Question: 1

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.

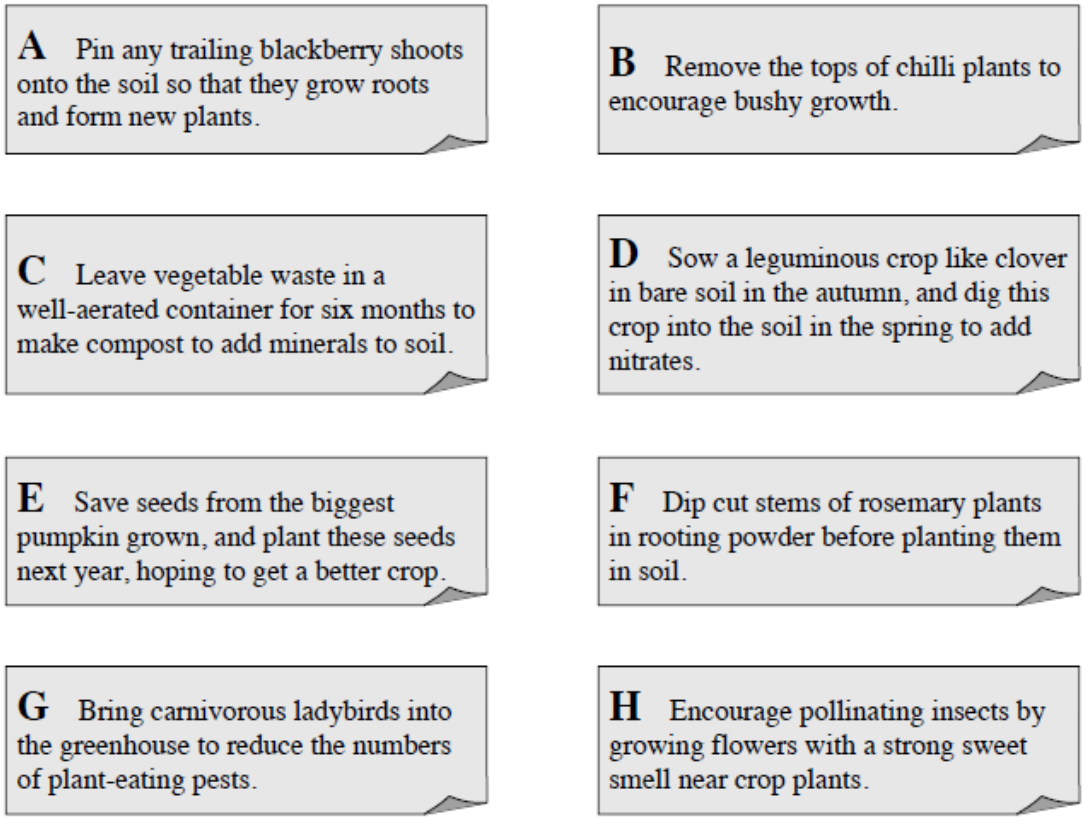

Fig. 4.1

(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.

_____

_____

_____

_____

_____

[3]
[Total: 15]

Question: 2

(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.

_____

_____

_____

_____

_____

[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.

_____

_____

_____

_____

_____

[4]
[Total: 18]

Question: 3

(a) (i) A gene controlling coat colour in cats is sex linked. The two alleles of this gene are black and orange. When both are present the coat colour is called tortoiseshell.

Define the following terms:

gene.....

_____

_____

_____

_____

_____

allele.....

_____

_____

_____

_____

_____

[2]

(ii) Explain why there are no male tortoiseshell cats.

_____

_____

_____

_____

_____

[2]

Two pure breeding strains of snapdragon, a garden plant, were obtained. One strain had red flowers and the other had white flowers. The two strains were crossed yielding F_1 plants all with pink flowers. The F_1 were then interbred to produce F_2 plants with the following colours:

red	**62**
pink	**131**
white	**67**

The following hypothesis was proposed:

Flower colour is controlled by a single gene with two codominant alleles.

(b) Complete the genetic diagram to explain this cross. Use the following symbols to represent the alleles:

C^r = red, C^w = white

Parental phenotypes:	red flowers	x	white flowers
Parental genotypes:	.....		.....
Gametes:	.....		.....

F_1 genotypes: .....

F_1 phenotypes: .....

Gametes: .....

F_2 genotypes: .....

F_2 phenotypes: .....

Expected F_2 phenotypic ratio:.....

[6]

(c) A chi-squared (χ^2) test is carried out on the experimental data to determine whether the hypothesis is supported.

(i) Complete Table 1.1 by calculating the expected numbers.

Table 1.1

F_2 phenotype	observed numbers	expected numbers
red	62	
pink	131	
white	67	
total	260	260

[3]

The χ^2 statistic is calculated in the following way:

$$\chi^2 = \Sigma \frac{(\text{observed} - \text{expected})^2}{\text{expected}}$$

Σ = "sum of ..."

(ii) Calculate the value of χ^2 for the above data. Show your working.

χ^2 value = ...

[2]

(iii) The critical value of χ^2 for this type of investigation with two degrees of freedom is 5.991.

Explain whether your answer to (b) (ii) supports the hypothesis.

[1]

(d) Phenotype is influenced by genetic and environmental factors.

Describe one example of how the environment influences phenotype.

[2]

(e) The bacterium *Escherichia coli (E. coli)* uses glucose as a respiratory substrate. In the absence of glucose, *E. coli* can use lactose. The use of a different substrate is determined by the interaction between genes and the environment.

[5]

[Total: 23]

Question: 4

Fig 3.1 represents the transfer of energy through a woodland ecosystem.

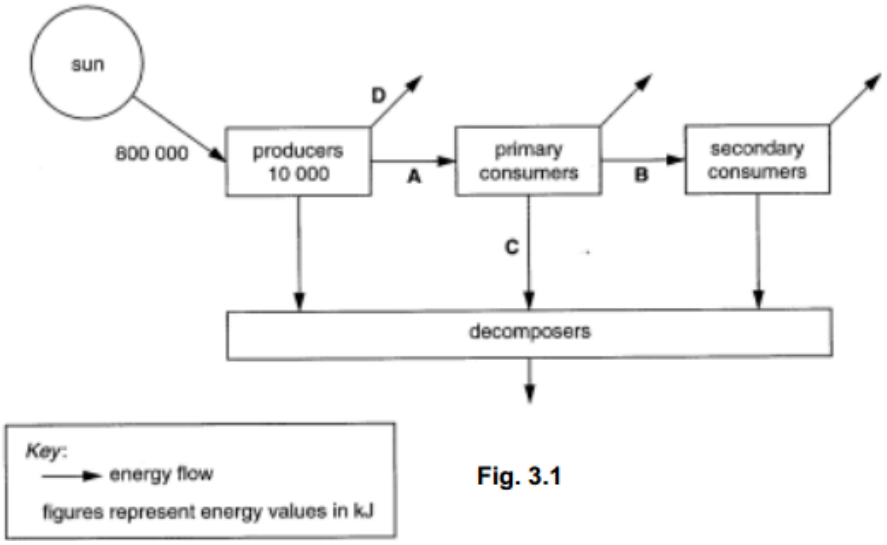

Fig. 3.1

(a) Of the 800 000 kJ of energy which reaches the producers, only 10 000 kJ of energy is converted to growth in the producers.

(i) Calculate the percentage of the energy reaching the producers that is converted to growth in the producers. Show your working.

..... %

[2]

(ii) Explain what happens to the energy reaching the producers that is not converted to growth.

[2]

(iii) Name one decomposer.

[1]

(iv) State two ways in which energy is transferred from primary consumers to decomposers at C.

1

2

[2]

(b) Suggest why the percentage energy transfer between producers and primary consumers at A is less than that between the primary consumers and secondary consumers at B.

[3]

[Total: 10]

Question: 5

One product manufactured using microorganisms is insulin. The process involves genetically engineering bacteria to synthesise human insulin.

(a) (i) Describe how the isolated human insulin gene is inserted into a bacteria plasmid.

[4]

(ii) Suggest two ways in which the bacteria which take up the modified plasmids can be identified.

[2]

(b) Suggest one reason why it is considered preferable to use genetically engineered sources of human insulin rather than insulin obtained from pigs.

[1]

(c) Another product manufactured using microorganisms is single cell protein (SCP).

Describe how a protein would be synthesised in the cell of a single celled fungus.

In your answer, you should make clear the sequence of the steps in the process.

[10]

[Total: 17]

Question: 6

Fig. 5.1 is a drawing of the brain that shows the origin of the cranial nerves.

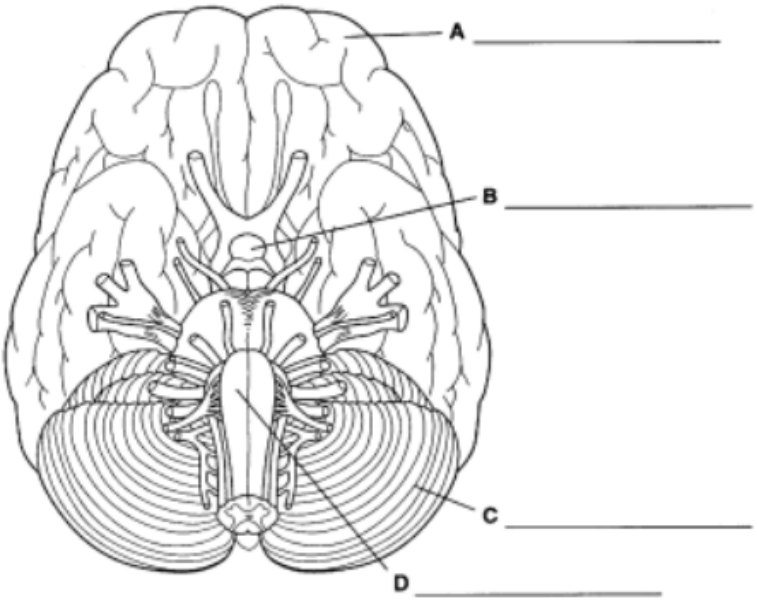

Fig. 5.1 Taken from Human physiology: Foundations and Frontiers, © Moffett, D., Moffett,S., Schauf, Times-Mirror Mosby Publishers ,1990, ISBN 08016435540

(a) State the direction from which the brain has been drawn.

_____

_____

_____

_____

_____

[1]

(b) (i) Name the structures A, B, C and D shown on Fig. 5.1.

A

B

C

D

[4]

(ii) State two roles of structure D.

1

_____

_____

_____

_____

_____

2

_____

_____

_____

_____

_____

[2]

(c) The hypothalamus constantly monitors and regulates the concentration of hormones in the blood. Outline how the hypothalamus regulates the concentration of hormones in the blood.

_____

_____

_____

_____

_____

[2]

[Total: 9]

Question: 7

An investigation was carried out into the effects of two plant growth substances, gibberellins and auxins, on apical dominance. The terminal (apical) buds of a number of pea plants were removed and discarded. The tops of each of the remaining shoots were given one of the following treatments:

- Coated with a paste containing gibberellin.
- Coated with a paste containing auxin (IAA).
- Coated with a paste without any plant growth substance.

In addition, a control group of plants did not have their terminal buds removed and were not coated with paste.

The growth of the side shoots was measured at regular time intervals and a mean value calculated. The results are shown in Fig. 6.1.

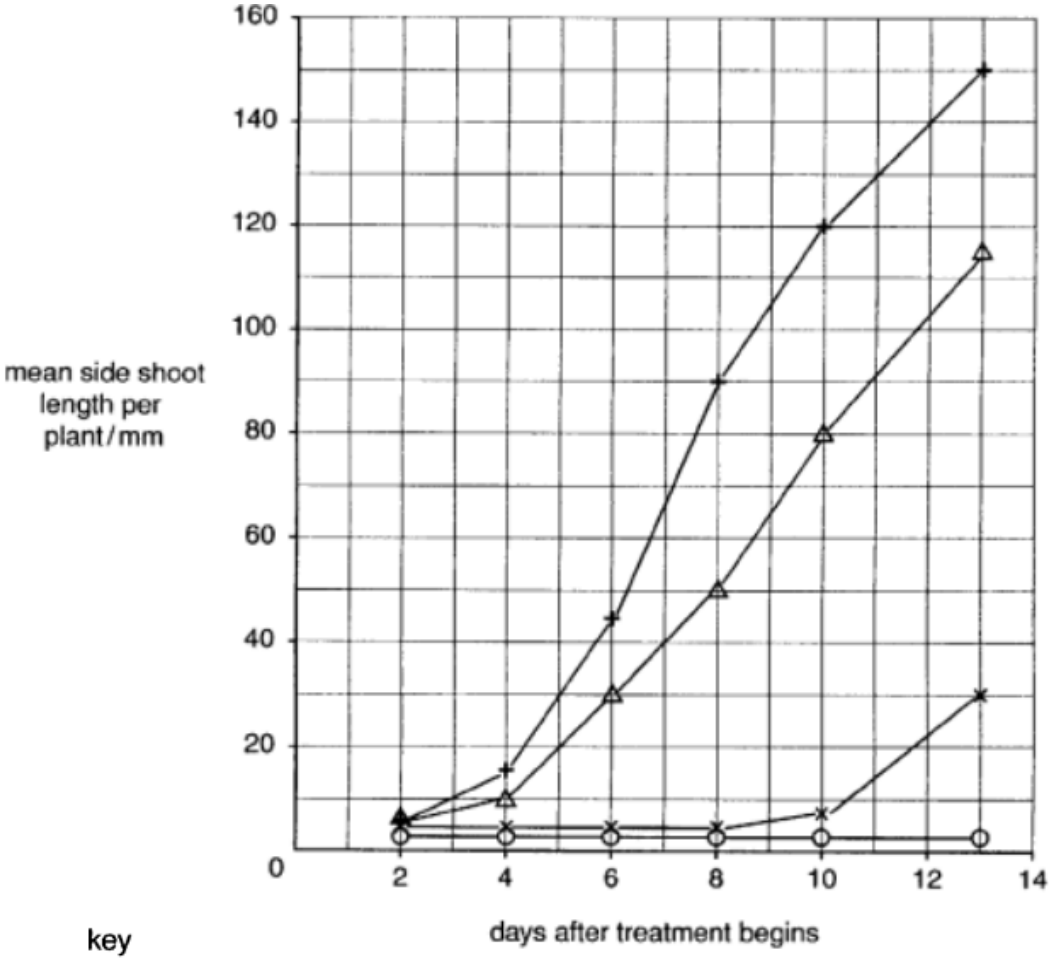

Fig. 6.1

(a) Explain why the side shoots grow when the terminal buds are removed.

[3]

(b) Side shoots show greater growth when paste containing gibberellin is applied than when paste without any plant growth substance is applied.

Calculate the percentage increase in growth due to gibberellin in 8 day old seedlings compared to seedlings with paste only. Show your working.

.....%

[2]

(c) Using data from Fig. 6.1 describe and explain the effect of auxin (IAA) on the growth of side shoots.

[3]

[Total: 8]

Question: 8

(a) Explain the meaning of the term *primary succession.*

[2]

Fig. 8.1 shows a primary succession in a temperate climate.

X represents an example of deflected succession.

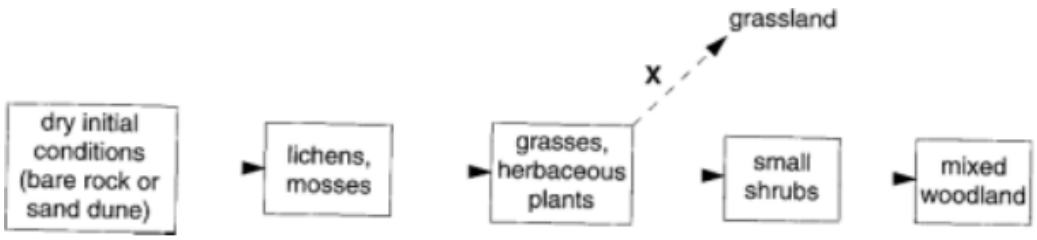

Fig. 8.1

(b) Explain the role of pioneer plants in succession on a bare rock or sand dune.

[3]

(c) Suggest two ways in which deflected succession at X could be caused.

1

2

[2]

(d) Explain how biomass changes during a primary succession.

[2]

(e) Using timber production in a temperate country as an example, explain how ecosystems can be managed in a sustainable way.

In your answer, you should make clear how the management is sustainable.

[7]

[Total: 16]

Question: 9

(a) Immobilised enzymes can be used in bioreactors that attach to space suits. The bioreactors recover water from the astronauts' urine. The bioreactors use immobilised urease enzyme which catalyses the hydrolysis of urea, forming carbon dioxide and ammonia. These products react to form ions, which are then removed by the bioreactor.

(i) State the meaning of the term immobilised enzyme *and describe how immobilisation can be achieved.*

[3]

(ii) Suggest three practical advantages of using an immobilised urease bioreactor in a spaceship.

1

2

3

[3]

(b) An investigation was carried out to compare lipase in soluble and immobilised forms. Palm oil was hydrolysed to produce fatty acids and glycerol.

- The two forms of lipase showed optimal activity at the same pH and temperature (pH 7.5 and 35^{o}C).
- At that pH and temperature, 100% of the oil was hydrolysed in two minutes.
- If the temperature was increased to 45^{o}C, the immobilised enzyme hydrolysed 100% of the oil but the soluble enzyme hydrolysed only 80% of the oil in two minutes.

(i) Define the term *hydrolysis.*

_____

_____

_____

_____

_____

[1]

(ii) Explain, using the information in the passage, the advantages of using an immobilised enzyme to hydrolyse palm oil.

_____

_____

_____

_____

_____

[4]

[Total: 11]

Question: 10

(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.

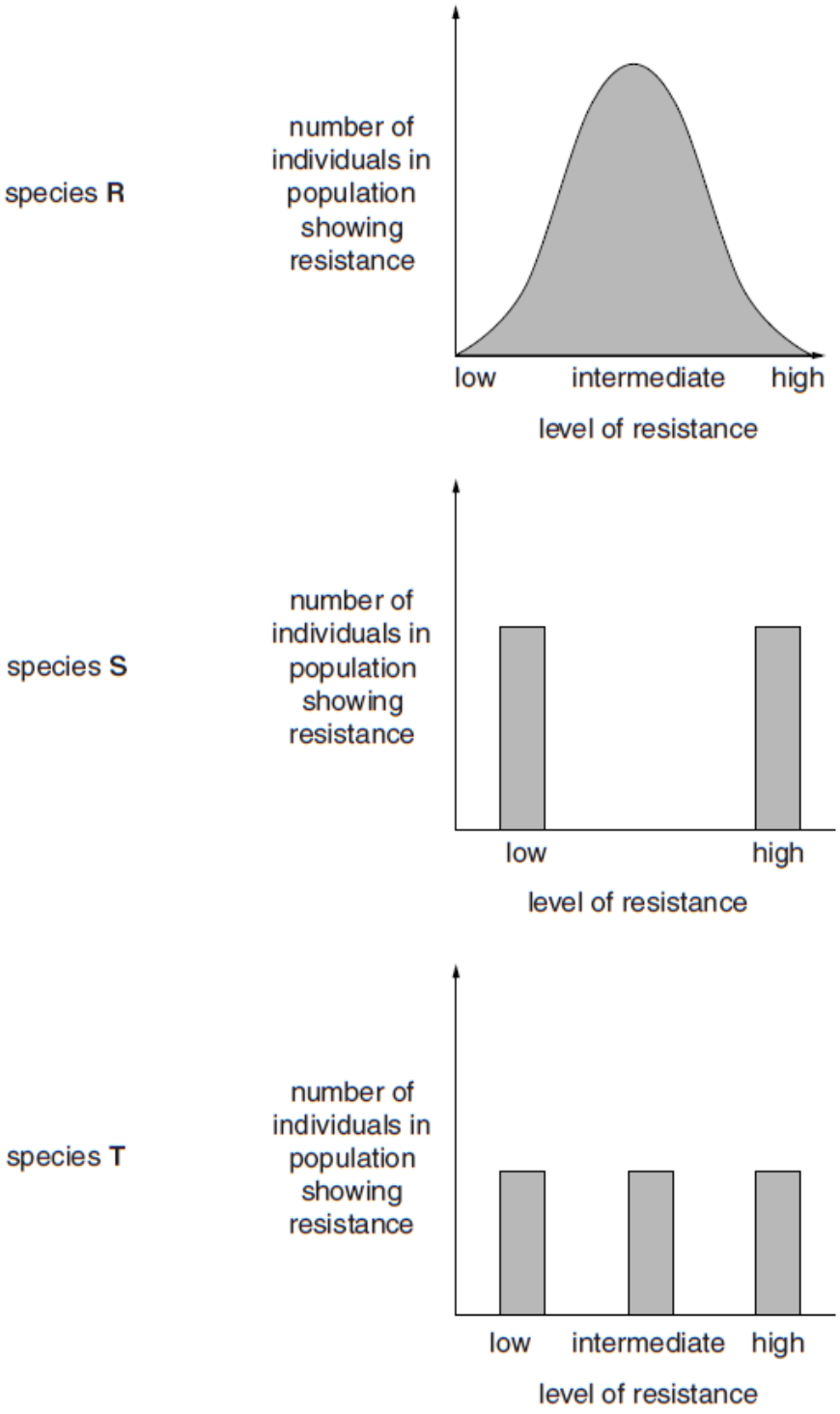

Fig. 6.1

(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 dataprocessing in a logical series of steps.

_____

_____

_____

_____

_____

[7]
[Total: 15]

Question: 11

(a) Cystic fibrosis (CF) in humans is caused by mutations of a gene coding for transmembrane protein (CFTR) which acts as an ion pump. A large number of different mutations of the gene have been found. Explain what is meant by a gene mutation.

_____

_____

_____

_____

_____

[2]

(b) CFTR regulates the transport of chloride ions (Cl-) across the plasma (cell surface) membrane. Tissues that express the normal CFTR allele secrete alkaline fluids, whereas the secretions of tissues expressing some mutant alleles are acidic.

The transport of Cl- by epithelial cells expressing the normal CFTR allele was compared with that by epithelial cells expressing one of 10 different mutant CFTR alleles. The results are shown in table 2.1.

In the table, normal digestive functioning of the pancreas associated with a particular allele is indicated with a tick (✓) and the absence of normal functioning by a cross (✗).

Table 2.1

CFTR allele	percentage of Cl^- transported in comparison with normal allele	normal digestive functioning in pancreas
normal	100	✓
mutation 1	6	×
mutation 2	4	×
mutation 3	0	×
mutation 4	3	×
mutation 5	1	×
mutation 6	33	✓
mutation 7	41	✓
mutation 8	46	✓
mutation 9	37	✓
mutation 10	44	✓

With reference to the information given in the table, explain why some mutant CFTR alleles allow normal digestive functioning of the pancreas and others do not.

_____

_____

_____

_____

_____

[3]

[Total: 5]