OCR
Oxford Cambridge and RSA

Wednesday 17 June 2015 – Morning

A2 GCE BIOLOGY

F215/01 Control, Genomes and Environment

Candidates answer on the Question Paper.

OCR supplied materials:
Insert (inserted)

Other materials required:
- Electronic calculator
- Ruler (cm/mm)

Duration: 2 hours

* F 2 1 5 0 1 *

* 4 8 3 6 9 7 2 7 7 2 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined pages at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **100**.
- Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- This document consists of **28** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Fig. 1.1 shows changes over time in the mass of nuclear DNA in some of the cells of the testes of a diploid organism.

During this time period, two different types of nuclear division occurred.

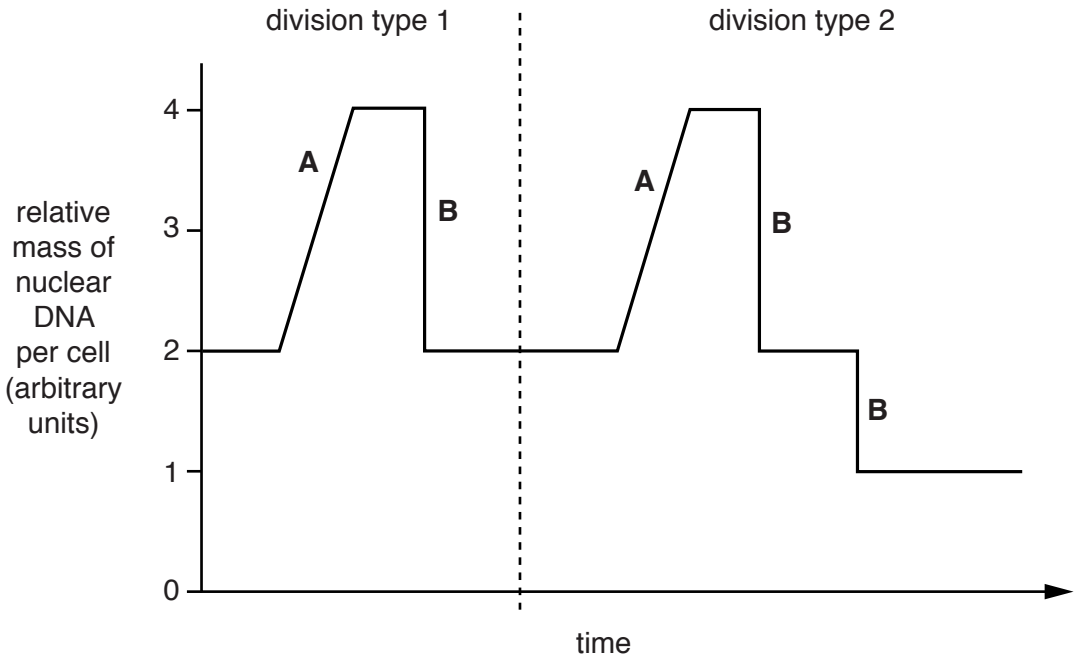


Fig. 1.1

(i) Identify the two types of division represented in Fig. 1.1.

division type 1 .....

division type 2 .....

[1]

(ii) Name the processes that are occurring at the points labelled **A** and **B**, which cause the change in the mass of DNA per cell.

A .....

B .....

[2]

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(b) Discuss the ways in which genetic variation is produced, including the role of nuclear division.



In your answer you should link the processes to the ways in which the genetic variation is produced.

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2 The elk, *Cervus canadensis*, is a large herbivore.

Fig. 2.1, **on page 2 of the Insert**, shows figures relating to the number of elk in Yellowstone National Park in the USA between 1965 and 2002.

The figures were obtained in two different ways:

- the white bars show estimated numbers of live elk obtained by ecological sampling
- the black bars show numbers of elk that were legally shot by hunters.

In some years no data for live elk were obtained.

(a) (i) Using Fig. 2.1, describe the pattern shown by the data for the estimated number of live elk from 1965 to 2002.

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..... **[3]**

(ii) The recorded number of elk legally shot by hunters provides accurate data.

Suggest why these data are accurate, but the method used to obtain these data is not a valid way of estimating the number of elk in the population.

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..... **[2]**

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(b) The grey wolf, *Canis lupus*, is a large predator whose diet includes elk.

By 1926, grey wolves had been hunted to extinction in Yellowstone Park. However, this species could still be found in other parts of the world.

In 1995, a population of grey wolves was introduced to Yellowstone Park and their numbers increased.

(i) With reference to Fig. 2.1, discuss the factors that may have affected the size of the elk population:

- before 1995
- after 1995.

In your answer you should provide a balanced account referring to factors before and after 1995.

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.....**[7]**

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(ii) Explain why the introduction of wolves to Yellowstone Park in 1995 is an example of conservation.

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..... **[2]**

[Total: 14]

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3 Gene sequencing is an important technique in molecular biology.

Fig. 3.1, **on page 3 of the Insert**, shows part of a computerised graph obtained from an automated gene sequencing machine.

- The section of the DNA molecule represented in Fig. 3.1 is from base position 117 (on the left of the graph) to base position 137 (on the right of the graph).
- The bases in the DNA sequence are labelled with four different coloured fluorescent dyes.
- The identities of some of the bases (117 to 119 inclusive and 129 to 137 inclusive) are indicated below the graph.

(a) Use Fig. 3.1 to identify the order of bases from positions 120 to 128.

.....	.....	.....	.....	.....	.....	.....	.....	.....
120	121	122	123	124	125	126	127	128

[1]

(b) To produce the type of graph shown in Fig. 3.1, the automated gene sequencing machine needs to be loaded with the following:

- the DNA to be sequenced
- short primer sequences specific to the DNA to be sequenced
- many normal DNA nucleotides
- some chain-terminating DNA nucleotides labelled with coloured dyes
- the enzyme *Taq* polymerase.

A regular cycle of temperature changes allows many DNA fragments of different lengths to be built up by the polymerase chain reaction (PCR).

Fig. 3.2 (**on the next page**) shows the end parts of the sequences of seven of these different length fragments, labelled 1 to 7. The end parts of the sequences for fragments 1 to 4 are complete but those for fragments 5 to 7 are not.
These seven fragments correspond to the **last seven peaks** on the right hand side of the graph in Fig. 3.1.

The letters in boxes represent labelled chain-terminating DNA nucleotides.
The letters not in boxes represent normal DNA nucleotides.

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(i) Use the information in Fig. 3.1 to fill in the missing nucleotide bases on fragments 5 to 7 on Fig. 3.2.

You should distinguish between the normal and labelled nucleotides in the sequence for each fragment.

1 – **T**

2 – **T** **A**

3 – **T** **A** **T**

4 – **T** **A** **T** **T**

5 – **T** **A**

6 – **T** **A**

7 – **T** **A**

[2]

Fig. 3.2

(ii) Explain how the automated sequencing machine orders the DNA fragments from the PCR reaction into the size order shown in Fig. 3.2.

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..... **[3]**

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(c) Gene sequencing can help us to understand how an individual's genome affects their body's response to drugs.

One research study has looked at the effectiveness of drugs used to treat asthma in children. Asthma is a condition in which the bronchioles become reduced in diameter. This results in the child finding it difficult to breathe.

(i) Using your knowledge of the structure of bronchioles, suggest how their diameter might become reduced.

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.....**[2]**

(ii) Explain why it is difficult to expel air from the lungs if the bronchioles become reduced in diameter.

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..... **[1]**

(d) Asthma in children may be treated with drugs. One of the most commonly used drugs is salmeterol.

Salmeterol acts by binding to protein receptors in the lining of the bronchioles. However, in approximately 14% of children with asthma, salmeterol is not very effective. This is thought to be the result of a genetic mutation in these children.

Suggest why this mutation reduces the effectiveness of salmeterol.

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..... **[3]**

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(e) In a recent medical trial, 62 children with this genetic mutation were studied.

- Their asthma was not controlled well by salmeterol.
- 31 children continued using salmeterol and the remaining 31 were given an alternative drug, montelukast.
- Montelukast is not routinely prescribed because salmeterol is far more effective for most children with asthma.

(i) After one year, the children taking montelukast had better control of their asthma and were able to reduce their use of montelukast.

Suggest why these children responded better to montelukast than to salmeterol.

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..... **[2]**

(ii) Comment on the reliability of the results of this medical trial.

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..... **[1]**

(iii) It is proposed that a simple saliva test could identify those children who have the mutation.

What would be the source of the genetic material used in this test?

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..... **[1]**

[Total: 16]

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4 This question looks at two ways of using mathematical concepts in Biology.

(a) When a new road system was constructed, it split a population of a rare snail species into three smaller populations, **A**, **B** and **C**. As a result, each of these populations became reproductively isolated.

The Hardy-Weinberg principle was used to calculate the relative frequencies, p and q, of a dominant and a recessive allele in each population.

Table 4.1 shows the values of p and q, and the estimated sizes of these three populations.

Snail population	Estimated population size	Immediately after road building		10 years after road building	
		p (frequency of dominant allele)	q (frequency of recessive allele)	p (frequency of dominant allele)	q (frequency of recessive allele)
A	1000	0.50	0.50	0.52	0.48
B	100	0.49	0.51	0.63	0.37
C	10	0.40	0.60	0.20	0.80

Table 4.1

(i) Name the type of isolating mechanism that prevents interbreeding between these three snail populations.

..... **[1]**

(ii) The habitat of these snail populations did not change over the ten years.

State the term used to describe the **random** changes in allele frequency in a small population.

..... **[1]**

(iii) Explain which of the populations, **A**, **B** or **C**, experienced most genetic change.

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..... **[2]**

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(b) The inheritance of different alleles in fruit flies, *Drosophila* spp., has been studied extensively in the laboratory.

Two genes that affect the appearance of *Drosophila* are:

R / r red / pink eyes
Y / y yellow / ebony body

Flies known to be heterozygous at both of these loci were crossed with homozygous pink-eyed ebony flies.

Based on the hypothesis that the two genes assort independently, the offspring expected from this cross would be four different phenotypes in a ratio of 1:1:1:1.
The results obtained, however, are shown in Table 4.2.

Phenotype	Expected number	Observed number
Red eye, yellow body	360	6
Pink eye, yellow body	360	701
Red eye, ebony body	360	729
Pink eye, ebony body	360	4

Table 4.2

The chi-squared (χ^2) test can be used to assess whether the results in Table 4.2 are significantly different from the expected results.

The equation for working out the value of χ^2 is given below.

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

where Σ = 'sum of …'
O = observed value
E = expected value

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(i) Calculate the value of χ^2 **to the nearest whole number** for the genetic cross results shown in Table 4.2.

Complete the table below and determine the value of χ^2.

Phenotype of fly	**O – E**	**$(O - E)^2$**	**$\frac{(O - E)^2}{E}$**
Red eye, yellow body	–354	125316	348
Pink eye, yellow body	341	116281	323
Red eye, ebony body			
Pink eye, ebony body			

χ^2 = ... **[3]**

(ii) Statistical tables show that, for this data set, if χ^2 has a value of 11.35, the observed results would only be produced by chance in 1% of trials.

Use this information and the value for χ^2 that you have calculated in **(i)** to explain whether the original hypothesis should be accepted or rejected.

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..... **[1]**

(iii) The difference in the observed numbers from the cross compared with the expected numbers has **not** occurred by chance. Suggest a genetic explanation for this difference.

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..... **[3]**

[Total: 11]

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5 The efficiency of energy transfer between trophic levels limits the number of organisms in a particular ecosystem.

(a) Outline how the **percentage efficiency** of energy transfer between producers and herbivores can be estimated.

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..... **[4]**

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(b) One way that humans try to maximise food production is to manipulate the transfer of energy through ecosystems.

A number of methods can be used to increase energy transfer through agricultural ecosystems and other food production systems.

These methods include:

A artificial selection

B recombinant DNA technology

C growing microorganisms in a fermenter

D use of immobilised enzymes

E control of plant physiology with synthetic plant hormones

F manipulation of the nitrogen cycle.

Using the letters **A** – **F**, select the **most suitable** method that could be used to achieve each of the aims shown in the table below.

You may select each letter more than once.

Aim	**Letter**
improving soil that is low in nutrients for the growing of wheat	
preventing the spoilage of fruits after picking	
reducing the impact of a fungal disease on yields from cucumber plants	
producing strawberry plants that grow quicker and fruit earlier	
making sugar syrup from waste starch	
producing large amounts of a fungus for food	

[6]

Question 5(c) begins on page 18

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(c) Some animal pests compete with humans for food.

Some examples of pest behaviour are described below. These include examples of innate (instinctive) and learned behaviours.

Name each **specific** type of innate or learned behaviour described in the table below.

Description	Name of innate or learned behaviour
Sparrows initially fly away from fruit bushes on which shiny CDs are hung, particularly when the CDs move in the wind.	
After a few days the sparrows start visiting the fruit bushes again, and do not fly away even when the CDs move.	
Carrot flies move towards chemicals released by carrot plants.	
Raccoons learn to remove lids from containers of grain in a barn.	
A line of young chicks follow their mother into a cornfield.	

[5]

[Total: 15]

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6 This question considers some similarities and differences in plant and animal biology.

(a) (i) Describe two **similarities** in the action of plant and animal hormones **in cell signalling**.

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[2]

(ii) Asexual reproduction and the ability to produce natural reproductive clones is common in plants but rare in animals.

Explain why plants are more able to form **natural** reproductive clones than animals.

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..... **[2]**

(iii) Polyploidy is the possession of more than two sets of chromosomes in the nucleus. Polyploidy is common in plants.

Suggest an explanation for the significance of polyploidy in forming new species of plant such as bread wheat, *Triticum aestivum*.

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(b) A student setting up an experiment to investigate the effect of light on cress plant seedlings accidentally shone the bright light onto one side of the face of another student. He noticed that the student immediately responded by raising her hand to shield her eye from the light.

The response of the cress seedlings to light shining from one direction was slower, but after 24 hours the cress seedlings had grown towards the light.

Describe the mechanisms that produced the responses to light in the cress seedlings **and** in the human.

cress seedlings .....

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human .....

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[7]

[Total: 13]

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7 **(a)** Nicotine is a toxic chemical. Smokers take in low doses of nicotine that are not toxic in the short term, but these low doses affect cardiovascular health in the longer term.

Nicotine increases blood pressure and increases the likelihood of a thrombosis (formation of a blood clot). Either of these effects can lead to a stroke, which is when cells in part of the brain die, leading to loss of function.

(i) Suggest how each of these stated effects of nicotine could contribute to cell death in the brain.

increased blood pressure .....

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thrombosis .....

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[4]

(ii) It is important that the correct treatment is given when a stroke is suspected.

Research has led to the ability to identify whether a stroke has resulted from a thrombosis or from increased blood pressure.

The standard emergency treatment for a suspected stroke is to give a drug that will counteract a thrombosis. If, however, the cause of the stroke is found to be high blood pressure, an alternative treatment would be more appropriate.

Explain why.

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..... **[1]**

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(iii) The effects of a stroke will depend on which part of the brain has been affected.

Some possible effects of a stroke are listed below.

- Problems with coordination of movement.
- Loss of memory and speech.
- Paralysis of the body below the neck.

With reference to named parts of the brain, explain how each of these specific effects is caused.

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..... **[4]**

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(b) Nicotine is produced by plants of the genus *Nicotiana*.

In an experiment, the leaves of a *Nicotiana* plant were punctured with tiny holes. This damage imitated insect attack.

Table 7.1 shows the effect of this damage on the nicotine concentration and seed production of a *Nicotiana* plant compared with a plant that was not damaged.

	Nicotine concentration (%)	**Number of seeds produced**
Control plant	0.67	2600
Plant with leaves punctured with holes	0.98	1100

Table 7.1

Discuss whether the ability to produce nicotine can be considered a selective advantage or a selective disadvantage to *Nicotiana* plants.

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..... **[3]**

Question 7(c) begins on page 24

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(c) Nicotine molecules have a shape that is complementary to acetylcholine receptors. As a result, nicotine interferes with the nervous systems of insects and mammals by binding with these receptors.

(i) Where, precisely, are acetylcholine receptors found?

..... **[1]**

(ii) The way that nicotine is thought to work is outlined in Fig. 7.1.

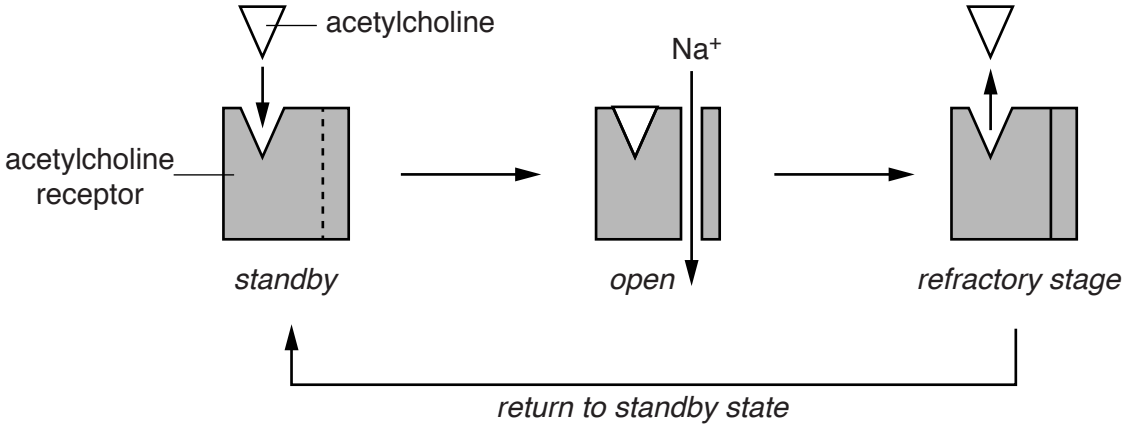


Fig. 7.1(a) When nicotine absent

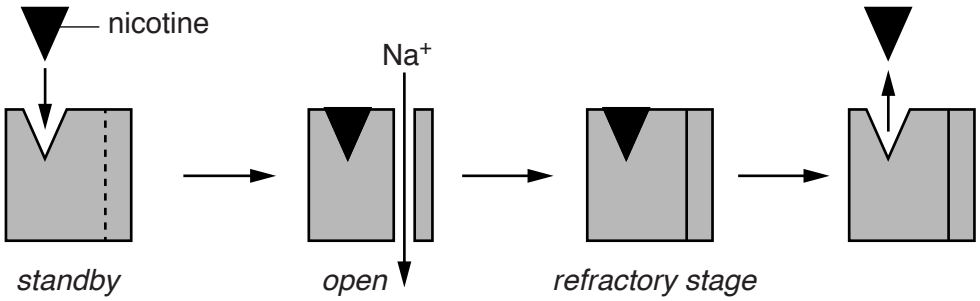


Fig. 7.1(b) When nicotine present

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Using the information in Fig. 7.1(a) and Fig. 7.1(b), suggest and explain the effect that nicotine has on the nervous system.

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(d) Neonicotinoids are chemicals with a similar structure to nicotine. The effects of these chemicals on insects have led to their use as insecticides over the last 20 to 30 years.

(i) Neonicotinoid insecticide molecules are absorbed by the roots and leaves of maize plants.

Describe how, once these molecules have been absorbed, they may be transported to the fruits of the maize plant.

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.....**[2]**

(ii) Despite the similarity to nicotine, neonicotinoids have been permitted for use on crops that would be used for human consumption.

Suggest why neonicotinoids have been considered to be safe.

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..... **[1]**

[Total: 19]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

If additional answer space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margins.

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