OXFORD CAMBRIDGE AND RSA EXAMINATIONS
A2 GCE

F215/01

BIOLOGY

Control, Genomes and Environment

TUESDAY 11 JUNE 2013: Morning
DURATION: 2 hours
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	

Centre number						Candidate number				

Candidates answer on the Question Paper.

OCR SUPPLIED MATERIALS:

None

OTHER MATERIALS REQUIRED:

Electronic calculator
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (SJF/SW) 2291050599 80244

INSTRUCTIONS TO CANDIDATES

- **Write your name, centre number and candidate number in the boxes on the first page. 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.**

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.**
- **Any blank pages are indicated.**

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Answer ALL the questions.

1 Enzyme immobilisation is an important technique in biotechnology.

Figs 1.1 and 1.2 opposite show two stages in making a bioreactor to remove lactose sugar from milk.

In Fig. 1.1 the enzyme lactase is immobilised in alginate beads.

In Fig. 1.2 milk flows over the beads and the lactose sugar is hydrolysed to two other sugars.

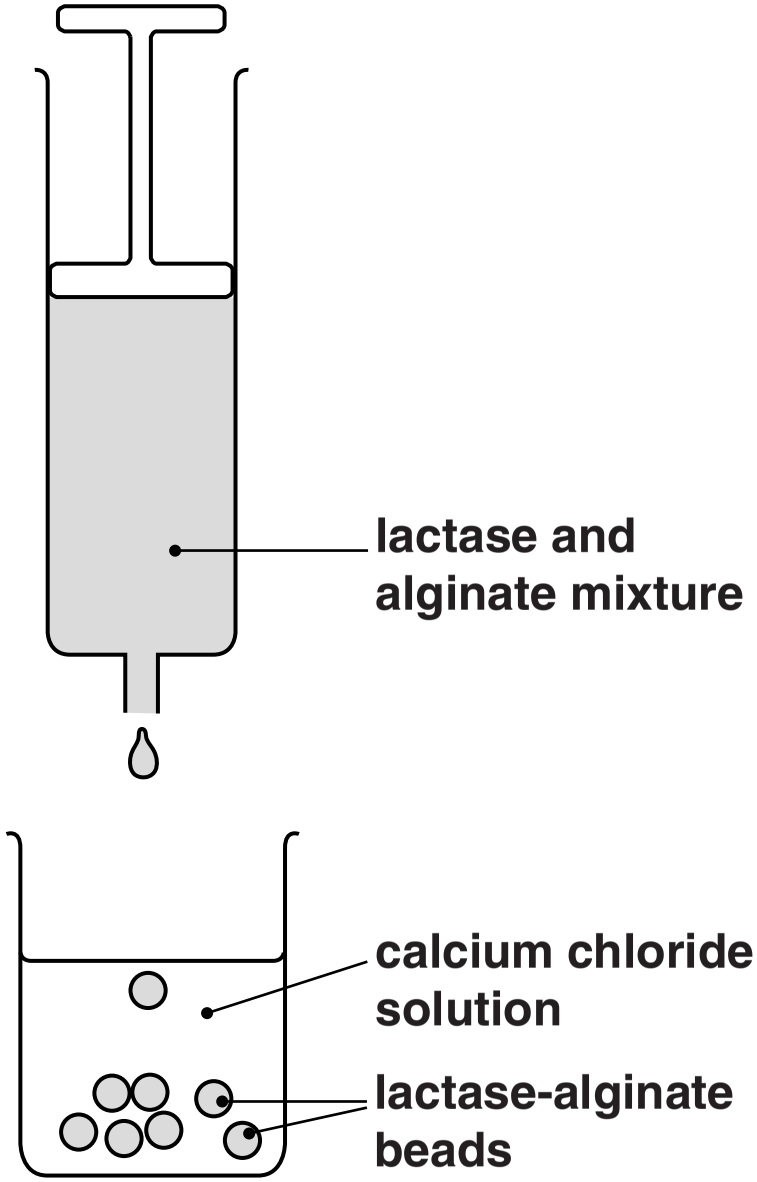
lactase and
alginate mixture
calcium chloride
solution
lactase-alginate
beads

FIG. 1.1

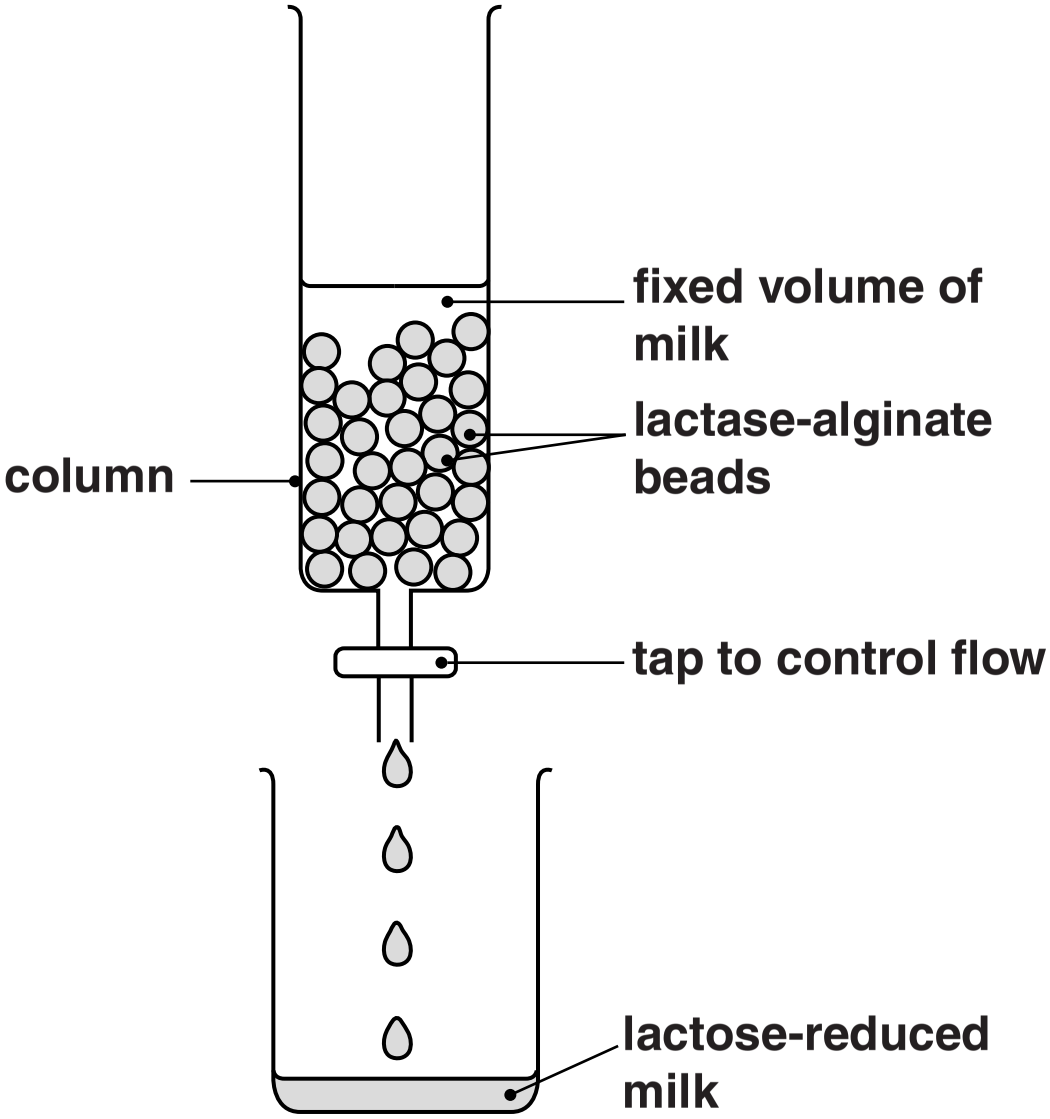
fixed volume of
milk
lactase-alginate
beads
column
tap to control flow
lactose-reduced
milk

FIG. 1.2

(a) Suggest AND explain how you might use the method shown in Fig. 1.2 to obtain milk that was LACTOSE-FREE.

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_____ **[2]**

(b) (i) Fig. 1.1 and Fig. 1.2 show that alginate beads can be used to immobilise an enzyme.

Outline TWO OTHER methods of immobilising enzymes.

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_____

_____

_____

_____

_____ **[2]**

(ii) Enzyme immobilisation is used in the biotechnology industry for the large-scale production of materials.

Discuss the benefits of using immobilised enzymes for large-scale production.

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_____ **[4]**

[TOTAL: 8]

2 Fig. 2.1 is a diagram showing a section through the human brain.

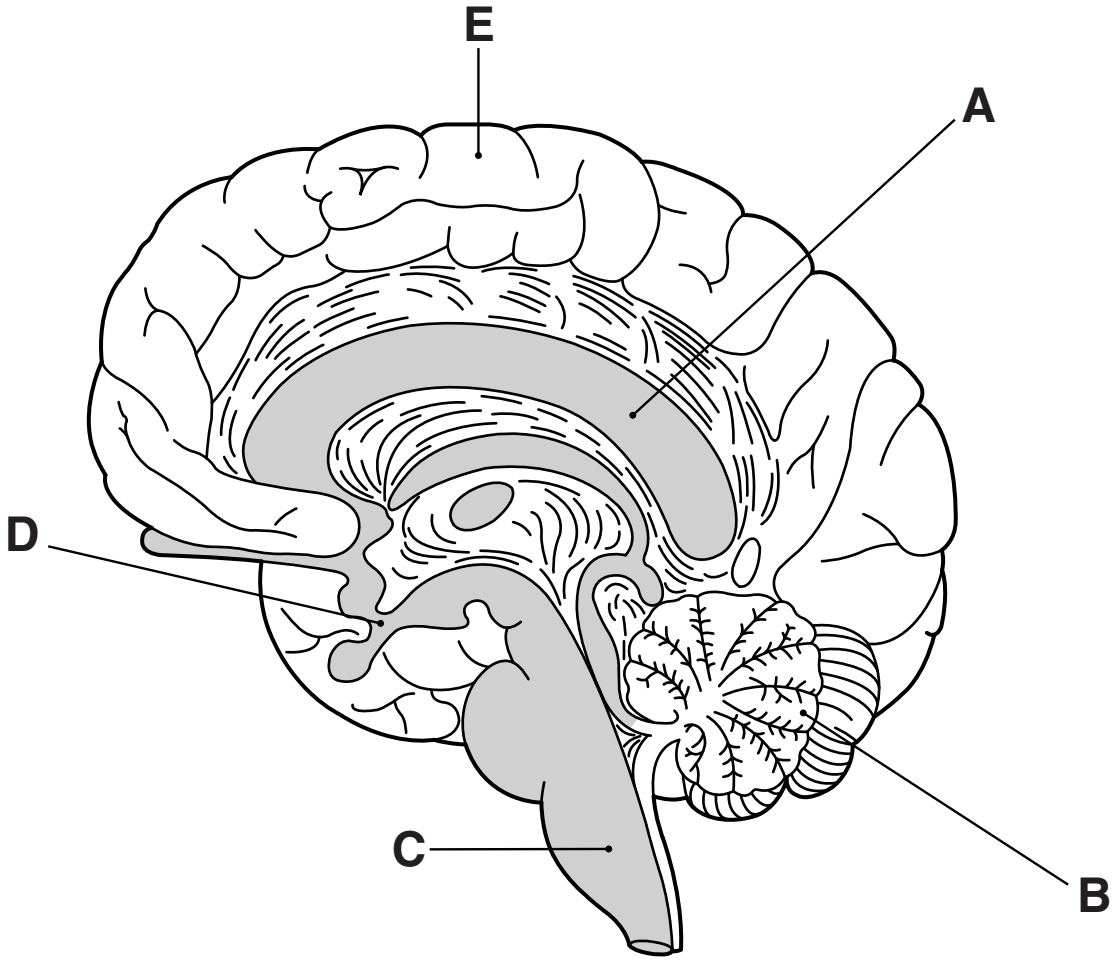

FIG. 2.1

(a) Use Fig. 2.1 to identify a part of the brain, A, B, C, D, or E, that is responsible for:

(i) co-ordination of the autonomic control of heart rate _____ [1]

(ii) co-ordination of osmoregulation by the kidney _____ [1]

(iii) co-ordination of the muscles involved in walking in an adult _____ [1]

(iv) co-ordination of the muscles required to bend the elbow joint deliberately _____ [1]

Fig. 2.2 shows the components of the human elbow joint.

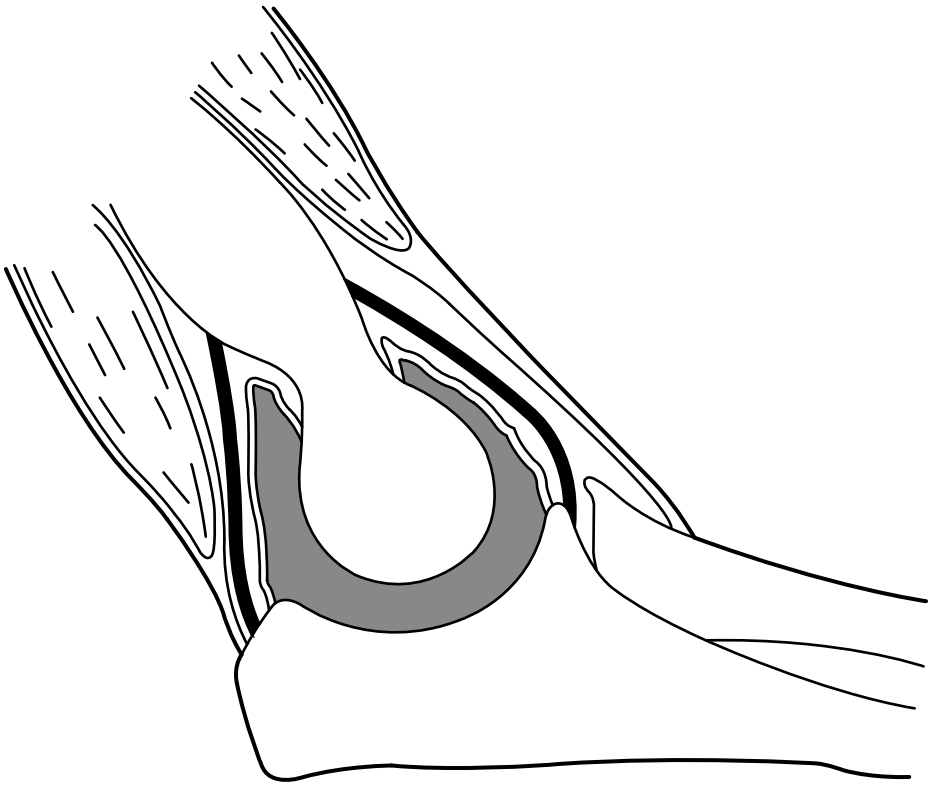

FIG. 2.2

(b) Describe how THREE named components of the ELBOW JOINT interact to bring about hinge movement (bending of the arm).

_____

_____

_____

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_____ **[3]**

(c) Outline the ORGANISATION and ROLES of the autonomic nervous system in mammals.

In your answer you should discuss the differences in physical arrangement and the differences in function, of both parts of the autonomic nervous system. [8]

_____

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[TOTAL: 15]

3 (a) The following boxes show the names of different stages that occur during MEIOSIS.

anaphase I	metaphase II	anaphase II
telophase II	prophase I	metaphase I

State the stage(s) in which the following events occur:

independent assortment

_____

formation of the spindle apparatus

_____

separation of sister chromatids

_____

formation of nuclear membranes

_____

chromosomes pulled to opposite poles

_____

[5]

(b) Meiosis is used in many organisms for the production of gametes.

Explain why meiosis needs to have twice as many stages as mitosis.

_____

_____

_____

_____

_____

_____

[2]

(c) Meiosis is a source of genetic variation. Mutation is another source of variation.

(i) What feature of the DNA molecule is changed as a result of mutation?

_____ **[1]**

(ii) Discuss the possible effects that mutation can have on the structure and function of a protein.

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_____ **[3]**

[TOTAL: 11]

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QUESTION 4 BEGINS ON PAGE 18

4 Fig. 4.1 shows some notes that a gardener pinned to his notice board to remind him of jobs to do.

Each is based upon a different biological principle.

A Pin any trailing blackberry shoots onto the soil so that they grow roots and form new plants.

B Remove the tops of chilli plants to encourage bushy growth.

C Leave vegetable waste in a well-aerated container for six months to make compost to add minerals to soil.

D Sow a leguminous crop like clover in bare soil in the autumn, and dig this crop into the soil in the spring to add nitrates.

E Save seeds from the biggest pumpkin grown, and plant these seeds next year, hoping to get a better crop.

F Dip cut stems of rosemary plants in rooting powder before planting them in soil.

G Bring carnivorous ladybirds into the greenhouse to reduce the numbers of plant-eating pests.

H Encourage pollinating insects by growing flowers with a strong sweet smell near crop plants.

FIG. 4.1

(a) Match the notes, A to H, with the biological principles on which they are based.

Write the correct letter next to the description of each principle.

Biological principle	Letter
artificial selection	_____
predator-prey interaction	_____
apical dominance	_____
nitrogen fixation	_____
reproductive cloning	_____
positive chemotaxis	_____
decomposition	_____
use of plant hormones	_____

[8]

(b) Four OTHER procedures associated with growing or storing crops are described in Table 4.1 below.

Name a biological process that is slowed down or stopped by each procedure.

Procedure	Biological process slowed down or stopped
storing apples at a low temperature of 5° C	
removing weeds from a vegetable garden	
placing seedlings so they are lit from all sides equally	
removing elm suckers and self-sown tree seedlings from farmland	

TABLE 4.1 **[4]**

(c) Suggest THREE ways that farmers can maximise the efficiency of the transfer of energy up food chains from PRIMARY CONSUMERS to humans.

_____

_____

_____

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_____ **[3]**

[TOTAL: 15]

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5 (a) The Oxford Botanic Garden was founded in 1621 to grow plants for the teaching of medicine. Since that time it has seen many changes. When the ideas of Linnaeus were adopted in the 18th century, the plants were dug up and re-planted in family groups according to his new system of taxonomy.

Recently, the plants have once again had to be re-organised:

DNA sequencing techniques, together with cladistic analysis, have provided a radical new view of plant evolutionary relationships.

The same techniques have also improved the ability of researchers to pinpoint new cures for diseases, by examining the closest relatives of plants already known to have medicinal properties.

(i) Comment on what the different arrangements of plants in the Oxford Botanic Garden over time tell us about the nature of scientific knowledge.

_____

_____ **[1]**

(ii) **Suggest TWO purposes of a plant collection in a modern botanic garden.**

_____

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_____

_____ **[2]**

(b) **DNA sequencing techniques have provided new information about plant relationships.**

Outline the ROLES of each of the following procedures IN SEQUENCING A GENOME:

(i) **the polymerase chain reaction (PCR)**

_____

_____

_____

_____

_____ **[2]**

(ii) electrophoresis

_____

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_____ [2]

(iii) digestion of DNA by restriction enzymes.

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_____ [2]

(c) Suggest why a genome has to be fragmented before sequencing.

_____

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_____

_____ [2]

(d) Table 5.1 lists some plants considered for genome sequencing by the 'Floral Genome Project'. The chromosome numbers and genome sizes in mega base pairs (Mbp) are shown.

One Mbp is equal to 1 000 000 base pairs of DNA.

Name	Chromosome Number(s)	Genome Size (Mbp)
Amborella	2n = 26	870
sweet rush	2n = 18	392
monkey flower	2n = 28	430
blueberry	2n = 12, 4n = 24, 6n = 36	1078

TABLE 5.1

(i) The sequencing method that will be used is only able to sequence fragments of DNA with a maximum length of 750 base pairs.

Calculate the minimum number of DNA fragments that would need to be sequenced to read the genome of *Amborella*.

Show your working.

Answer = _____ [2]

(ii) Monkey flower and blueberry belong to the same taxonomic group within the plant kingdom. Only one of the pair was chosen for further sequencing work.

Using the data in Table 5.1, suggest reasons why monkey flower was chosen instead of blueberry.

_____

_____

_____

_____ **[2]**

(iii) Use your knowledge of the effects of polyploidy in bread wheat to suggest one way in which the fruit of a hexaploid (6n) blueberry might differ in appearance from that of a diploid (2n) blueberry.

_____ **[1]**

(e) DNA sequence information is most useful when used with the phylogenetic (cladistic) approach to classification.

How does the phylogenetic approach to classifying species differ from the biological species concept?

_____

_____

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_____ **[2]**

[TOTAL: 18]

6 (a) Many species of insects have evolved resistance to chemical insecticides.

Three different patterns of resistance in insect species R, S and T are shown in Fig. 6.1 opposite.

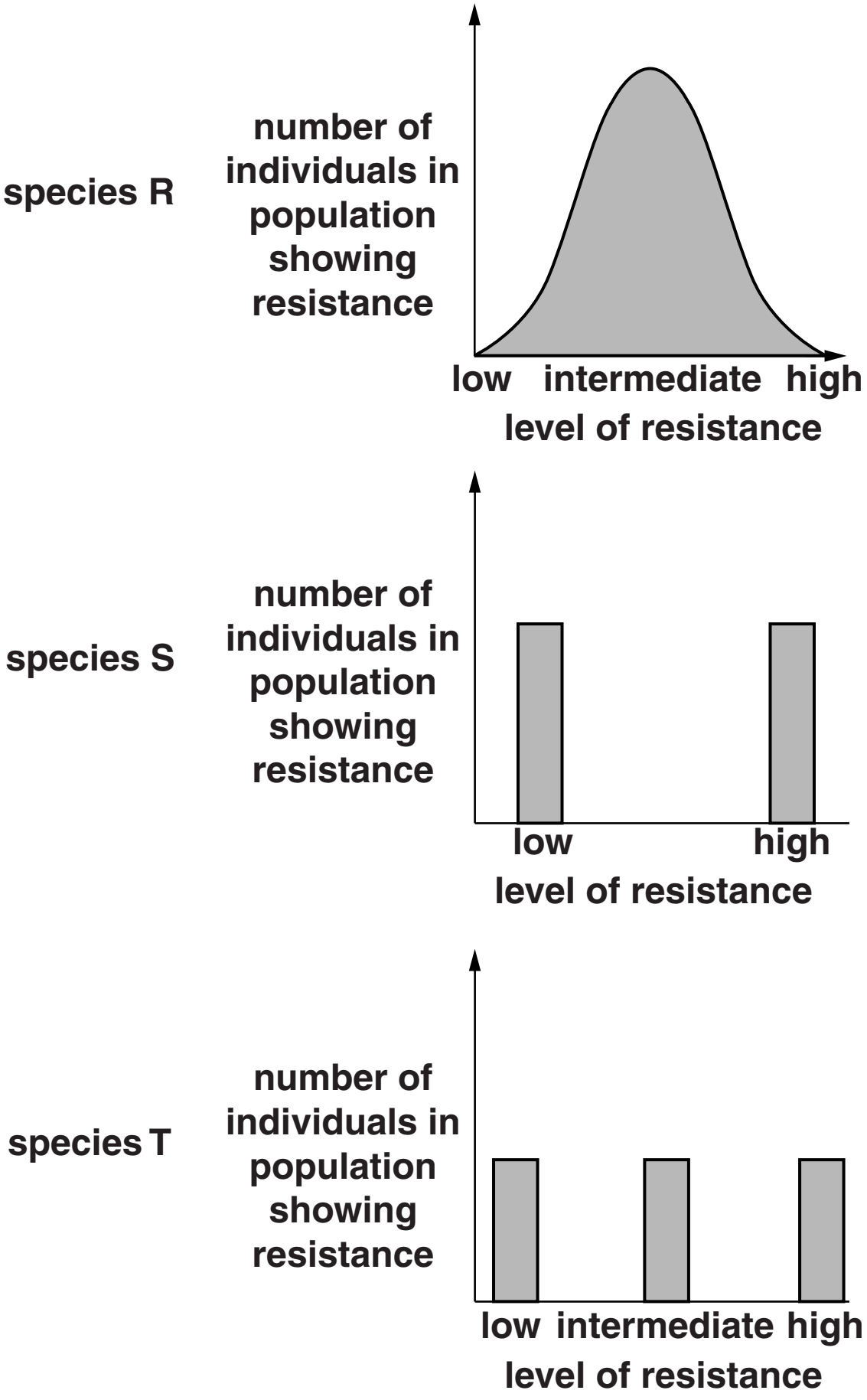
species R
number of individuals in population showing resistance
low
intermediate
high
level of resistance
species S
number of individuals in population showing resistance
low
high
level of resistance
species T
number of individuals in population showing resistance
low
intermediate
high
level of resistance

FIG. 6.1

(i) Complete the table below with the letter(s), R, S and T, to indicate which species show a continuous pattern of variation and which species show a discontinuous pattern.

	Discontinuous	Continuous
Species identified by letter		

[2]

(ii) A student noted a number of statements on his revision card that referred to the patterns of resistance shown in species R, S and T in Fig. 6.1.

REVISION CARD – PATTERNS OF RESISTANCE

1. It's controlled by a single gene
2. There is an additive effect
3. May involve multiple alleles
4. Heterozygote shows a distinct phenotype
5. It's controlled by many genes (polygenic)
6. Involves a dominant and a recessive allele
7. Shows co-dominance or incomplete dominance
8. Involves just two alleles

Complete Table 6.1 below, by selecting the correct numbered statement(s) that explain the genetic basis of each pattern of resistance for each species.

You may select a number more than once.

Species	Statement number(s)
R	
S	
T	

TABLE 6.1

[6]

(b) Dog fleas are small parasitic insects that live in the fur of dogs and feed on their blood. Dogs are routinely treated with sprays or powders to kill fleas.

A vet believes that dog fleas may have become resistant to a popular flea-killer product.

He asks an A-level work experience student to plan an experiment to test this hypothesis.

The student needs to sample fleas from dogs visiting the surgery and also fleas from long grass in fields visited by dog-walkers. The fleas then need to be tested for resistance to the flea-killer.

Describe the methods the student could use to:

collect both samples of fleas

find out the proportion of fleas that are resistant

process the data.

In your answer you should describe the methods for collection, testing and data processing in a logical series of steps. [7]

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[TOTAL: 15]

7 (a) Animals and plants need to respond to changes in their environment.

(i) Give TWO reasons why BOTH plants and animals need to be able to respond to changes in their environment.

_____

_____

_____

_____ **[2]**

(ii) Plants co-ordinate their responses to environmental stimuli using hormones. Mammals also co-ordinate responses to some stimuli using hormones.

State THREE DIFFERENCES in the ways in which plant and mammalian hormones operate.

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_____

_____ **[3]**

(b) Most mammalian hormones are made of protein. An example is human growth hormone (HGH). Lack of this hormone causes dwarfism (short height).

(i) Explain why dwarfism can be described as a genetic condition.

_____

_____

_____

_____ **[2]**

(ii) Children with dwarfism can be given HGH produced by genetic engineering. A method for engineering bacteria to make HGH has many stages that are similar to the method used to produce human insulin, and is described below.

Complete the following paragraph using the most suitable term or terms to fill in the gaps.

The _____ for HGH is cut from human DNA using a restriction enzyme. The human DNA fragments are then inserted into plasmids using the enzyme called _____ . Bacterial cells are treated so that they take up these plasmids. Bacteria that contain the new DNA are described as _____ bacteria. They are first grown on agar plates containing _____ which allow scientists to distinguish them from bacteria that have not taken up any new DNA. A _____ can then be used to identify the bacteria that have the desired sequence of DNA. [5]

(c) Steroid hormones are not made of protein. They are classed as lipids. Their structure means that they can diffuse through the cell surface and nuclear membranes. The hormones then bind to DNA in the nucleus and switch genes on and off.

Explain why steroid hormones can diffuse through cell membranes.

_____

_____

_____

_____ **[2]**

(d) Steroid hormones are one example of molecules that can switch genes on and off in mammalian cells.

Other molecules involved in genetic control have been studied in both eukaryotes and prokaryotes.

Describe ONE other example of genes being switched on or being switched off by a molecule that binds directly to DNA.

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_____

_____ **[4]**

[TOTAL: 18]

END OF QUESTION PAPER

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.
