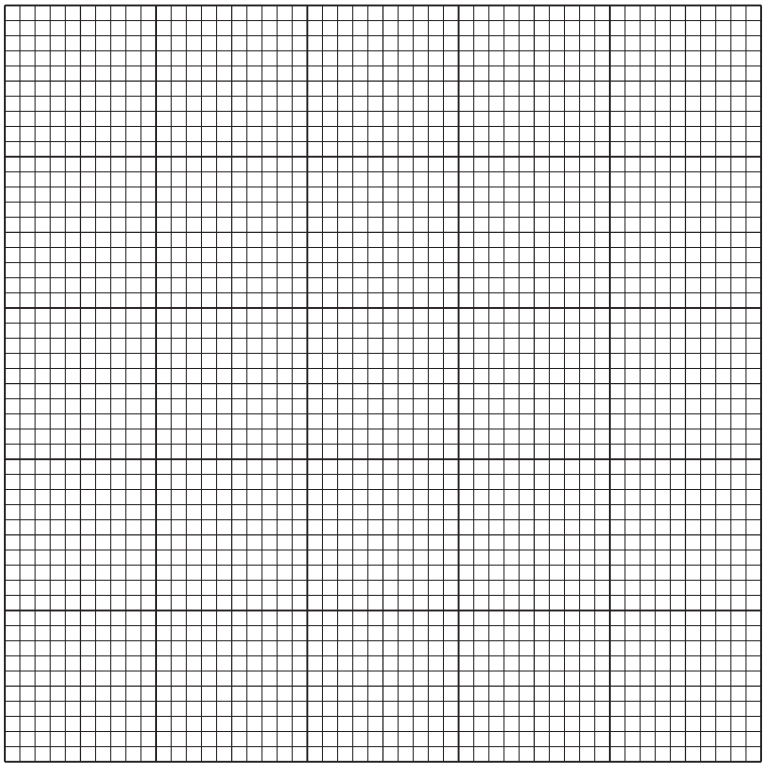

Fig. 2.2

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The effectiveness of an inhibitory drug can be measured as the concentration that inhibits division in 50% of the cells tested. This is known as IC_{50}.

(ii) Use Fig. 2.2 to determine the IC_{50} of papaya peel extract on human liver tumour cells.

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(iii) Suggest why IC_{50} is a useful measure of the effectiveness of inhibitory drugs.

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(iv) Suggest how the papaya peel extract could prevent the tumour cells from dividing by mitosis.

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(v) A student stated that $20\,\mu g\,cm^{-3}$ papaya peel extract would be suitable as a treatment for skin tumours in humans.

State, with reasons, whether this statement is supported by this study.

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Section B – Planning

3 During the light-dependent stage of photosynthesis, hydrogen ions and electrons are transferred to NADP.

This can be investigated using the Hill reaction, in which 2,6-dichlorophenol-indophenol (DCPIP) can be used as a substitute for NADP.

The herbicide atrazine is known to inhibit photosynthesis by blocking the electron transport chain on the thylakoid membranes of chloroplasts.

To test the effectiveness of atrazine, its effect on the rate of the light-dependent stage of photosynthesis can be determined in a suspension of isolated chloroplasts.

Plan an investigation to find out if there is a statistically significant correlation between the concentration of atrazine and the rate of the light-dependent stage of photosynthesis in isolated chloroplasts.

Atrazine poses a potential health risk and is an environmental toxin.

You are provided with the following materials. Choose your materials from this list. You may **not** use any additional materials.

- freshly isolated chloroplast suspension in isolation medium
- isolation medium at pH 7
- buffered DCPIP solution at pH 7
- 1% stock solution of atrazine
- distilled water
- bench lamp
- water-resistant marker
- beakers and flasks of different sizes
- test-tubes and boiling tubes
- test-tube and boiling tube racks
- pipettes and pipette fillers
- glass rods for stirring
- syringes of different sizes
- stopwatch or electronic timer
- 30 cm ruler, mm scale
- thermometer, –10 °C to 110 °C
- thermostatically controlled water-bath
- aluminium foil
- black paper
- white card
- rubber bands
- light meter
- safety spectacles

Your plan should:

- include a clear statement of the hypothesis or prediction
- identify the key variables
- give full details and explanations of the procedures that you would adopt to ensure that the results are as precise and repeatable as possible
- show how you would present and analyse your results
- include a brief risk assessment
- be written in clear, scientific language.

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