OCR A-LEVEL BIOLOGY A

BIOLOGY



EXAM QUESTION PACK

UNIT F215 OLD SPECIFICATION PAPERS

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OCR
Oxford Cambridge and RSA

Thursday 23 June 2016 – Morning

A2 GCE BIOLOGY

F215/01 Control, Genomes and Environment

Candidates answer on the Question Paper.

OCR supplied materials:
None

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

Duration: 2 hours

F 2 1 5 0 1

5 8 7 8 2 9 2 4 2 6

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

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

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Answer **all** the questions.

1 This question is about management of ecosystems.

Mink are small carnivorous mammals. In recent years, many mink have escaped from fur farms.

The Hebridean Mink Project is working to remove this invasive species from Scottish islands. The mink arrive on an island by swimming. Once on the island, they reproduce and act as predators on the native mice.

Fig. 1.1 is a graph recording the growth of a mink population from its first arrival on a new island.

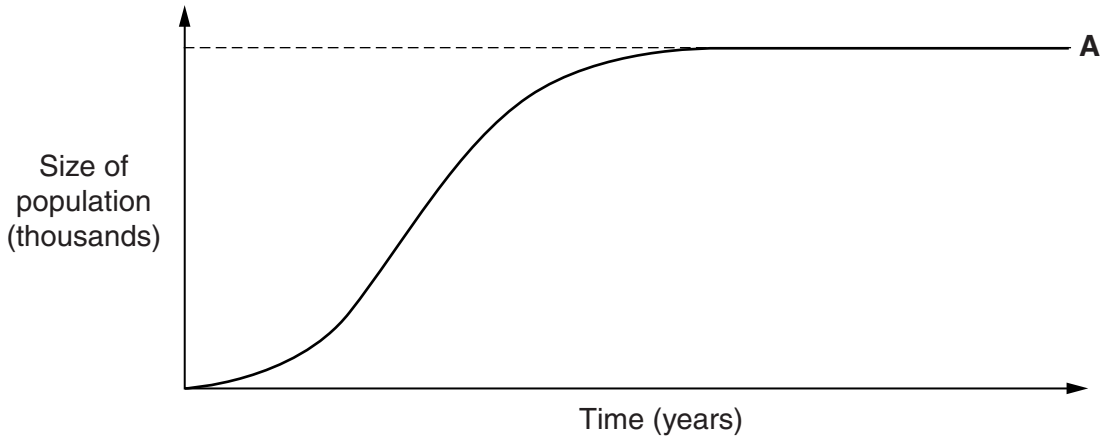


Fig. 1.1

(a) (i) The line **A** represents a limiting level to the size of the mink population on the island. The number of mink will not increase beyond it.

What name do ecologists give to such a limiting level for a population in a particular area?

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

(ii) Suggest **two** factors that limit the mink numbers on the island.

1 .....

2 .....

[2]

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(b) In the last century, large areas of natural woodland on the Scottish mainland were removed by the Forestry Commission. The large areas of land were replanted with closely-spaced conifer trees.

As the young conifers grew, they reduced the light reaching the ground. Other plant species died.

When mature, the conifers were felled for industries like paper and chipboard. The area was left covered with unwanted conifer branches.

(i) This method of producing timber is now regarded as **ecologically** undesirable.

Suggest why.

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.....

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

Fig. 1.2 is a photograph of a woodland that is managed differently.



Fig. 1.2

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(ii) The woodland in Fig. 1.2 can supply timber continuously, sustainably and economically.

Discuss some social, aesthetic and ethical benefits of managing woodland in this way compared to coniferous monoculture.

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

(c) The tall 'oak standards' in woodland like those in Fig. 1.2 are cut down close to ground level for sale to sawmills. Certain tree species, like the English elm (*Ulmus procera*) respond to the loss of a main trunk by natural vegetative propagation.

(i) Describe how this vegetative propagation would proceed after the cutting down of elm trees in such a woodland.

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

(ii) Vegetative propagation allows trees to survive the loss of a main trunk due to a natural event like fire or high winds. In Britain, many elm trees have been lost because of 'Dutch elm disease'. This disease is caused by the fungus *Ophiostoma ulmi*.

Why might vegetative propagation be less effective at enabling a tree to survive Dutch elm disease, compared to surviving fire or high wind?

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

[Total: 13]

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2 This question is about genetic control and selective breeding.

(a) Fill the gaps in the following passage using the most appropriate term:

Much of the ..... in cells contains sequences called genes. Many genes code for ..... that fold to make enzymes. Often, enzymes are kept in an inactive form until needed. These enzymes may then be activated by cAMP, which involves changes in their ..... . **[3]**

(b) Control is also achieved by genes switching on and off. There is a highly conserved set of genes called homeobox genes that control the development of body plans.

(i) Name **all** the **kingdoms** of living organisms that use homeobox genes to control the development of body plans.

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

Fig. 2.1 shows a human embryo during the second month of development.

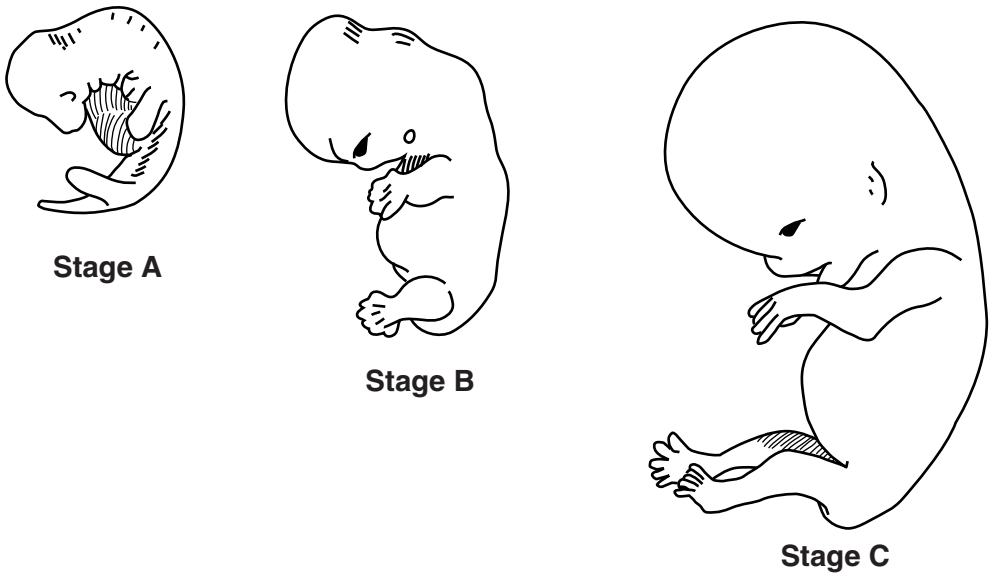


Fig. 2.1

(ii) How can the control of development by homeobox genes be seen in **Stage A** in Fig. 2.1?

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.....

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

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(iii) Describe how the process of apoptosis can be seen between **Stages A** and **B**, and between **Stages B** and **C**, in Fig. 2.1.

Stages A to **B** .....

.....

Stages B to **C** .....

.....

[2]

(c) Different forms of genes (alleles) control cells in different ways. In mice, the allele for grey colour is dominant to the allele for black. Black mice are unusual in the wild. Natural selection favours grey as the mice are better camouflaged.

Starting with a supply of grey mice, explain how **artificial** selection could be used to breed a population of grey mice whose offspring were always grey.

In your answer, you should provide a logical explanation of the sequence of steps.

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..... **[5]**

[Total: 12]

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3 A motorway is made up of three lanes of traffic travelling in each direction. The vehicles travelling in opposite directions are separated from each other by a central region in which plants can grow. This is illustrated in Fig. 3.1.

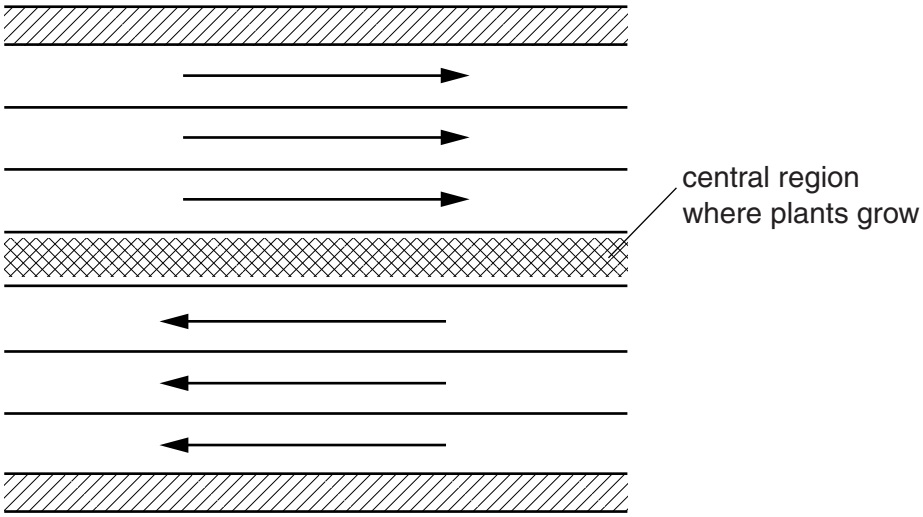


Fig. 3.1

(a) (i) Plants can respond to their environment during times of stress.

Suggest **one** biotic and **one** abiotic stress that might particularly affect flowers growing on motorway central regions compared to growing in open countryside.

Biotic .....

Abiotic .....

[2]

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(ii) A tropism is one way in which a plant responds to an environmental stimulus. Fig. 3.2 shows an ivy seed germinating at the base of a wall.

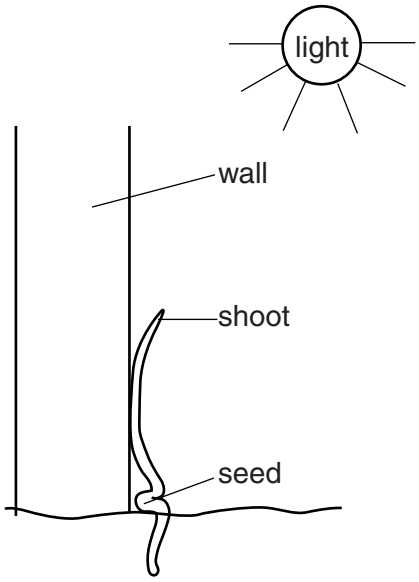


Fig. 3.2

A biology class observed the seedling over several days.

How would the students know that the shoot of the seedling was showing phototropism?

.....

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

(b) Plant hormones are used commercially.

Some of these hormones are:

A – Auxin **C** – Cytokinins **E** – Ethene **G** – Gibberellins

The table below lists some problems that could be solved by using plant hormones.

Complete the table by selecting the **letter** of the hormone that would best solve each problem.

Problem	**Hormone**
Bananas picked green and shipped in a container are not ripe when the ship arrives.	
Pot plants grown for sale at Christmas will not be bought if their leaves drop off.	
Barley grains delivered to a brewery do not contain much maltose for the yeast.	
In plant tissue culture, calluses on plain agar will develop shoot buds too slowly.	

[4]

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(c) The chemical hypochlorite is also used in plant tissue culture. The explant is sterilised with hypochlorite before culturing into a callus.

What might go wrong if this sterilisation was not done?

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

(d) Specialised biotechnology companies have managed to culture some nitrifying bacteria. The bacteria are sold in water-suspension by aquarium suppliers. Aquarium owners use these bacteria to prevent fish death due to toxic levels of ammonia.

(i) With reference to the role of *Rhizobium* in the nitrogen cycle, why would the aquarium suppliers be unlikely to sell *Rhizobium*?

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

(ii) Explain why the use of nitrifying bacteria by aquarium owners is an example of biotechnology.

.....

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

(iii) One of the organisms cultured for sale to aquarium owners is *Nitrosomonas europaea*. This bacterium is highly sensitive to pH.

With reference to the desired product, explain why biotechnology companies need to control pH when culturing *N. europaea*.

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

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(e) Suspensions of nitrifying bacteria could also be used by farmers to improve soil fertility.

Some students at agricultural college experimented with the aquarium cultures of *Nitrosomonas* and *Nitrobacter.* They used cloned maize plantlets on trays of identical sterile sand in a greenhouse. The trays were:

- evenly inoculated with equal volumes of the bacterial suspensions
- watered daily with equal volumes of dilute ammonia solution
- kept close together so that they had the same light intensity and temperature throughout the trial.

On each of ten days, the students uprooted twenty maize plantlets, washed and dried them, and recorded their dry mass. They tabulated their results, as shown in Table 3.1.

Day	**Dry maize plantlet mass with** *Nitrosomonas*	**Dry maize plantlet mass with** *Nitrobacter*	**Dry maize plantlet mass with** *Nitrosomonas* and *Nitrobacter*	**Control. Dry maize plantlet mass with** no bacteria
1	4.0 g	3.7 g	3.7 g	3.9 g
2	4.1 g	3.9 g	3.9 g	4.1 g
3	4.2 g	4.0 g	4.1 g	4.2 g
4	4.3 g	4.1 g	4.2 g	4.3 g
5	4.3 g	4.1 g	4.2 g	4.3 g
6	4.4 g	4.1 g	4.3 g	4.4 g
7	4.5 g	4.2 g	4.5 g	4.4 g
8	4.5 g	4.2 g	4.6 g	4.4 g
9	4.5 g	4.2 g	4.8 g	4.4 g
10	4.5 g	4.2 g	5.1 g	4.4 g

Table 3.1

(i) What change should the students make to the way they have presented their results in Table 3.1?

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

(ii) Growing conditions in the greenhouse were kept the same for all trays.

Suggest a variable that has **not** been controlled in the method described.

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

[Total: 16]

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4 The Galapagos Islands is an ecosystem of exceptional biological interest.

The lava cactus, *Brachycereus nesioticus*, is found only in the Galapagos Islands. It speciated rapidly from a very few individuals of a parent species, perhaps only two. These individuals were carried on currents from the mainland of South America.

There is a gene that enables the mainland *Brachycereus* species to obtain water from damp mists in the atmosphere:

- let Q be the normal allele, allowing the cactus to obtain water from damp mists
- let q be a rare recessive allele that, when homozygous, could allow the cactus to obtain water from salty sea spray.

(a) (i) Consider a cross between two heterozygous individuals.

What is the **theoretical** percentage of the offspring from these two individuals that would be able to obtain water from sea spray?

Use the space below for any working.

Answer = ... % **[1]**

(ii) *B. nesioticus* colonises bare rock at the edge of the Galapagos Islands.

Explain how individuals homozygous for the q allele would soon come to dominate the gene pool.

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

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(b) In the last century, farmers were encouraged to settle on the Galapagos Islands. Some farmers introduced grasses for grazing livestock. These tough grasses spread and competed with native Galapagos species, particularly on sand dunes behind beaches.

Fig. 4.1 shows a typical succession from the beach (where salt spray might give native grasses an advantage), to rain-watered low dunes (where salt is increasingly washed away), and to post-pioneer dunes where grasses are absent.

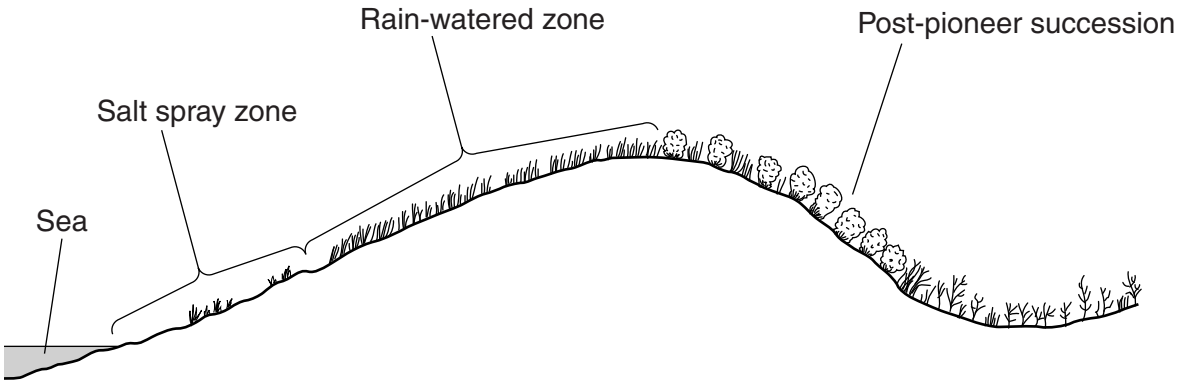


Fig. 4.1

Researchers could investigate the distribution and abundance of grasses across the salt spray and rain-watered zones.

Choose and describe sampling techniques that would show how the distribution and abundance of native and introduced grasses change across the two zones.

In your answer, you should make clear how the equipment is used.

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

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(c) Apart from introducing plants, suggest three **different** human activities that have affected the Galapagos ecosystem.

For each activity, give an example of its effect on the ecosystem.

Human activity 1

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Effect on ecosystem

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Human activity 2

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Effect on ecosystem

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Human activity 3

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Effect on ecosystem

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[3]

[Total: 15]

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5 The peripheral and central nervous systems work together to enable mammals to respond to changes in their external environment.

(a) Outline the roles of the peripheral and central nervous systems in responding to changes in the environment.

The names and functions of regions in the brain are **not** required.

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

(b) The endocrine system is also involved in responding to changes in the external environment. For example, adrenaline is released in the 'fight or flight' response. When adrenaline arrives at a liver cell membrane, it binds to a receptor. Inside the cell, a cascade of events leads to glycogenolysis.

Explain how this response would be of use to a rabbit that has seen a predator.

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

Question 5(c) begins on page 16

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(c) (i) All three types of muscle in the rabbit's body contribute to the 'fight or flight' response.

Complete the table below by filling in the blank boxes.

Organ	**Type of muscle**	**Action of muscle in fight or flight response**
heart		increases pulse rate
leg muscle		
arteriole to liver	smooth	

[3]

(ii) Muscles in the rabbit's leg are made up of units.

Fig. 5.1 is a diagram of one unit.

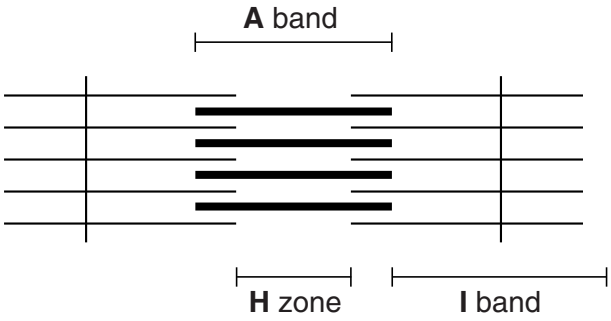


Fig. 5.1

The thick lines in the **A** band represent a protein.

Name this protein.

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

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(d) Innate behaviour and the capacity to learn are further assets that animals have in avoiding danger.

(i) Slugs are active at night. It would be useful to slugs to eat all day. But when dawn comes, they move away from the light.

State **one** advantage of this innate behaviour.

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

(ii) Describe how you could use the slug's response to light to demonstrate habituation.

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

(iii) Woodlice also respond to light. When it shines, they tend to move away from it.

What name do biologists give to this behaviour?

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

(e) Chimpanzees are usually vegetarian. Meat is a dietary supplement for them.

A famous TV wildlife documentary showed a group of chimpanzees trapping colobus monkeys in order to eat them. The colobus sought refuge in trees. They can climb better than chimpanzees. Being much lighter, they can retreat to thinner branches.

(i) Place a tick ✓ in **one** box next to the biological name that correctly describes this type of chimpanzee behaviour.

- ☐ Classical learning
- ☐ Social behaviour
- ☐ Disruptive behaviour
- ☐ Insight learning
- ☐ Natural selection **[1]**

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(ii) Fig. 5.2 shows the arm bones of a chimpanzee and a human, drawn to the same scale.

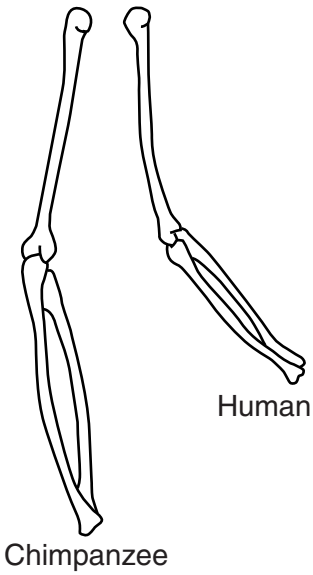


Fig. 5.2

The muscles of the chimpanzee arms are approximately the same thickness as the arm muscles of an athletic man, yet those of the chimpanzee are stronger than those of most men.

Suggest why.

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

[Total: 18]

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6 Biologists often judge how polluted an environment is by observing indicator species.

Table 6.1 lists some freshwater invertebrates, the presence of which indicates the level of water pollution.

Freshwater invertebrate	**Water quality indicated**
Stonefly nymph	Clean water
Freshwater shrimp	Slightly polluted water
Water louse	Badly polluted water
Sludge worm	Very badly polluted water

Table 6.1

Fig. 6.1 below shows two streams draining the same piece of moorland. They are close together and the water in them should be of identical quality.

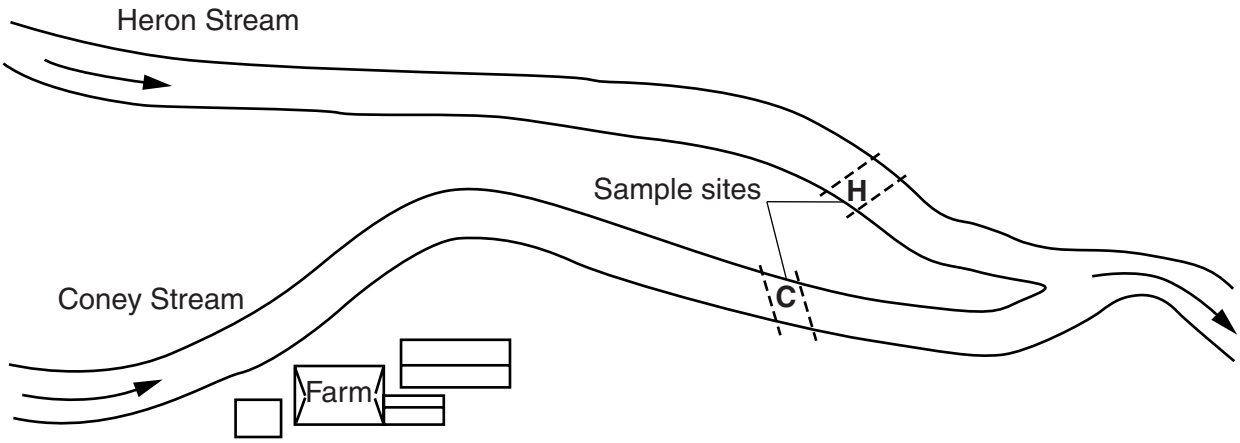


Fig. 6.1

The farm beside Coney Stream was suspected of occasionally discharging polluting manure from the cattle sheds into the stream.

The indicator species living in a stream are a record of the level of pollution in the stream over time.

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A Water Board biologist collected samples of invertebrates from Coney Stream and Heron Stream at the sites (**H** and **C**) indicated in Fig. 6.1. The processed data from the samples collected are shown in Table 6.2.

Indicator species	**Percentage of catch in Heron Stream sample (%)**	**Percentage of catch in Coney Stream sample (%)**
Stonefly nymph	58	44
Freshwater shrimp	33	43
Water louse	7	12
Sludge worm	2	1

Table 6.2

If no serious pollution was coming from the farm, there would be no significant difference in the percentages of each type of invertebrate collected from Coney Stream and Heron Stream. The percentages would be similar.

(a) (i) Use the formula and the table below to calculate the χ^2 value for the invertebrate samples from the two streams.

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

Indicator species	**E**	**O**	**(O – E)**	**$(O - E)^2$**	**$\frac{(O - E)^2}{E}$**
Stonefly nymph	58	44			
Freshwater shrimp	33	43			
Water louse	7	12			
Sludge worm	2	1			

χ^2 = ... **[4]**

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(ii) Look on Table 6.3 to find the probability that the difference between Coney Stream and Heron Stream is due to chance and is not due to pollution from the farm.

Degrees of freedom	Probability of a larger value of χ^2							
	0.95	**0.90**	**0.75**	**0.50**	**0.25**	**0.10**	**0.05**	**0.01**
1	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09

Table 6.3

The Water Board biologist concluded that the farm beside Coney Stream had been causing water pollution.

Use your calculated value for χ^2 (on page 21) and the information in Table 6.3 to justify whether the biologist's conclusion can be supported or not.

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

(b) The Water Board biologist said that discharge of cattle-shed manure into the stream would affect its ecosystem.

(i) What is meant by the term *ecosystem*?

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

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(ii) Cattle-shed manure is a mixture of straw and faeces (with undigested carbohydrates and proteins) containing numerous bacteria.

Is the concentration of cattle-shed manure in the water of the stream a biotic or abiotic factor?

Explain your choice.

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

(c) (i) In unpolluted Heron Stream, energy may be transferred between organisms in the following food chain:

aquatic producers → protoctists → shrimps → fish → kingfisher (bird) → hawk

The arrows represent energy transfer.

Name the process that is responsible for the transfer of energy through this food chain.

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

(ii) Which energy transfer between animals would be the **least** efficient in this food chain?

Explain your choice.

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

[Total: 11]

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7 This question is about aspects of genetic engineering.

The remains of Ice-Age mammoths are often found in permafrost and tar pits. The high state of preservation allows DNA to be extracted and analysed. Genes can be sequenced and compared with other specimens to see how closely they might be related.

Some of the steps required for gene sequencing are listed below.

One step is out of order, and one step contains an error in the technical term(s) used.

1. Take a tissue sample from the mammoth's remains and send it, deep-frozen, to the laboratory.

2. Digest the DNA with a transferase enzyme that will cut at either side of the cytochrome c gene.

3. Extract DNA from the cells.

4. Amplify the DNA fragments by the polymerase chain reaction using Taq polymerase.

5. Obtain cytochrome c DNA specimens from other mammoth populations.

6. Run the samples side by side in gel electrophoresis.

7. Compare the banding patterns.

8. The new mammoth is most closely related to the population whose cytochrome c gene banding pattern is most similar.

(a) (i) Using the numbers listed above, state which step is in the wrong order, and between which steps it should go.

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

(ii) State which step contains the error and state the correct technical term(s) that should have been used.

.....

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

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(b) Genetic engineering often takes the form of extracting a gene from one organism to put into another organism. Genes can also be supplied by cDNA libraries.

Suggest one **other** way to obtain a gene.

.....

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

(c) A useful vector for moving and storing genes is the bacterial plasmid. Plasmids are closed loops of DNA. Plasmids in bacterial cells are separate from the main chromosome.

(i) Bacteria can transmit plasmids from one cell to another, or take up plasmids from the surrounding medium.

What is the benefit to bacteria of having these abilities?

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

(ii) In genetic engineering, DNA fragments can be inserted into plasmids, which are then taken up by bacteria. The plasmid is cut open and the DNA fragment is sealed in using an enzyme.

Name the enzyme used to seal a DNA fragment into a plasmid.

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

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(d) Scientists used a transformed plasmid to insert genes into Golden Rice™, via the plant-infecting *Agrobacterium*.

Fig. 7.1 outlines the metabolic pathway by which early types of Golden Rice™ made β carotene, the precursor of vitamin A.

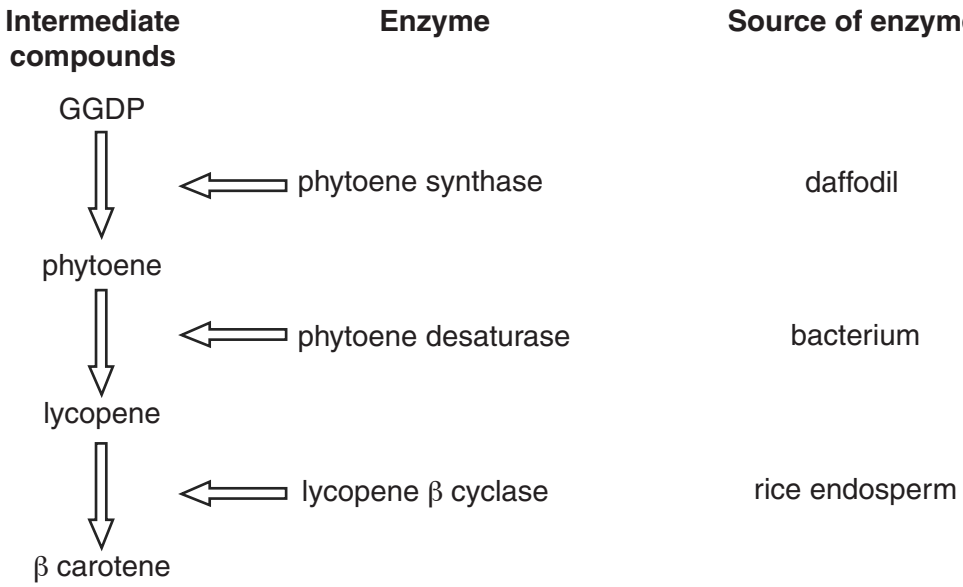


Fig. 7.1

At first, conversion to β carotene was very inefficient. Analysis of quantities of intermediate compounds in the rice showed a build-up of GGDP and little phytoene.

(i) Explain how the information above shows that the enzymes phytoene desaturase and lycopene β cyclase were **not** limiting the manufacture of β carotene.

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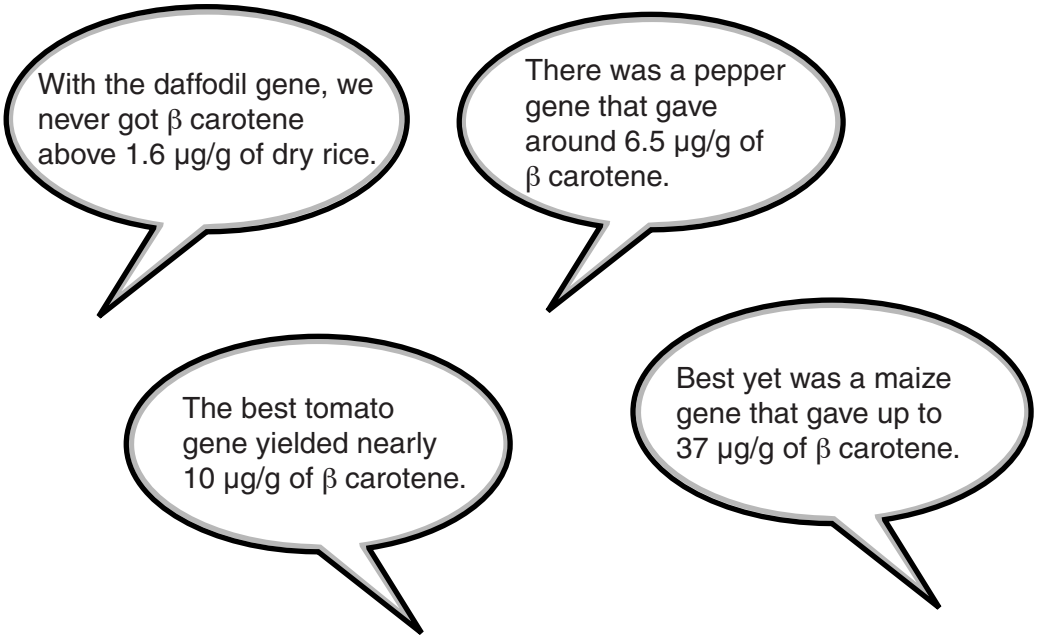
.....

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

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(ii) Phytoene synthase genes from other sources were then tried with these results:



The gene that makes phytoene synthase enzymes has slight differences between the species.

Suggest explanations for the different performances of these enzymes.

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

(e) State two ethical arguments, one **for** and one **against** this example of genetically manipulating a plant.

Argument for

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Argument against

.....

.....

[2]

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(f) Another objective of genetic engineering is to produce animals whose organs might be used for transplantation to humans.

- The pig is an animal viewed as promising for xenotransplantation. But it grows rather slowly, and is objectionable to some religious faiths.
- The rat grows much faster, and is easy to feed and house.

Suggest a **technical** difficulty that might prevent the rat becoming useful in xenotransplantation of organs into humans.

.....

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

(g) Genetic engineering is successful in isolating healthy alleles of a gene and putting them into suitable vectors. This opens exciting possibilities for treating human genetic diseases.

Explain the difference between **somatic cell gene therapy** and **germ line cell gene therapy**.

.....

.....

.....

.....

.....

.....

.....

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

[Total: 15]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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

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GCE

Biology

Unit **F215:** Control, Genomes and Environment

Advanced GCE

Mark Scheme for June 2016

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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning
DO NOT CREDIT	Answers which are not worthy of credit
IGNORE I	Statements which are irrelevant
ALLOW or **ACCEPT**	Answers that can be accepted
( )	Words which are not essential to gain credit
__	Underlined words must be present in answer to score a mark
AW	Alternative wording
ORA	Or reverse argument
✓	Mark is awarded
X	Answer incorrect
^	Omission mark
BOD	Benefit of doubt
BP	Blank page
CON	Statement that contradicts a correct statement
●	Use to indicate when part of a mark point has been achieved
ECF	Error carried forward
GM	Mark has already been awarded (given mark)
	Horizontal wavy line to indicate incorrect statements
NBOD	Not giving the benefit of doubt

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Here are the subject specific instructions for this question paper

Unless otherwise stated, accept phonetic spelling throughout unless there is clear ambiguity with another term.
For each correct mark point awarded the tick annotation should be used.
Ensure that the answers to all part questions are acknowledged with a suitable annotation – e.g.

- an omission mark or NBOD if the answer is incomplete or not good enough
- a wavy line if some information is inaccurate
- CON if a potential mark point is contradicted
- a cross if the answer is completely wrong.

Use BOD with care and only if you are certain that the answer is close enough to the required information for the mark.

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Question			Answer	Marks	Guidance
1	(a)	(i)	carrying capacity ;	1	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **CREDIT** carrying capacity written on the graph, if no answer written or answer crossed out on answer line
		(ii)	(supply / amount, of) food / mice / prey ; predation (upon mink) ; (inter/intraspecific) competition ; (lack of) breeding / nesting, sites ; disease;	2 max	*Mark first **two** answers only, ignoring the numbered sections* **IGNORE** activities of the Mink Project **DO NOT CREDIT** plants **ACCEPT** named predator e.g. eagles **IGNORE** mates / space / shelter / nests, alone **IGNORE** parasites
	(b)	(i)	loss of , (natural/original) biodiversity / species richness ; planting/felling , in one go / not continuous ; disruption to food chains/webs ; prevents a climax community (from being reached) ; destruction of habitats ; soil erosion ;	2 max	**ACCEPT** prevent other species, growing (in conifer monoculture) **ACCEPT** pressure on, rare / endangered, species **ACCEPT** deflected succession , plagioclimax **IGNORE** disrupts / disturbs, habitats

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Question			Answer	Marks	Guidance
		(ii)	*social* amenity / recreation / (eco)tourism **;** educational benefit (to visitors / children) **;** improve (mental) well-being **;** *aesthetic* landscape more attractive / AW (for local people / visitors)**;** *ethical* (continuous management) better for local employment **;** duty of care for, habitat / environment / biodiversity / food webs /ecosystems **;**	**4 max**	*Mark as continuous prose* **IGNORE** commercial / economic reasons **ACCEPT** landscape aesthetically pleasing e.g. greater variety of species to look at / deciduous leaf changes / more flowers to see **ACCEPT** prevents soil erosion **IGNORE** vague refs to "playing God" / species have the right to live
	(c)	**(i)**	root suckers / basal sprouts **;** from , meristem / undifferentiated , tissue **;** grow , up around / in circle / between , felled trees **;** correct ref. to time **;**	**2 max**	**IGNORE** refs to genetics **IGNORE** suckers alone **ACCEPT** forms clonal patch / grows close to felled trees e.g. sprouts appear in a few months, **not** "years" / grow quickly
		(ii)	(new sprouts / trees are) <u>clones</u> / <u>genetically identical</u> **OR** no <u>genetic variation</u> **;** (new sprouts) as susceptible, as parent tree (to fungus attack) **;** *idea that* fungus , is systemic / remains in the tree **;**	**2 max**	 **ACCEPT** original / mother tree **ACCEPT** fungal hyphae spread in vascular tissue **IGNORE** fungal spread by, spores / beetles
			Total	**13**	

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Question			Answer	Marks	Guidance
2	(a)		DNA ; polypeptide(s) ; tertiary, structure / shape ;	3	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** chromosomes **IGNORE** protein **ACCEPT** 3D, shape / structure **IGNORE** active site
	(b)	(i)	animal **and** plant **and** fungi ;	1	any order **DO NOT CREDIT** other kingdoms
		(ii)	head-tail orientation / anterior-posterior axis ; position / development, of limbs ; (traces of) segmentation ; position / development , of eyes ;	1 max	**IGNORE** dorso-ventral orientation / head , thorax , abdomen / polarity unqualified **ACCEPT** head at one end, tail at the other **ACCEPT** has limbs **DO NOT CREDIT** head segment / thorax segment / abdomen segment
		(iii)	(**A** to **B**) disappearance of tail / AW ; (**B** to **C**) webbing / tissues /cells, removed between fingers / toes ;	2	**(B** to **C) ACCEPT** fingers / toes / digits , become more defined / separate / form individual digits **IGNORE** fingers / toes / digits, forming / developing

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Question			Answer	Marks	Guidance
	(c)		1. (at start / parental) grey mice may be heterozygous / AW ; 2. breed (grey) mice together ; 3. only breed from individuals that never produce black offspring ; 4. (continue breeding grey offspring together) for many generations ; 5. carry out test cross (with black mice) ;	**4 max**	**ACCEPT** mp1 from annotated genetic diagram 2. **IGNORE** homozygous / heterozygous / IVF 3. **ACCEPT** exclude parents of black offspring from further breeding ; 4. **ACCEPT** repeat the breeding (process) 5. **ACCEPT** breed black mice with grey mice 5. **IGNORE** back cross
			QWC ;	**1**	**Answer must obtain** mp 2 **followed by** one mark from mps 3 to 5 **Please insert next to the pencil icon:** • **a tick (✓) if QWC has been awarded** • **or a cross (×) if QWC has not been awarded** • **You should use the green dot to identify the QWC terms that you are crediting.**
			Total	**12**	

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Question			Answer	Marks	Guidance
3	(a)	(i)	*Biotic - any **one** from* mowing (by workers) ; impoverished soil community ; fewer, bees / insects / pollinators ; lack of grazers ; *Abiotic - any **one** from* limited space ; soil chemistry ; (named) pollution from vehicles (exhaust gases) ; wind from vehicle (slipstream) ; mud / dust , covering leaves ;	2	**Mark the first answer on each line.** If that answer is correct and an additional answer is given that is implausible or contradicts the correct answer then = **0 marks** **IGNORE** any suggestion that would apply equally to both surroundings. **ACCEPT** nitrifiers / worms **ACCEPT** road-salt, toxins from oil or rubber , soil pH **ACCEPT** particulates / lead / NO_x / SO_x / CO **DO NOT CREDIT** carbon dioxide
		(ii)	*(the shoot is)* growing, towards light / upwards ;	1	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** bending unqualified / away from wall / towards sun e.g. 'shoot bends and grows towards the light' = 1

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>Problem to be solved</th><th>Hormone</th></tr>
<tr><td>Bananas picked green and shipped in a container are not ripe when the ship arrives.</td><td>E / Ethene ;</td></tr>
<tr><td>Pot plants grown for sale at Christmas will not be bought if their leaves drop off.</td><td>A / Auxin ;</td></tr>
<tr><td>Barley grains delivered to a brewery do not contain much maltose for the yeast.</td><td>G / Gibberellins ;</td></tr>
<tr><td>In plant tissue culture, calluses on plain agar will be too slow in developing shoot buds.</td><td>C / Cytokinins ;</td></tr>
</table>
</td><td>4</td><td>Mark the first answer in each box. If that answer is correct and other material is added that is incorrect or contradicts the correct answer then = 0 mark</td></tr>
<tr><td></td><td>(c)</td><td></td><td>fungi / bacteria / microorganisms ;

on / from, the explant ;
contaminates / in, agar / medium ;

idea of competition for resources (between microorganisms and explant) / decrease in nutrients (in culture medium) ;</td><td>2 max</td><td>ACCEPT pathogens
IGNORE parasites

ACCEPT culture
IGNORE infection

IGNORE competition for space</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>idea that Rhizobium is, involved in nitrogen fixation / not involved in nitrification ;

(Rhizobium) will not reduce / increases levels of, ammonia / ammonium ions ;</td><td>1 max</td><td>IGNORE refs to plant host / symbiosis / legume / nodules / not aquatic / not free living

ACCEPT description e.g. Rhizobium produces, ammonia / ammonium ions from nitrogen gas

ACCEPT NH_3 / NH_4^+</td></tr>
</table>

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Question			Answer	Marks	Guidance
		(ii)	use of (micro)organisms to, remove / oxidise, ammonia / ammonium ions ; use of (micro)organisms for , commercial process / industrial process ;	1 max	**ACCEPT** NH_3 / NH_4^+ **IGNORE** 'prevents build- up of ammonia' **IGNORE** refs to products of nitrification / food production / drug production / for human benefit
		(iii)	*idea that* the desired product is *Nitrosomonas (europaea)* (cells) ; enzymes / proteins , are <u>denatured</u> (by incorrect pH) ; enzymes needed for , (named metabolic) processes in growth ; (incorrect pH) disruption of, tertiary / 3D,structure / shape ; *ref to* effect of hydrogen ions on , H / ionic , bonds ;	3 max	**ACCEPT** increases yield of *N. europaea* **IGNORE** ref to products of *Nitrosomonas europaea* **DO NOT CREDIT** nitrogenase is denatured **CREDIT** enzymes for, respiration / protein synthesis / cell reproduction / DNA replication **IGNORE** active site
	(e)	(i)	unit should be in (column) headings ;	1	
		(ii)	number of bacteria (in bacterial suspensions) ; plantlets not sterilized ; (initial) size / mass , of plantlets ; concentration of ammonia solution ;	1 max	**ACCEPT** "concentration" of bacteria **IGNORE** amount of bacteria **IGNORE** decimal places of grams / duration of trial / age of plantlets / time of day dry mass measured / volume of sand / number of plantlets
			Total	16	

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Question			Answer	Marks	Guidance
4	(a)	(i)	25 (%);	1	**IGNORE** working
		(ii)	1. (island edges / cacti) subject to, sea/salt, spray ; 2. qq (genotype) confers ability to obtain water from salt spray; 3. (gives) selective advantage ; 4. (individuals with qq genotype) survive / reproduce ; 5. allele / q, frequency increases ; 6. directional selection ; 7. geographic , isolation / barrier ; 8. (means) no new alleles coming in ;	4 max	**ACCEPT ORA** for mp 2 – 5 **IGNORE** mist / sea water for **mp1 and 2** **ACCEPT** homozygous recessive / 'they' for qq genotype **2.ACCEPT** qq gets water supply from salt spray **2.ACCEPT** qq genotype confers tolerance to salt (spray) **3.ACCEPT** description e.g. 'they are (at an advantage and are) selected for' **5.DO NOT CREDIT** gene frequency increases **5. IGNORE** 'qq frequency increases' **6.IGNORE** natural selection

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Question	Answer	Marks	Guidance
(b)	T1. lay, tape / string , in a line / across zones ; T2. from sea to post-pioneer (boundary) / AW ; T3. perform , line / belt, transect ; Q4. (frame / open / point) quadrat ; Q5. placed systematically / back to back / intervals (along tape) ; K6. use a key ; K7. identify species present ; K8. estimate percentage cover / count plants / species frequency / use ACFOR scale ; R9. ref. to repeated sampling over time ; R10. ref. to repeated sampling in one area ;	6 max	Look for wording that indicates up to the end of the pioneers or to first post-pioneers, e.g. top of dune ' lay tape across salt spray and rain - watered zone' = T1 and T2 **Q5. DO NOT CREDIT** randomly **K8. IGNORE** percentage abundance
	QWC – award if **TWO** items of equipment above is linked to description of correct use ;	1	Award if any **TWO of the following pairs** of marking points have been awarded : **T1,T2/ T3** **Q4,Q5** **K6,K7/ K8** **Please insert next to the pencil icon:** • **You should use the green dot to identify each pair of mps that you are crediting** • **a tick (✓) if QWC has been awarded** • **or a cross (×) if QWC has not been awarded**

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Question	Answer	Marks	Guidance
(c)		3 max	*Marks awarded for **activity** (within the categories given) correctly **linked** to **effect***
	Activity: agriculture / farming / roads / building / deforestation ,		
	Effect: soil erosion / habitat destruction / loss of biodiversity**;**		**IGNORE** disruption / disturbance, of, habitat / biodiversity
	Activity: introduced (animal) species,		**ACCEPT** named animal species e.g. cats
	Effect: (native) animal / bird / egg, predation **OR** (native) plant damage / grazing **OR** (interspecific) competition **;**		**ACCEPT** destroys nests
	Activity: tourism / recreation,		
	Effect: litter / sewage / habitat destruction / loss of biodiversity **;**		**IGNORE** pollution unqualified **IGNORE** disruption / disturbance, of, habitat / biodiversity
	Activity: shipping ,		
	Effect: oil spills / sewage / bilge / (named) flotsam **;**		**ACCEPT** named example (e.g.plastic) **IGNORE** pollution unqualified
	Activity: (over-)fishing / hunting,		
	Effect: disruption of food chains **OR** (native) species , are threatened / may become extinct**;**		**IGNORE** loss of biodiversity **ACCEPT** 'kills species' **ACCEPT** named species e.g. sea cucumber / sharks / tortoises
	Total	**15**	

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Question			Answer	Marks	Guidance
5	(a)		1 (named) receptor detects, stimulus / change in environment ; 2 sensory neurones conduct action potentials ; 3 (from receptors) to CNS **;** 4 motor neurones conduct action potentials ; 5 (from CNS) to <u>effector</u> **;** 6 relay / intermediate, neurones conduct action potentials **;** 7 from sensory to motor neurones; 8 *ref to* role of synapses ; 9 (CNS / brain) coordinates response **;**	**4 max**	***For mp2,4,6 action potentials / impulses must be mentioned at least once*** **2.ACCEPT** impulses **2.IGNORE** messages / signals. **3.ACCEPT** brain/spinal cord **4.ACCEPT** impulses **4.IGNORE** messages / signals. **6.ACCEPT** impulses **6.IGNORE** messages / signals. **8.ACCEPT** summation / creation of new pathways / interconnection of existing pathways / memory / learning / filtering (out) low-level <u>stimuli</u> / inhibitory / excitatory **9.ACCEPT** coordination described
	(b)		glycogen converted into glucose (in liver)**;** glucose released into blood **;** (carried / available) to cells **;** (glucose needed for) respiration / glycolysis **;** to release energy / make ATP **;** for increased, breathing rate / heart rate **/** muscle contraction **;**	**3 max**	**ACCEPT** increased levels of blood glucose **DO NOT CREDIT** ref to producing / creating **,** energy **ACCEPT** more energy available **ACCEPT** increased muscle activity **IGNORE** 'adrenaline increases breathing rate /heart rate' alone , 'rabbit runs quicker'

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td>(i)</td><td>
<table>
<tr><th>Organ</th><th>Type of muscle</th><th>Action of <u>muscle</u> in fight or flight response</th></tr>
<tr><td>Heart</td><td><u>cardiac</u></td><td>increase pulse rate</td></tr>
<tr><td>Leg muscle</td><td>voluntary / skeletal/striated</td><td>contract</td></tr>
<tr><td>Arteriole to liver</td><td>smooth</td><td>contract / relax</td></tr>
</table>
; ; ;
</td><td>3</td><td>Mark the first answer in each box. If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks.

IGNORE relax for second box

ACCEPT (vaso)constrict / (vaso)dilate for third box (as in context of effect of muscle on arteriole)
IGNORE increases/decreases, blood flow
IGNORE increases/decreases,diameter</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><u>myosin</u> ;</td><td>1</td><td>IGNORE thick filament.
DO NOT CREDIT myelin
Mark the first answer. If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks.</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>avoidance of predation / desiccation / overheating ;</td><td>1 max</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>shine a light/torch on slugs, when feeding / at night / in dark ;
Idea of repeated (stimulus) ;
(observe) reaction / response , diminishes / stops ;</td><td>2 max</td><td>ACCEPT no longer moves away from light
IGNORE ' slugs learn to ignore the light'</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>taxis / kinesis ;</td><td>1</td><td>Mark the first answer. If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks.

ACCEPT (negative)phototaxis
DO NOT CREDIT positive phototaxis</td></tr>
</table>

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Question			Answer	Marks	Guidance
	(e)	(i)	social behaviour ;	1	**If more than one box is ticked then = 0 marks.**
		(ii)	bones of lower arm / radius and ulna, are longer ; muscles are longer / more muscle tissue ; (so) more muscle fibres (to deliver contracting force) ;	2 max	*each marking point must be comparative* **IGNORE** longer arms / longer levers / longer bones **ACCEPT** 'they' for muscles **ACCEPT** muscles have greater, volume / mass **IGNORE** more muscles / bigger muscles / muscle density **ACCEPT** more, muscle cell / myofibrils / sarcomeres / motor units
			Total	18	

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td>(i)</td><td>χ^2 = 10.48 / 10.480 / 10.5 ; ; ; ;</td><td>4</td><td>
<table>
<tr><th>Indicator species</th><th>E</th><th>O</th><th>O - E</th><th>$(O - E)^2$</th><th>$\frac{(O - E)^2}{E}$</th></tr>
<tr><td>Stonefly nymph</td><td>58</td><td>44</td><td>-14</td><td>196</td><td>3.38</td></tr>
<tr><td>Freshwater shrimp</td><td>33</td><td>43</td><td>10</td><td>100</td><td>3.03</td></tr>
<tr><td>Water louse</td><td>7</td><td>12</td><td>5</td><td>25</td><td>3.57</td></tr>
<tr><td>Sludge worm</td><td>2</td><td>1</td><td>-1</td><td>1</td><td>0.50</td></tr>
<tr><td></td><td></td><td></td><td>;</td><td>;</td><td>;</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
Correct answer = 4 marks

If answer is incorrect or missing
then
CREDIT correct working in table columns as follows:

All figures in one column correct = 1 mark
to 3 max
DO NOT CREDIT column mark if minus signs on figs missing or incorrect
IGNORE number of d.p.in table
CREDIT fractions for last column
ALLOW ecf from any incorrect column to the next and for χ^2.
</td></tr>
</table>

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Question			Answer	Marks	Guidance
		(ii)	calculated value / χ^2 / 10.48 / 10.5, is (much) larger than, critical value / 7.81 **; ORA** *idea that* probability that these results are due to chance is (much) less than, 5% / 0.05**; ORA** conclusion is justified / result not due to chance / significant difference between observed and expected results (at the 0.05 level)**;**	**2**	**ALLOW** ecf for a correct explanation that corresponds to the candidate's incorrect calculation for (a)(i) **ACCEPT** probability lies between, 5%/0.05, and 1%/0.01 confidence limits **IGNORE** ref to null hypothesis
	(b)	**(i)**	all the living organisms and non-living components (in a habitat), and their interactions **;**	**1**	**ACCEPT** all the biotic and abiotic components (in a habitat), and their interactions **ACCEPT** all community and abiotic environment and their interactions **ACCEPT (**inter)relationships for interactions
		(ii)	*biotic because:* manure contains, bacteria / microorganisms**;** manure contains, straw / plant material (for bacteria) **;**	**1 max**	*Green blob biotic, then look for reason.* If biotic not given = 0 mark **ACCEPT** 'it' for manure **IGNORE** food **IGNORE** refs to oxygen concentration / BOD.
	(c)	**(i)**	feeding / eating / consuming / ingesting **;**	**1**	**IGNORE** digestion/ heterotrophic nutrition/ predation
		(ii)	shrimp to fish **;** (because) more indigestible parts (in shrimp) **;** **OR** fish to kingfisher **;** (because) more indigestible parts (in fish) **;** **OR** kingfisher to hawk **;** (because) kingfisher, is small / has large SA : Vol ratio / has more indigestible parts**;**	**2**	*Marks awarded for **link in food chain** correctly **linked** to **explanation*** **ACCEPT** named parts e.g. outer skeleton /shell **ACCEPT** named parts e.g. scales/ bones **ACCEPT** more energy lost as heat **ACCEPT** named parts e.g. bones /feathers/beak
			Total	**11**	

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Question			Answer	Marks	Guidance
7	(a)	(i)	step 3, should be between 1 and 2 / should be second ; **OR** step 2, should be between 3 and 4 / should be third ;	1	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks.**
		(ii)	step 2, enzyme should be restriction;	1	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks.**
	(b)		chemical synthesis / polynucleotide sequencing;	1	**ACCEPT** make an artificial (gene) / manufactured (gene) / synthetic (gene) **IGNORE** refs to gene bank, cDNA library, BAC's , using reverse transcriptase/ making cDNA from RNA
	(c)	(i)	(bacteria) acquire / take up / gain , (useful) genes ; example of useful gene; faster / without waiting for mutation ;	2 max	**ACCEPT** sharing genetic information/ increase genetic variation / sharing DNA **IGNORE** ' transfer / passing on genes' **ACCEPT** (gene for) antibiotic resistance, enzyme to metabolize new nutrients **DO NOT CREDIT** 'become immune to antibiotics' Look for the idea of accelerated acquisition .e.g. quicker /in one generation
		(ii)	(DNA) ligase ;	1	**Mark the first answer.** If that answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks.**

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Question			Answer	Marks	Guidance
	(d)	(i)	*phytoene synthase* is, limiting / in low quantities / low activity**;** little, phytoene / substrate, for *phytoene desaturase* **;** little, lycopene/ substrate, for *lycopene β cyclase***;**	**2 max**	
		(ii)	different base sequences (in the different genes/ DNA**) ;** different amino acid sequences (in the different enzymes) **;** different, tertiary/3D, structures/ shape (in the different enzymes) **;**	**2 max**	**ACCEPT** different, triplet /codon/ nucleotide, sequences. **ACCEPT** different primary structures **ACCEPT** refs to active site different shape
	(e)		*For:* relief of, vitamin A deficiency / symptoms of vitamin A deficiency **;** *Against:* expense of, seed to (poor) growers / grain to consumers **;** (uncontrolled) hybridization with other <u>rice</u>, species / types / varieties**;** unknown long-term effects on consumers' health **;**	**2 max**	**IGNORE** refs to other instances of genetic engineering. **ACCEPT** prevents blindness, improves immune system, increase vitamin A uptake **IGNORE** helps eyesight / prevents death **ACCEPT** refs to putting (non GM) farmers out of business **IGNORE** refs to gene crossing to different plant species. **IGNORE** refs to "against nature", "playing God", loss of biodiversity

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Question			Answer	Marks	Guidance
	(f)		differences in organ size ; difference in body temperature ; earlier aging of organs ;	1 max	e.g. organs too small / organ size not compatible **IGNORE** rejection idea (as applies to both animals)
	(g)		**S1** cannot be inherited **OR** **G1** can be inherited ; **S2** introduces (functional), gene/allele, into, patient/ body cell /non reproductive cell **OR** **G2** introduces, (functional), gene/allele, into sperm / egg / zygote/ embryo ; **S3** only some cells have (functional), gene/ allele **OR** **G4** all cells have (functional), gene/ allele; **S5** short lived / temporary / needs repeating **OR** **G5** long lived / permanent / does not need repeating;	2 max	***one mark for somatic (S) and one mark for germ line (G)*** **IGNORE** ref to legality / ethical issues **S1 /G1 ACCEPT** (gene /allele) passes e.g. S (gene / allele) does not pass to offspring **S1 / G1 IGNORE** (gene / allele**)** affects e.g. G (gene / allele) does not affect offspring **S2 / G2 DO NOT CREDIT** altering / removing / replacing, genes
			Total	15	

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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 *

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.

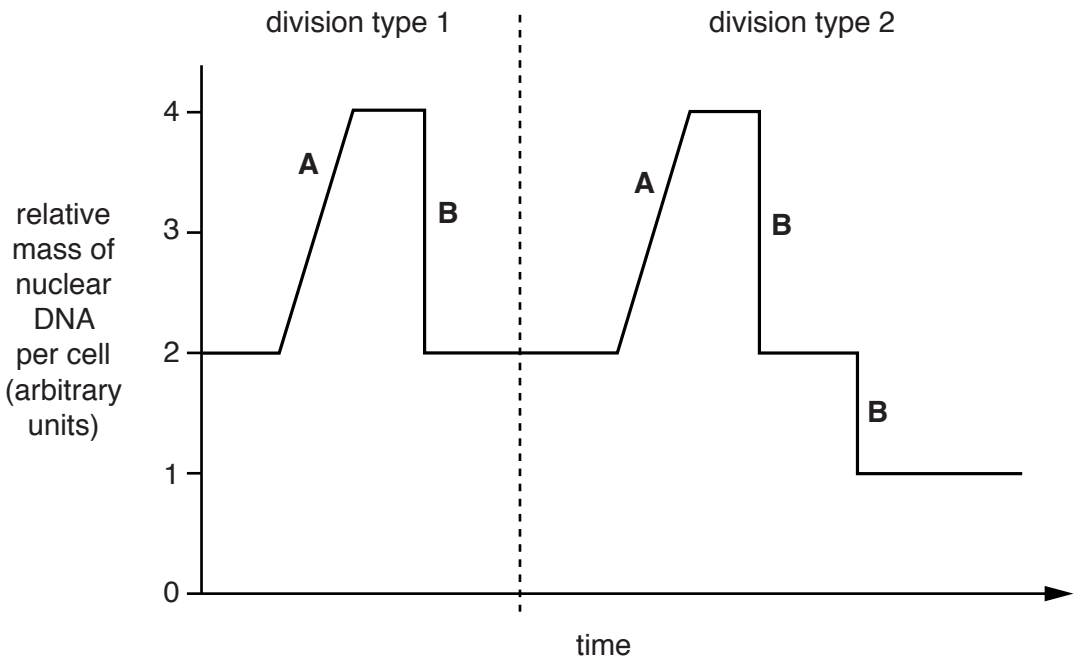


Fig. 1.1

(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.

.... **[9]**

[Total: 12]

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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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.....

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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?

.....

..... **[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**.

1 .....

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2 .....

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

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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.

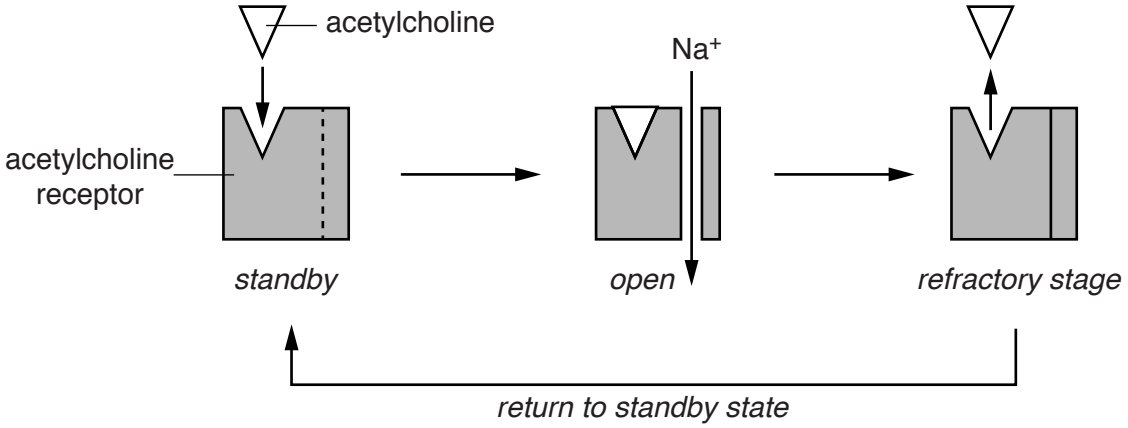


Fig. 7.1(a) When nicotine absent

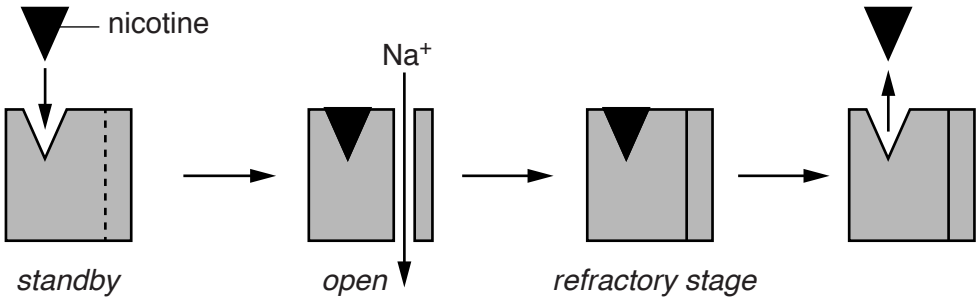


Fig. 7.1(b) When nicotine present

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

(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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GCE

Biology

Unit **F215:** Control, Genomes and Environment

Advanced GCE

Mark Scheme for June 2015

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1. Annotations used in the detailed Mark Scheme (to include abbreviations and subject-specific conventions).

Annotation	Meaning
	Correct answer
	Incorrect response
BOD	Benefit of Doubt
NBOD	Not Benefit of Doubt
ECF	Error Carried Forward
GM	Given mark
	Underline (for ambiguous/contradictory wording)
^	Omission mark
I	Ignore
	Correct response (for a QWC question)
BP	Blank Page
CON	Response that contradicts previous correct response

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Question			Answer	Marks	Guidance
1	(a)	(i)	*division type 1* mitosis **and** *division type 2* meiosis ;	1	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** correct spelling only **ACCEPT** correct spelling only **CREDIT** meiosis I **and** II **DO NOT CREDIT** meiosis I / meiosis II alone
1	(a)	(ii)	**A** (DNA) replication ; **B** cytokinesis ;	2	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** stages of cell division **IGNORE** cell division / stages of cell division

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Question			Answer	Marks	Guidance
1	(b)		**A1** independent assortment / random segregation **,** of (homologous) chromosomes / bivalents; **A2** in **,** metaphase I / meiosis I **;** **A3** *of* chromatids in **,** metaphase II / meiosis II **;** **A4** (so) homologous chromosomes , have different alleles / come from different parents **;** **A5** produces large number of allele combinations **;** **C1** crossing over / (formation of) chiasma(ta) **;** **C2** in **,** prophase I / meiosis I **;** **C3** (so) chromatids will have new combination of alleles **;** **C4** amount of variation depends on distance between crossover points **;** **M1** mutation **;** **M2** changes the (DNA) nucleotide/ base, sequence **;** **M3** DNA checks (during duplication) did not recognise damage **;** **M4** *idea of* differences in (named) protein(s) **;** **N1** non-disjunction **;** **N2** homologous chromosomes do not separate (in metaphase I) **;** **N3** one **,** more / less **,** chromosome present **;** **F1** random, mating / fusion of gametes/ fertilisation **;** **F2** gametes are not genetically identical; **F3** produces large number of (allele) combinations **;**	**8 max**	**A1 ACCEPT** Random assortment / independent segregation **A2 /A3 DO NOT CREDIT** metaphase /meiosis, I **and** II **A2 /A3 ACCEPT** correct anaphase stage linked to segregation **A2** must be in context of independent assortment / random segregation **A4/ A5 DO NOT CREDIT** genes **A4 ACCEPT** pairs of chromosomes / maternal **and** paternal chromosomes, have different alleles/ come from different parents **A5 ACCEPT** different combinations of, chromatids /chromosomes, in gametes **CREDIT** figures e.g. for humans 2^{23} possible combinations **C1 DO NOT CREDIT** between sister chromatids **C2 DO NOT CREDIT** prophase / meiosis, I **and** II **C2** must be in context of crossing over **C3 ACCEPT** shuffles / swaps/exchanges, alleles on chromatids **C4** e.g. more variation the further apart the crossovers occur **M2 IGNORE** **'**pairs' **M2 CREDIT** deletion,/substitution/ addition, of, base / nucleotide **M3 ACCEPT** proof reading did not recognise damage **M4** e.g. change in, amino acid sequence/primary structure **N1 CREDIT** inversion / translocation (chromosome mutation) **N2 CREDIT** description of inversion / translocation **N3 CREDIT** examples of chromosome changes e.g. Trisomy 21 **F2 ACCEPT** gametes are genetically different **F3 DO NOT CREDIT** produce large number of gene combinations

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Question			Answer	Marks	Guidance
			QWC ;	1	**Awarded for one change and consequence of that change** **Award if ONE of the following has been awarded** mp **A1 or A2 or A3** **and** mp **A4 or A5** **OR** mp **C1 or C2** **and** mp **C3 or C4** **OR** mp **M1 or M2** **and** mp **M3 or M4** **OR** mp **N1 or N2** **and** mp **N3** **OR** mp **F1 or F2** **and** mp **F3**
			Total	**12**	

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Question			Answer	Marks	Guidance
2	(a)	(i)	**1** peak in **,** 1988 / 1994 **;** **2** trend decrease after 1994 **;** **3** ref. decrease and then increase **,** 1988 to 1994 **;** **4** fluctuations (within pattern) **;** **5** overall increase from 1965 to 2002 **;**	**3 max**	**IGNORE** ref to population figures **1 ACCEPT** increases until / highest number in, 1988/1994 **4 ACCEPT 'goes up and down' / oscillates**
2	(a)	(ii)	*accurate because* *idea that* actual number of elk shot is recorded **;** *method not valid because* *idea that* number of elk shot / hunting success **,** varies independently of population size **;**	**2**	**ACCEPT** elks shot are counted / reported **CREDIT** suitable reason e.g. numbers of licences issued / number of hunters set quotas to hunt illegal hunting if weather suitable for hunting only younger / older / diseased / larger**,** elk killed **IGNORE** length of time spent hunting

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Question			Answer	Marks	Guidance
2	(b)	(i)	**1** *idea that population size is determined by* <u>limiting</u> <u>factor</u>(s) **;** *Before 1995, population increases due to* **2** example of factor that is not limiting population **;** *Before 1995, population levels off because* **3** reaches <u>carrying capacity</u> **;** *Before 1995, population becomes limited by* **4** intraspecific competition for named resource; **5** interspecific competition for named resource; *Population can decline at any time/ dips, due to* **6** severe weather / natural disaster ; **7** decrease before 1995 not due to wolves (as none present) **;** **8** decrease after 1995 (probably) due to wolves**;** **9** *idea that* effect of wolves on population may be debatable **;**	**6 max**	**IGNORE ref to abiotic / biotic factors throughout** **2** e.g. plenty of, enough, food Less **/** no predation Less / no overcrowding/ enough space less hunting **2 IGNORE** water / nutrients/ availability of food **4 CREDIT** description of intraspecific **5 CREDIT** description of interspecific **4 & 5 CREDIT** any suitable limiting factor eg competition for, food / space / mates/ overcrowding **6 CREDIT** ref to parasites/disease/ drought/floods/fires **9** e.g. lack of data in 1996 and 1997 makes it difficult to form conclusions
			QWC **;**	**1**	**Award if** **1 mark** awarded from **mps 1 to 6 (limiting factors)** <u>**and**</u> **1 mark** awarded from **mps 7 to 9 (effect of wolves)**

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Question			Answer	Marks	Guidance
2	(b)	(ii)	*re-introduction of wolves is conservation because* **1** restoring the <u>ecosystem</u> (to its original form) **or** maintains <u>biodiversity</u> **;** **2** helps the (global) wolf population **;** **3** active / dynamic / sustainable, management / maintenance **;** **4** prevents over-population by the elk **;** **5** prevents over-grazing **or** damage to, habitat / ecosystem **;**	**2 max**	**ACCEPT** controls/ increases, <u>biodiversity</u> **ACCEPT** wolves do not become extinct / increase in number 'Actively maintains biodiversity' = **MP1 and 3** **ACCEPT** wolves, limit / control, elk population or lack of wolves causes elk population to grow **ACCEPT** if wolves absent, elk would damage habitat / other species may become extinct
			Total	**14**	

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Question			Answer	Marks	Guidance
3	(a)		AAA TCT GGT ;	1	
3	(b)	(i)	the correct bases inserted in **all** 3 rows before box ; correctly identifying the last base in each sequence as the labelled base ; 5 **T** **T** **T** 6 **T** **T** **T** **C** 7 **T** **T** **T** **C** **C**	2	
3	(b)	(ii)	electrophoresis ; (negatively-charged DNA) moves towards , positive electrode / anode ; smallest/smaller (fragments) move, fastest / faster ; **ora** resolution on gel sufficient to register 1, nucleotide / base;	3 max	**ACCEPT** positive, end /terminal **IGNORE** ref to distance **ACCEPT** lightest / shortest **ACCEPT** description ' machine detects fragments to one base in length' **IGNORE** pair
3	(c)	(i)	contraction of smooth muscle ; circular (muscle) ; extra mucus production ; inflammation ;	2 max	**ACCEPT** involuntary muscle / non-striated muscle **ACCEPT** blocked by mucus / build-up of mucus **ACCEPT** swelling / oedema **IGNORE** scarring

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Question			Answer	Marks	Guidance
3	(c)	(ii)	(reduced diameter means) increased , resistance to air flow / friction ; *idea that* exhalation is passive / no (muscular) force behind exhalation / requires additional, force / pressure, to exhale;	1 max	**ACCEPT** 'breathes harder'
3	(d)		(mutation) change in (DNA) nucleotide/ base, sequence ; (mutation causes) change in, amino acid sequence / primary structure (of protein) ; change in , tertiary structure/ 3D shape / binding site , of receptor ; salmeterol unable to bind ; *idea that* no response triggered in cell / no second messenger system activated ;	3 max	**IGNORE** triplet/codon/gene / frameshift **DO NOT CREDIT** active site **ACCEPT** salmetorol not complementary shape to receptor **ACCEPT** salmeterol cannot bind as easily e.g. adenyl cyclase not activated **IGNORE** 'has no effect'
3	(e)	(i)	(mutation resulted in) receptor having complementary shape to montelukast ; montelukast able to bind ; (whereas) salmeterol cannot ; montelukast may have a different receptor ;	2 max	**DO NOT CREDIT** active site **IGNORE** fit **ACCEPT** attach **ACCEPT** cannot bind as easily **ACCEPT** montelukast receptors not damaged
3	(e)	(ii)	not reliable because, sample size **too** small / **only** 62 children in study; **or** could be reliable because 31 is quite a large sample ;	1	**Note** *31 is a suitable number for a phase 1 trial*
3	(e)	(iii)	(epithelial) cells lining cheek ;	1	**ACCEPT** (named) white blood cells in saliva / salivary gland cells
			Total	**16**	

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Question			Answer	Marks	Guidance
4	(a)	(i)	geographic(al) ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** ecological **IGNORE** physical / barrier
4	(a)	(ii)	genetic drift ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
4	(a)	(iii)	*C because* has the greatest change in allele frequency / described; smaller population / fewer individuals ; *idea that* more , subject to founder effect / unrepresentative at start ; *(more subject to genetic change because)* each random mating more significant **or** each individual forms a greater proportion of gene pool **or** each individual has greater effects on gene pool (than in large population) **or** easier to lose allele from gene pool;	2 max	**If C not identified then no marks awarded** **Look for comparative points with other populations** **ACCEPT** p and q for allele eg 'frequency of allele in C changed by 0.20 whilst it changed by 0.02 in A and 0.14 in B' **ACCEPT** figs as % **ACCEPT** smallest /fewest

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(b)</td><td>(i)</td><td>1401 ; ; ;</td><td>3</td><td>Correct answer = 3 marks

Award 2 max
if answer not given to the nearest whole number or is incorrect or missing,
then

CREDIT correct working in table columns as follows:
both figures in one column correct = 1 mark. (N.B. Minus sign required for column 1)

ALLOW ecf from any incorrect column to 2 max

<table>
<tr><th>Phenotype of fly</th><th>O - E</th><th>$(O - E)^2$</th><th>$\frac{(O - E)^2}{E}$</th></tr>
<tr><td>red eye, yellow body</td><td>- 354</td><td>125316</td><td>348 (348.100)</td></tr>
<tr><td>pink eye, yellow body</td><td>341</td><td>116281</td><td>323 (323.003)</td></tr>
<tr><td>red eye, ebony body</td><td>369</td><td>136161</td><td>378</td></tr>
<tr><td>pink eye, ebony body</td><td>- 356</td><td>126736</td><td>352</td></tr>
</table>
</td></tr>
<tr><td>4</td><td>(b)</td><td>(ii)</td><td>reject hypothesis because
calculated χ^2 value / 1401 , is
(much) larger than , critical value / 11.35 ;</td><td>1</td><td>ALLOW ecf for a correct explanation that corresponds to the candidate's incorrect calculation for (b)(i)

CREDIT idea that probability that these results are due to chance is (much) less than 1% / 0.01</td></tr>
</table>

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Question			Answer	Marks	Guidance
4	(b)	(iii)	(autosomal) linkage **or** genes / alleles, are linked **;** on same chromosome **;** linked alleles inherited together **;** **Ry** and **rY** (on chromosomes in heterozygotes) **;** crossing-over produced (rare) recombinants **;** tight linkage / two genes close together **;**	**3 max**	**DO NOT CREDIT** sex linkage **IGNORE** epistasis **ACCEPT** annotated drawing **ACCEPT** recombinant phenotypes described **ACCEPT** loci close together **Note** '*The alleles R & y and r & Y are inherited together*' = 2 marks (mps 3 & 4) '*The alleles for red eyes and ebony body, and pink eyes and a yellow body, are inherited together*' = 2 marks (mps 3 & 4)
			Total	**11**	

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Question			Answer	Marks	Guidance
5	(a)		**1** $\frac{\text{herbivore / primary consumer,energy}}{\text{producer energy}}$ x 100 ;		**1 CREDIT** $\frac{\text{trophic level 2 energy}}{\text{trophic level 1 energy}}$ x 100 ; **CREDIT** sample figures. e.g. if producer energy 20 000 kJ m^{-2} and herbivore 2000 kJ m^{-2} calculation is 2000 / 20000 x 100 = 10% **CREDIT** $\frac{\text{Energy available after transfer}}{\text{Energy available before transfer}}$ x100 **IGNORE** ref to productivity
			Plus any 3 of the following:		
			2 (a sample of) producers collected **;**		**CREDIT named examples for 2 and 3**
			3 (a sample of) herbivores /primary consumers collected;		**ACCEPT '**organisms at each trophic level collected' for **1 mark**
			4 (collected from) the same area **;**		
			5 **(**measure) biomass / dry mass (of individual or population) **;**		**5 ACCEPT** wet / fresh,mass **5 IGNORE** mass unqualified / pyramids of biomass
			6 energy content calculated of producer **and** herbivore **;**		**6 ACCEPT** expressed as J/KJ/MJ, per gram **IGNORE** calories per gram
			7 use of calorimeter / described;		**7** e.g. burn sample, in oxygen / in measure temperature increase **ACCEPT** use of published tables for energy values of, fresh /wet, mass
				4 max	

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Question			Answer	Marks	Guidance
5	(b)			6	**Mark the first answer in each box.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**

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

ACCEPT A / B

ACCEPT C

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>5</td><td>(c)</td><td></td><td>
<table>
<tr><th>Description</th><th>Name</th><th></th></tr>
<tr><td>Sparrows initially fly away from fruit bushes on which shiny CDs are hung, particularly when the CDs move in the wind.</td><td>escape reflex</td><td>;</td></tr>
<tr><td>After a few days the sparrows start visiting the fruit bushes again, and do not fly away even when the CDs move.</td><td>habituation</td><td>;</td></tr>
<tr><td>Carrot flies move towards chemicals released by carrot plants.</td><td>(positive chemo-) taxis</td><td>;</td></tr>
<tr><td>Raccoons learn to remove lids from containers of grain in a barn.</td><td>operant conditioning / trial and error (learning)</td><td>;</td></tr>
<tr><td>A line of young chicks follow their mother into a cornfield.</td><td>imprinting</td><td>;</td></tr>
</table>
</td><td>5</td><td>Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks

IGNORE innate / instinctive / learnt (as stated in Q)

DO NOT CREDIT negative chemotaxis
ACCEPT taxes

CREDIT insight (learning) / latent (learning)/ intelligent learning / observational learning</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>15</td><td></td></tr>
</table>

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Question			Answer	Marks	Guidance
6	(a)	(i)	**1** (hormone) binds to <u>receptor</u> **;** **2** causing **,** cascade of events / enzyme reactions **;** **3** may involve switching **,** on / off, genes **;** **4** only **,** present / needed **,** in small **,** concentrations / quantities (to have an effect) **;** **5** may have effect on more than one **,** location / target tissue **;** **6** *idea that* effect may involve interaction of more than one hormone **;**	**2 max**	**IGNORE** prompt lines and mark as prose **1 ACCEPT (**hormone) complementary shape to <u>receptor</u> **1 ACCEPT** attach **1 IGNORE** fit **3 CREDIT** ref to changing gene expression
6	(a)	(ii)	**1** (most) plant cells retain ability to differentiate / <u>totipotent</u> **;** **2** plants have **,** meristems / meristematic tissue **;** **3** *idea that* plant cells can de-differentiate and then differentiate into a different cell type; **4** (most) animal cells are **,** differentiated / not totipotent / not pluripotent / only able to differentiate into the same type(s) of cell / are multipotent;	**2 max**	**2 ACCEPT** named meristematic tissue e.g. shoot apex / root apex / cambium **4 ACCEPT** 'stem cells found in few (named) tissues' 'bone marrow cells only differentiate into blood cells'

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Question			Answer	Marks	Guidance
6	(a)	(iii)	**1** (inter-species / triploid) hybrids **,** are sterile / cannot reproduce sexually;		**1** **CREDIT** hybrid from named examples e.g. einkorn (wheat) x **,** wild / goat **,** grass emmer (wheat) x wild grass
			2 polyploidy (in the hybrid) provides duplicate of each chromosome **;**		**2** **IGNORE** ref to 'more than two sets of chromosomes' as this is given in Q
			3 (polyploidy) allows the hybrid to **,** carry out meiosis / form gametes **or** (polyploidy) restores fertility / overcomes sterility **;**		**3** **ACCEPT** 'chromosome number doubling restores fertility' **3** **ACCEPT** can reproduce sexually
			4 (hybrids are) <u>reproductively isolated</u> (from other species);		**4** **ACCEPT** gametes incompatible with other species
			5 increased, cell size / grain size, increases yield;		**5** **ACCEPT** seed size
			6 sterile hybrids expensive for farming (especially in developing countries);		
			7 (plants) stronger/more vigorous/ healthier;		**7** must be a comparative statement **7 ACCEPT** less prone to disease / greater hybrid vigour **7 IGNORE** pest resistance
				2 max	

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Question			Answer	Marks	Guidance
6	(b)		*cress seedlings* **C1** apical cells / apex/ tip(of shoot), produce **,** auxin / IAA **;** **C2** diffusion / active transport (down shoot / through parenchyma) **;** **C3** greater auxin (concentration) on shaded side of stem **;** **C4** auxin causes cell <u>wall</u> loosening **;** **C5** auxin causes cell **,** elongation / expansion **;** **C6** further detail of changes in cell **wall** ; *Human* **H1** retina / rods / receptors**,** detect light / AW **;** **H2** action potentials/ depolarisation/nervous impulse**,** along sensory neurone (membrane) **;** **H3** intermediate neurone (in brain) **/** (somatic) motor neurone / neuromuscular junction **;** **H4** correct ref to detail of synaptic transmission**;** **H5** depolarisation / contraction, of muscle fibre(s); **H6** correct ref to detail of muscle contraction;	**7 max**	**C1 ACCEPT** secretes /releases **C2 CREDIT** PIN (polar auxin transport) **C3 ACCEPT** auxin, moves to / collects on, shaded side **C3 IGNORE** found on shaded side **C4 ACCEPT** cell <u>walls</u> become,stretchy / less rigid **C4 IGNORE** weakened cell <u>walls</u> **C6** e.g. H^+ ions pumped into cell wall / low pH to allow enzymes to work / bonds broken within cellulose in wall **H1 IGNORE** ref to cones **H2 / H3 DO NOT CREDIT signals / messages** **H2 IGNORE** ref to optic nerve **H3 CREDIT** ref to relay neurone **H5 ACCEPT** muscle cell **H6** e.g. actin and myosin slide over each other
			Total	**13**	

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Question			Answer	Marks	Guidance
7	(a)	(i)	*increased blood pressure* **B1** (small) blood vessels / capillaries**,** burst / break **;** **B2** bleeding causes (localised) build up of pressure (leading to cell death) **or** blood / oxygen **,** supply **,** reduced / stopped **;** **B3** cells cannot <u>respire</u> (leading to cell death) **;** *thrombosis* **T1** thrombus / clot **,** interrupts / reduces, blood flow **;** **T2** (cells) deprived of **,** oxygen / glucose **;** **T3** cells cannot <u>respire</u> (leading to cell death) **;**	**4 max**	**B1 CREDIT** haemorrhage / aneurism / arterioles / arteries **B1 IGNORE** veins / venules **B1 IGNORE** destroys / damages blood vessels **B2** e.g. bleeding leads to cell compression **B2 ACCEPT** brain deprived of **,** oxygen / glucose **B3 DO NOT ACCEPT** <u>respire</u> less 'Clot results in less oxygenated blood to cells' = **T1** and **T 2** **T2 ACCEPT** brain deprived of **,** oxygen / glucose **T3 DO NOT ACCEPT** <u>respire</u> less
7	(a)	(ii)	*idea that* (if the stroke has been caused by a bleed) then the drug will, increase the bleeding / be ineffective as a treatment (to prevent bleeding) **;**	**1**	e.g. 'the drug makes the problem worse' **DO NOT CREDIT** 'not effective in reduction of blood pressure'
7	(a)	(iii)	*idea of* disruption of **,** oxygen / glucose **,** supply (to brain cells) for <u>aerobic</u> <u>respiration</u> **;** *lack of oxygen / glucose / blood / damage to* <u>cerebellum</u> resulting in problems with coordination / movement **;** <u>cerebrum</u> / <u>cerebral</u> <u>hemisphere</u>(s) / <u>cerebral cortex</u> **,** resulting in loss of **,** memory / speech **;** <u>medulla</u> (oblongata)/ <u>cerebrum</u> / <u>cerebellum</u>, resulting in paralysis (of body below the neck) **;**	**4**	**Can be awarded at any point in the answer.** **Effect must be correctly linked to the part of the brain responsible.** **ACCEPT** Broca's / Wernicke's, area / hippocampus **ACCEPT** cerebral hemisphere(s) / cerebral cortex / corpus callosum

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Question			Answer	Marks	Guidance
7	(b)		*producing nicotine is (selectively) advantageous as* **A1** stops **,** plant being eaten / loss of leaf area **;** **A2** so plant **,** survives / does breed / (still) produces seeds; **A3** *idea that* gene must be advantageous to be selected for **or** gene is linked to another gene that is selected for **;** *producing nicotine is (selectively) disadvantageous* **D1** decreases **,** reproductive success / number of seeds **;** **D2** metabolic resources diverted to nicotine production**;**	**3 max**	**mp must be in correct context (ie advantage/ disadvantage) to be awarded** **A1 ACCEPT** deters / kills, grazers / insects
7	(c)	(i)	postsynaptic membrane(s) (in **,** neurone / neuromuscular junction) **;**	**1**	**ACCEPT** sarcolemma **DO NOT CREDIT** postsynaptic knob

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Question			Answer	Marks	Guidance
7	(c)	(ii)	*Effect* Nicotine slows down rate of / stops, transmission of, action potentials / nervous impulses; **Plus any 2 of the following:** *Explain* binds to <u>receptor;</u> (nicotine) has the same response / opens Na^+ channels / causes depolarisation **;** nicotine remains in receptor for longer **;** *idea that* <u>receptor</u> **,** remains in refractory stage for longer / unable to return to standby condition / cannot be reactivated **;**	**3 max**	**IGNORE** 'nervous system slows down' / 'acts as a depressant' **ACCEPT** competes with acetylcholine for the <u>receptor</u> **DO NOT CREDIT** active site **DO NOT CREDIT** 'acts as competitive inhibitor' **DO NOT CREDIT** binds to receptor permanently **ACCEPT** causes action potential in next neurone / mimics, action / effects, of acetylcholine **IGNORE** 'mimics acetyl choline' alone **IGNORE** delays refractory stage **ACCEPT** permanently in refractory stage

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Question			Answer	Marks	Guidance
7	(d)	(i)	in xylem (by),cohesion-tension / transpiration (stream); in phloem (by), translocation / mass flow **;**	**2**	**ALLOW** transport in phloem from roots **only if** clearly in the context of being associated with transport of (stored) assimilates from roots
7	(d)	(ii)	*idea that* neonicotinoids have **,** little / no **,** effect (on humans) **;**	**1**	e.g. they don't harm humans neonicotinoids, do not bind/ not complementary, to receptors neonicotinoids broken down in digestion concentrations used in insecticides **,** very low / not high enough, to affect humans neonicotinoids not present in part of plant consumed by humans neonicotinoids break down before plant consumed
			Total	**19**	

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PART OF THE CAMBRIDGE ASSESSMENT GROUP

UKAS MANAGEMENT SYSTEMS 001

OCR

Friday 20 June 2014 – 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

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 **32** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 In 1958, scientists made a breakthrough in artificial reproductive cloning by successfully cloning a vertebrate species. The species cloned was the African clawed frog, *Xenopus laevis*.

Fig. 1.1, **on page 2 of the insert**, shows the cloned offspring produced, labelled **D**, as well as the three adult frogs (**A**, **B** and **C**) that were used to create them.

- frog **A**, a brown-coloured female frog, laid eggs, which then had their nuclei removed.
- frog **B**, an albino (white-coloured) female, laid eggs that were fertilised by sperm from **C**.
- frog **C**, an albino male, produced sperm that fertilised the eggs of **B**.

One of the fertilised eggs from **B** was allowed to divide. Nuclei were extracted from the resulting cells and placed into the eggs from frog **A**. These eggs developed into the frogs labelled **D** in Fig. 1.1.

(a) (i) The frogs in Fig. 1.1 show discontinuous variation in colour.

Using your knowledge of discontinuous and continuous variation, and the information given, suggest:

one other phenotypic characteristic in which the frogs show a discontinuous pattern of variation

.....

one phenotypic characteristic in which they show a continuous pattern of variation.

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

(ii) State the extent to which the environment is likely to affect each of the phenotypic characteristics that you have suggested in **(i)**.

.....

.....

.....

.....

.....

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

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(iii) Suggest why albino frogs were used to produce the nuclei for transfer.

.....

.....

.....

.....

.....

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

Question 1(b) begins on page 4

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(b) Samples of DNA were taken from frogs **A**, **B**, **C** and **D**.

Electrophoresis was used to separate the different lengths of DNA after cutting.

Fig. 1.2 shows the results.

These results are known as genetic profiles. Only the genetic profile of frog **C** is identified. The remaining profiles are labelled **1** to **3**.

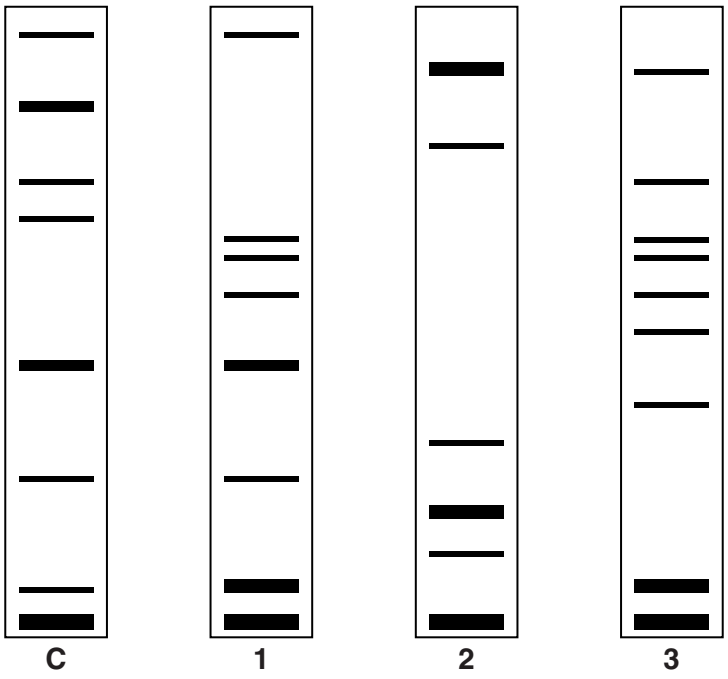


Fig. 1.2

(i) Identify which of the frogs in Fig. 1.1 gave genetic profiles corresponding to **1**, **2** and **3** in Fig. 1.2.

Write the letters **A**, **B** and **D**, as appropriate, in the table below.

Genetic profile number	Letter of frog
1	
2	
3	

[3]

(ii) Mitochondrial DNA from the frogs was sequenced.

State, giving a reason, which of the frogs **A, B** and **C** would have a mitochondrial DNA sequence identical to **D**.

.....

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

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(c) In the 1970s, the technique used to clone the frogs was successfully adapted to clone mice from embryos. Cloned mice are used to investigate factors affecting the development and treatment of disease.

(i) State **one advantage** and **one disadvantage** of using clones to test a treatment for a disease.

advantage

.....

.....

disadvantage

.....

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

(ii) In the 1990s, there were further developments in cloning technology when it became possible to make a clone of an adult mammal. The first clone produced from an adult cell nucleus was Dolly the sheep.

Adult cell cloning can be used to investigate the development and treatment of disease.

Outline **two other** potential applications of adult cell cloning.

1 .....

.....

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2 .....

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.....

[2]

Question 1(d) begins on page 6

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(d) Identical twins in humans are natural clones. They form when a fertilised egg cell divides by mitosis into two entirely separate groups of cells. Each group of cells develops into a baby.

Two brothers, who were identical twins, married two sisters, who were also identical twins. Each couple had one child.

Fig. 1.3 shows the relationships between these six people.

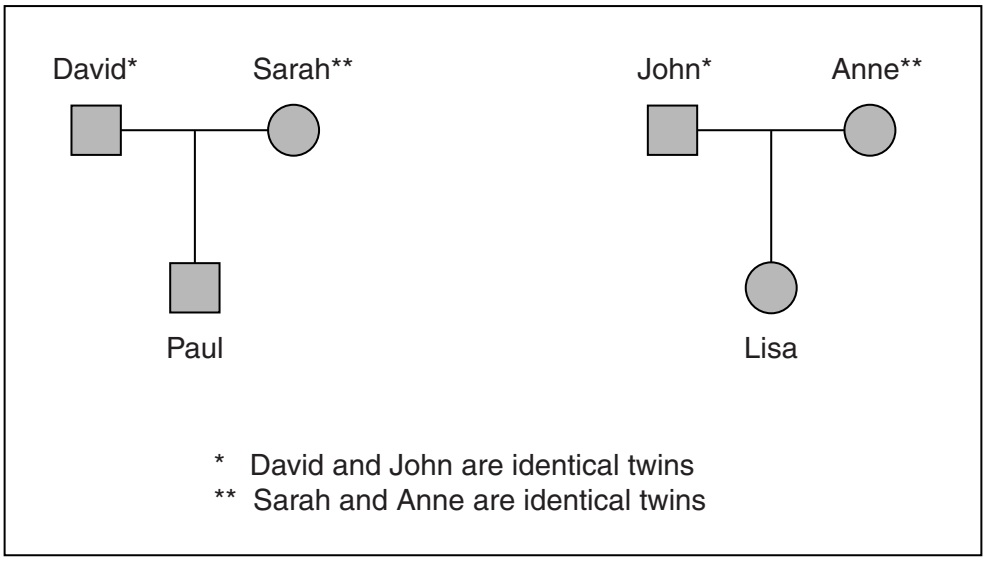


Fig. 1.3

Using your knowledge of mitosis and meiosis, estimate the percentage of alleles shared by the individuals listed in the table below.

Individuals	% of alleles shared
David and John	
Anne and Lisa	
Sarah and Lisa	

[3]

[Total: 17]

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2 **(a)** *Bombus pratorum* and *Bombus terrestris* are two British species of bumble bee.

These bumble bees are social insects. They live in colonies founded by a female queen bee who lays eggs. The eggs develop into female worker bees, who collect food (nectar and pollen) and look after the young and the nest.

When the number of worker bees starts to decrease, young queens and males are produced. These mate and the mated queens survive winter underground and start a new colony the following spring.

Why do the two bee species share the first name *Bombus*?

.....

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

Question 2(b) begins on page 8

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(b) Fig. 2.1 shows the number of worker bees of *B. pratorum* and *B. terrestris* observed at one location over a year.

Table 2.1 shows some differences in the food collecting behaviour of worker bees of these species.

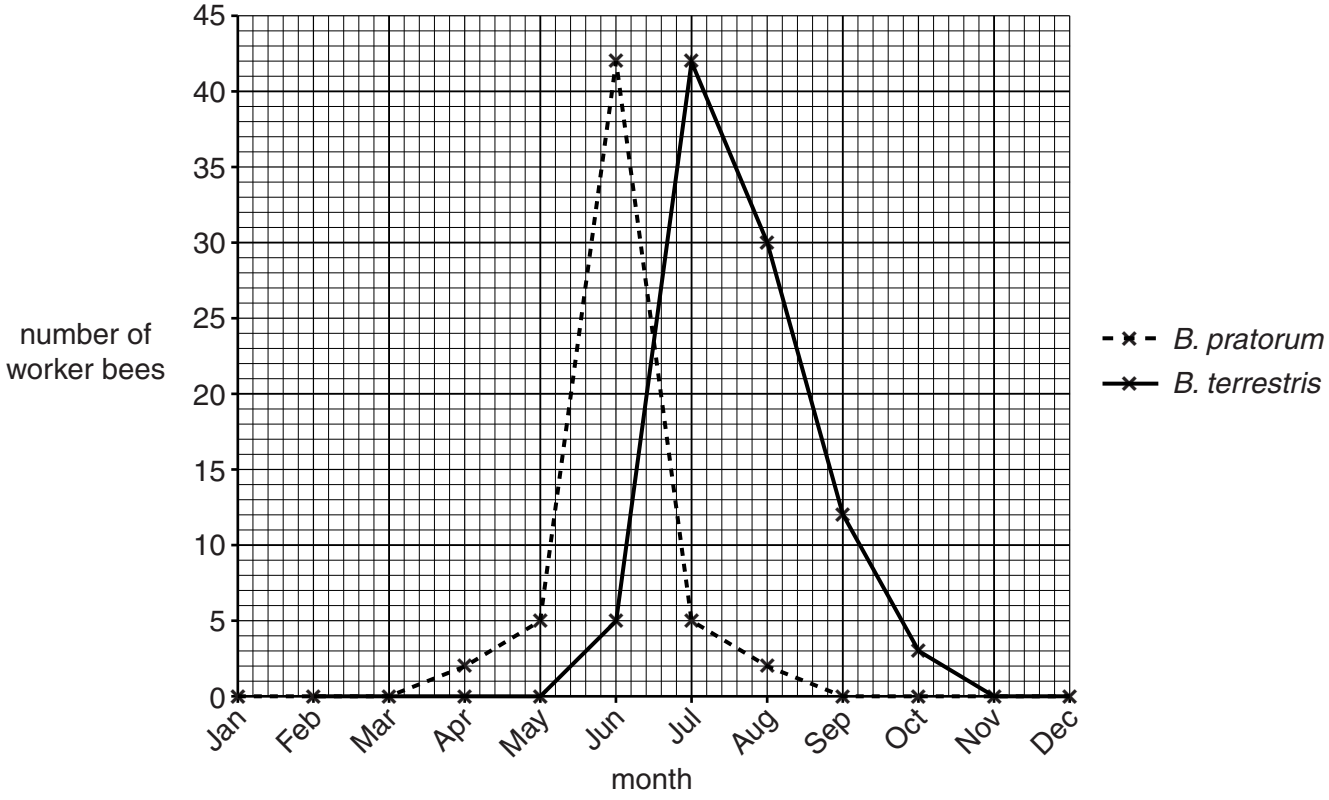


Fig. 2.1

Species of bumble bee	Mean depth of flower visited (mm)	Visits to flowers when nectar only collected (%)	Visits to flowers when pollen only collected (%)	Visits to flowers when both nectar and pollen collected (%)
Bombus pratorum	7.4	23	10	67
Bombus terrestris	6.3	80	11	9

Table 2.1

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(i) *B. pratorum* and *B. terrestris* both live in Britain. They can often be found in the same location, as their geographical distributions overlap.

Use Fig. 2.1 and Table 2.1 to evaluate the extent to which the two species may compete.

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

(ii) Use Fig. 2.1 and Table 2.1, and the information given on page 7, to suggest how an ancestral species might have evolved into the two species, *B. pratorum* and *B. terrestris*.

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

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(c) Bees show a variety of interesting behaviour patterns.

(i) Consider the following observations about bee behaviour and suggest what type of behaviour is being shown in each observation.

Observation	Type of behaviour
The time taken for a worker bee to collect food from a flower decreases with practice.	
All bumble bees start at the bottom of a vertical spike of flowers and work upwards.	

[2]

(ii) On returning to the colony, worker bees perform 'dances' to tell other bees the direction and distance of a food source.

How might this social behaviour benefit the colony?

.....

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

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(d) In a colony of bees, about 5% of the workers are more adventurous than other workers. These bees are known as scout bees. They actively seek out new food sources and, if necessary, new nest sites.

Researchers investigated how gene expression differed in the brains of the scout bees compared to the normal worker bees.

- The researchers extracted mRNA from the brain cells of **normal worker** bees.
- This mRNA was used to produce lengths of single-stranded DNA, which were then attached to a fluorescent dye.
- These lengths of single-stranded DNA were used as gene probes fixed onto a device known as a 'microarray DNA chip'.
- mRNA extracted from the brain cells of **scout** bees would only bind to the gene probes that matched it, causing these probes to fluoresce.
- The locations of the brightest fluorescent spots on the DNA chip revealed which genes were most active.

(i) Name the enzyme that can be used to convert mRNA to single-stranded DNA.

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

(ii) Explain how the locations of the fluorescent spots on the DNA chip reveal which genes are most active.

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

Question 2(d)(iii) begins on page 12

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(iii) The researchers found many differences in gene activity in the scout bees compared to the normal worker bees. One of these differences in activity was in a gene used to make the neurotransmitter, dopamine.

In a follow-up experiment, scout bees became less adventurous if dopamine signalling was prevented.

Use your knowledge of the DRD4 dopamine receptor in humans to comment on the findings of this research into scout bee behaviour.

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.....

.....

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

[Total: 18]

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Question 3 begins on page 14

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3 Animals and plants respond to changes in their environment.

(a) Plants respond to changes in their environment using chemicals known as plant hormones or plant growth regulators.

A student carried out a two-part experiment to identify the contents of two unlabelled bottles, **J** and **K**. One bottle contained auxin and the other contained gibberellin.

In Part 1 of the experiment, 30 seedlings had their shoot tips removed. The 30 seedlings were then divided into three groups of 10 and treated as shown in Table 3.1 and Fig. 3.1.

Group	Treatment
1	no treatment applied
2	solution of **J** applied to cut stem at apex of seedling
3	solution of **K** applied to cut stem at apex of seedling

Table 3.1

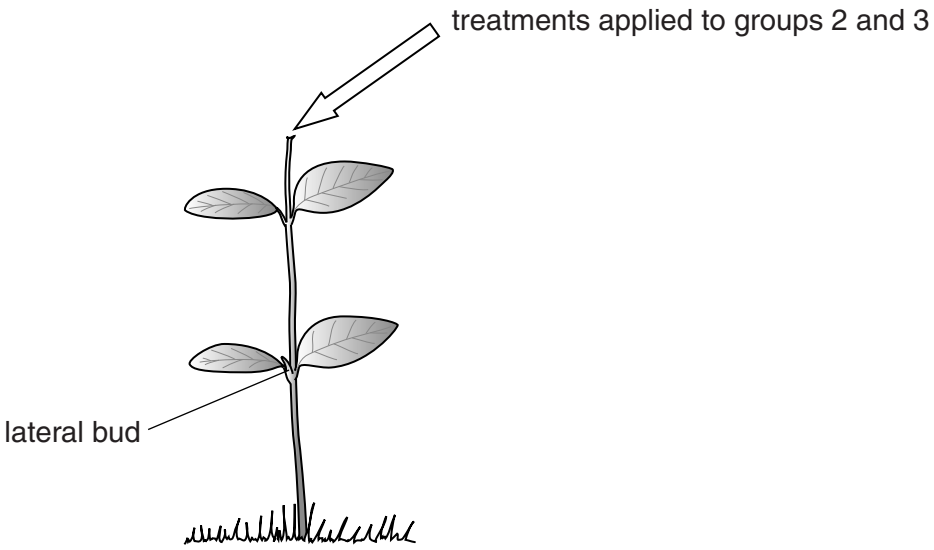


Fig. 3.1

All the seedlings were then exposed to light from **all** directions and left for seven days.

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In Part 2 of the experiment, 30 coleoptiles had their tips removed. They were then divided into three groups of 10 coleoptiles and treated as shown in Table 3.2 and Fig. 3.2.

Group	Treatment
4	no treatment applied
5	solution of **J** applied to cut tip of coleoptile
6	solution of **K** applied to cut tip of coleoptile

Table 3.2

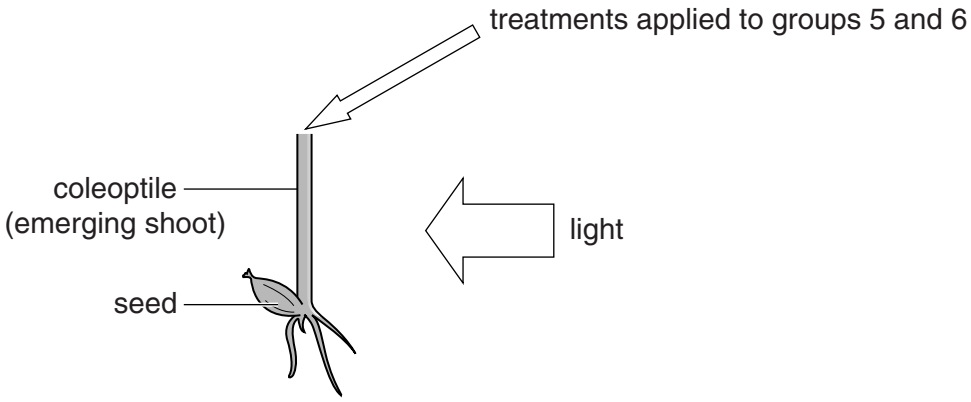


Fig. 3.2

The coleoptiles in groups **4**, **5** and **6** were then exposed to light from **one direction**, as shown in Fig. 3.2, and left to grow for two days.

(i) Identify **three** variables that must be controlled in this experiment to produce valid results.

1 .....

2 .....

3 .....

[3]

(ii) Groups **1** and **4** were controls in this experiment.

Explain why these controls were necessary.

.....

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

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The observations at the end of each part of the experiment are shown in Table 3.3.

Group	Treatment	Observations
1	none	increase in stem length of 10 mm and growth of lateral buds
2	**J** on cut stem apex	no growth of lateral buds
3	**K** on cut stem apex	increase in stem length of 40 mm and growth of lateral buds
4	none	vertical growth of the coleoptiles
5	**J** on cut coleoptile tip	growth of the coleoptiles towards the light source
6	**K** on cut coleoptile tip	vertical growth of the coleoptiles

Table 3.3

(iii) Using the information from Table 3.3, identify the contents of bottles **J** and **K and** give reasons for your answer.

J .....

K .....

reasons .....

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

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(b) Fig. 3.3 is a diagram representing the neuromuscular junction in mammals.

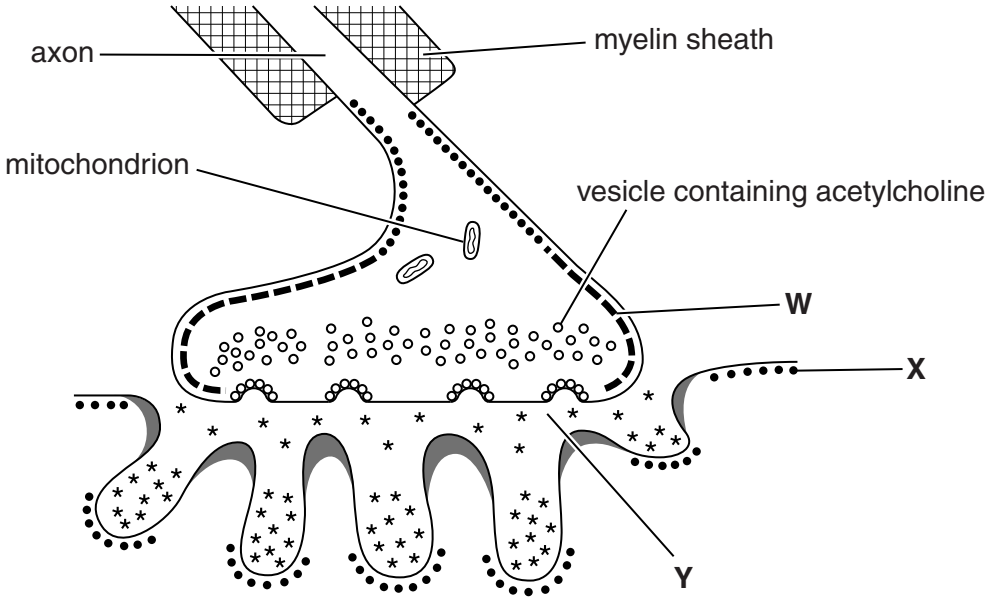


Fig. 3.3

(i) What type of molecule forms ion channels **W** and **X**?

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

(ii) Identify region **Y**.

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

(iii) Name the enzyme found in region **Y**.

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

Question 3(c) begins on page 18

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(c) As mammalian muscle uses energy to contract, it needs an energy supply.

Complete the following passage by choosing the best term to fill each gap.

Most ATP for muscle contraction is generated by aerobic respiration in organelles called ..... . Most of this ATP is produced by the stage of aerobic respiration called ..... .

If the oxygen supply is insufficient, ATP can also be obtained from anaerobic respiration, in which pyruvate is converted to the toxic product ..... .

A third source of ATP in muscle involves the transfer of a phosphate group to ADP from a substance called ..... .

During the contraction of skeletal muscle, energy from ATP is used to break the ..... that hold the actin and ..... together. **[6]**

[Total: 16]

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4 The genetic code carries instructions for the synthesis of polypeptides.

(a) (i) State the number of DNA nucleotide bases that code for a single amino acid.

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

(ii) There is a maximum of 64 different base combinations in DNA that could each code for an amino acid.

How is this number of combinations calculated?

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

(iii) Twenty different amino acids are commonly used for protein synthesis. In theory, this would need only 20 different base combinations.

Explain the uses of the remaining 44 combinations.

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

(iv) Which nucleotide bases are common to DNA and RNA?

.....

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

Question 4(b) begins on page 20

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(b) Describe how a nucleotide base sequence in a gene is used to synthesise a polypeptide.

In your answer you should describe the steps of the process in the correct order.

.... **[7]**

[Total: 12]

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5 A batch fermenter is used during the production of beer.

Fig. 5.1(a) and Fig. 5.1(b), **on page 3 of the insert**, show some changes that take place in the fermenter over the first 6 days.

(a) (i) Describe the pattern of growth of the yeast population in this fermenter.

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

(ii) Fig. 5.1(a) shows that as the sugar concentration decreases the ethanol concentration increases.

Explain this relationship.

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

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(iii) Using the information from Fig. 5.1(a), explain why ethanol is considered to be a primary metabolite of yeast.

.....

.....

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

(iv) Using only the information from Fig. 5.1(a) and Fig. 5.1(b), outline how **two** factors may limit the maximum size of the yeast population.

1 .....

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2 .....

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.....

[2]

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(b) A mixture of three sugars is added to the batch fermenter at the beginning of the process:

- the monosaccharide glucose, which the yeast uses up first, during days 0 to 2
- the disaccharide maltose, which is used during days 1 to 5
- the trisaccharide maltotriose, which is used during days 4 to 6.

Suggest why the yeast uses the sugars in this order.

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

Question 5(c) begins on page 24

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(c) Ethanol is an important chemical that is manufactured on a large scale.

One large-scale process to produce ethanol uses biotechnology, with yeast acting on sugar in a fermenter.

Another large-scale process uses a chemical method instead of microorganisms. This method needs:

- ethene (obtained from oil)
- a high temperature of 300 °C
- high pressure steam.

Discuss the advantages and disadvantages of **using yeast** to make ethanol rather than using the chemical method.



In your answer you should give a balanced account of both the advantages and disadvantages.

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..... **[6]**

[Total: 19]

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6 **(a)** Fig. 6.1 shows a number of examples of inheritance.

A	An *Antirrhinum* plant with red flowers is crossed with one that has white flowers. All the offspring have pink flowers.
B	A haemophiliac man has children with a woman who is not a haemophiliac. Their daughters all carry the allele for the disease, but their sons do not have the disease.
C	Two *Salvia* plants with purple flowers are crossed. The offspring are produced in the ratio 9 purple-flowered : 3 pink-flowered : 4 white-flowered.
D	A short-haired black mouse crossed with a long-haired brown mouse produces all short-haired black offspring. Mating one of these offspring with the long-haired parent produces mice in the ratio of 1 short-haired black : 1 long-haired black : 1 short-haired brown : 1 long-haired brown.
E	Two snails with plain shells produce 34 offspring with plain shells and 12 with striped shells.

Fig. 6.1

Complete the table below, by matching each of the examples **A** to **E** to the correct explanation of their pattern of inheritance.

Explanation	Letter of example
One gene with two alleles. The alleles show codominance.	
One gene with two alleles located on an autosome (gene not sex linked). One allele is dominant and the other is recessive.	
Two genes for two different characteristics on two different chromosomes.	
A sex linked gene with a dominant and a recessive allele.	
Epistasis, where two genes interact to affect one phenotypic character.	

[5]

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(b) The Hardy-Weinberg principle, represented by the equations below, can be used to estimate the frequency of alleles in a population.

$$p^2 + 2pq + q^2 = 1$$

$$p + q = 1$$

Albino rabbits have white fur as these individuals are unable to produce the pigment melanin. The ability to produce melanin is controlled by a gene with a dominant allele (B), resulting in brown fur, and a recessive allele (b), resulting in an albino.

Of the 60 rabbits in a pet shop, 45 are brown.

(i) A student decided to use the Hardy-Weinberg principle to estimate the frequencies of the alleles in this group of rabbits.

Using the Hardy-Weinberg equations, calculate the frequency of the dominant allele in this group.

Show your working.

Frequency of the dominant allele = ... **[3]**

(ii) Give **two** reasons why it was not appropriate to use the Hardy-Weinberg principle to estimate the frequencies of alleles in this group of rabbits in the pet shop.

1 .....

.....

.....

2 .....

.....

.....

[2]

[Total: 10]

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7 Describe the differences between the following biological terms:

(a) a pioneer community and a climax community

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

(b) decomposition and denitrification

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

(c) conservation and preservation

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

(d) nitrogen fixation and nitrification.

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

[Total: 8]

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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GCE

Biology

Unit **F215:** Control, Genomes and Environment

Advanced GCE

Mark Scheme for June 2014

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These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation	Meaning of annotation
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
	Tick
	Cross
	Unclear
BOD	Benefit of doubt
EE	Effective evaluation
L1	Level 1
L2	Level 2
L3	Level 3
L4	Level 4
NAQ	Not answered question
OFR	Own figure rule
SEEN	Noted but no credit given
TV	Too vague
^	Omission

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Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	*discontinuous* gender / male and female / eye colour **;** *continuous* size / length / mass **;**	**2**	**Mark the first answer on each prompt line.** If an additional answer is given that is incorrect or contradicts the correct answer, then **= 0 marks** **Note:** Suggestions must relate to **visible** characteristics of the **frogs**, **ACCEPT** sex **IGNORE** skin colour (as stated in Q) **CREDIT** example of a ***measurable*** characteristic (e.g. leg length, surface area, height, weight)
1	(a)	(ii)	*idea of* **1** no / little **,** environmental effect for **,** (named example of) discontinuous variation / example given for discontinuous variation in **(i)** as ecf **;** **2** some / large **,** environmental effect for **,** (named example of) continuous variation / example given for continuous variation in **(i)** as ecf **;** **3** gender may be affected by **,** temperature / atrazine exposure **;**	**2**	**IGNORE** examples of environmental factors **ACCEPT** discontinuous variation is ***only*** **,** genetic / due to alleles present **Note:** A comparative statement (e.g. ' environment has a greater effect on continuous variation') **= 2 marks** (mps 1 & 2) e.g ‘ no environment effect for discontinuous variation but it does affect continuous variation’ **= 2 marks** (mps1 &2)

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<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td>(iii)</td><td>1 idea that offspring visibly different from , A / egg donor ;

2 to show that the offspring produced were clones ;

3 to show / identify , (genetic) parents (of clone) / B and C ;</td><td>2 max</td><td>ACCEPT brown frog for A

2 ‘to show that cloning is successful’ is not enough

Note:
‘To show that the offspring were clones as they are not the same as A.’ = 2 marks (mps 1 & 2)</td></tr>
<tr><td>1</td><td>(b)</td><td>(i)</td><td><table><tr><th>Genetic fingerprint number</th><th>Letter of frog</th></tr><tr><td>1</td><td>D</td></tr><tr><td>2</td><td>A</td></tr><tr><td>3</td><td>B</td></tr></table>;
;
;</td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks

If no letters in the table <u>at all</u>, look at the diagram and award marks if the profiles are identified correctly.</td></tr>
<tr><td>1</td><td>(b)</td><td>(ii)</td><td>cytoplasm / mitochondria , came from A

or

mitochondria / (mitochondrial) DNA , in cytoplasm of A ;</td><td>1</td><td>If frog not identified correctly = 0 marks

Must refer specifically to frog A

Must refer specifically to frog A</td></tr>
</table>

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Question			Expected Answer	Mark	Additional Guidance
1	(c)	(i)	*advantage* (genetically identical so) all react the same **or** genetic variable controlled **;** *disadvantage* expensive (to produce) **or** don't see varied response to drug like in real populations (of mice) **or** *idea that* clones (of mice) may have unknown health issue (which would affect responses) **;**	**2**	**Note that the question refers to the use of cloned or uncloned mice in testing – and NOT to humans.** **ACCEPT ora** throughout **IGNORE** large numbers of clones produced **IGNORE** ref to animal welfare / religious objections **IGNORE** ref to validity **ACCEPT** 'no genetic diversity to affect results' **ACCEPT** 'rare allergies / adverse reactions **,** won't be seen'

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<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>1</td><td>(c)</td><td>(ii)</td><td>1 idea to produce , elite / best , animals ;
2 idea to save / preserve , endangered animals ;
3 grow / produce (spare) , stem cells / tissues / organs ;
4 AVP ;</td><td>2</td><td>IGNORE ref research into disease (as given in Q)
IGNORE ref to cost
1 ACCEPT example / desirable characteristics
2 ACCEPT recreating extinct animals
3 ACCEPT ref to named example of , tissue / organ
4 e.g. pet cloning / cloning GM animals / animals for xenotransplantation</td></tr>
<tr><td>1</td><td>(d)</td><td></td><td><table><tr><th>Individuals</th><th>% of alleles shared</th></tr><tr><td>David and John</td><td>100</td></tr><tr><td>Anne and Lisa</td><td>50</td></tr><tr><td>Sarah and Lisa</td><td>50</td></tr></table>;
;
;</td><td>3</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>17</td><td></td></tr>
</table>

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Question			Expected Answer	Mark	Additional Guidance
2	(a)		(belong to the) same genus ;	1	
2	(b)	(i)	**1** not much / little / some **,** competition / niche overlap **;** *reasons for little competition* **2** use / feed on **,** different sized flowers / different depth of flowers **;** **3** vary in proportions of pollen **and** nectar they collect **;** **4** fly / live / active / feed / visit flowers **,** at different times **;** *reason for competition* **5** *idea that* fly / live / active / feed / visit flowers **,** overlaps there must be competition **;** **6** AVP **;**	**4 max**	**This mark is for a stand alone statement** **DO NOT CREDIT no** competition **IGNORE** competition unqualified / inter / intra **2** **CREDIT** correct comparative description or use of data e.g. *B. pratorum feed* on **,** bigger / longer / deeper **,** flowers **or** *B. pratorum* 7.4(mm) **and** *B. terrestris* 6.3(mm) **3** **CREDIT** correct description e.g. *B. pratorum* mostly pollen and nectar **and** *B. terrestris* mostly nectar only **or** comparison of 2 species using table data **IGNORE** 'different amounts' of pollen and nectar **4** **CREDIT** correct description of difference e.g. *B. pratorum* peak in June **and** *B. terrestris* in July **or** *B. pratorum* appear in earlier in the year **or** comparison of 2 species using graph data **5** **CREDIT** correct description from data e.g. both compete for food between May and September / both collect pollen only from same % flowers **6** e.g. use / feed on **,** different species of flowers

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Question			Expected Answer	Mark	Additional Guidance
2	(b)	(ii)	**1** *idea of* isolation / isolating mechanism / barrier **;**		
			2 seasonal (difference) / temporal (difference) / males and queens (in different populations) produced in different months / breeding (in different populations) in different months **;**		**2** **CREDIT** example of seasonal / temporal (e.g. *B. pratorum* has its peak number of workers in June and *B. terrestris* in July)
			3 behavioural (difference) / visit different (types of) flowers / feed at different times / feed on different food types **;**		**3** **CREDIT** 'different mating rituals'
			4 different flower locations / different (micro)habitats **;**		
			5 *idea that* gene flow restricted / no gene flow (between populations) **;**		**5** **must refer to gene /allele**
			6 different adaptations / specialisation / niche partitioning **;**	**3 max**	**6** **IGNORE** speciation (as implied in Q) - can be mistaken for specialisation

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<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>2</td><td>(c)</td><td>(i)</td><td>
<table>
<tr><th>Observation</th><th>Type of behaviour</th></tr>
<tr><td>The time taken for a worker bee to collect food from a flower decreases with practice.</td><td>learned (behaviour) / learning /
operant conditioning / trial and error ;</td></tr>
<tr><td>All bumble bees start at the bottom of a vertical spike of flowers and work upwards.</td><td>innate / instinctive ;</td></tr>
</table>
</td><td>2</td><td>Mark the first answer in each box. If an additional answer is given that is incorrect or contradicts the correct answer, then = 0 marks

ACCEPT taxis / example of taxis eg chemotaxis
IGNORE inherited / genetically determined
DO NOT CREDIT kinesis</td></tr>
<tr><td>2</td><td>(c)</td><td>(ii)</td><td>Idea that better / more efficient , at , finding / getting , food ;

AVP ;</td><td>1 max</td><td>ACCEPT more food can be collected
less , time / energy , spent looking for food
easier to find food
e.g. ref to reduces competition from other colonies</td></tr>
<tr><td>2</td><td>(d)</td><td>(i)</td><td>reverse transcriptase ;</td><td>1</td><td>Mark the first answer. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks

DO NOT CREDIT DNA (reverse) transcriptase</td></tr>
</table>

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Question			Expected Answer	Mark	Additional Guidance
2	(d)	(ii)	**1** <u>mRNA</u> binds to **,** (gene) probes / cDNA / ssDNA **,** by complementary base pairing **;** **2** *idea that* the ***more*** active the gene the ***more*** mRNA produced **;** **3** during transcription **;** **4** ***more*** fluorescence indicates ***more*** mRNA (bound) **;**	**3 max**	**1** **DO NOT CREDIT** in the context of the gene probe binding to DNA **3** **IGNORE** translation
2	(d)	(iii)	**1** dopamine linked to **,** ADHD / addiction / risk-taking / adventurous behaviour / hyperactivity / erratic behaviour (in humans) **;** **2** *idea of* common mechanism in bees and humans (for adventurous behaviour) **;** **3** *idea that* as they are different organisms the mechanisms may not be comparable (even though apparently similar) **;** **4** AVP **;**	**3 max**	**1** **IGNORE** ref to schizophrenia / Parkinson's **This mark is for the effect of the *chemical* dopamine, not the dopamine receptors alone.** **2** e.g. ***both*** have **,** DRD4 / dopamine receptors e.g. dopamine has the same effect in ***both*** **4** e.g. other genes also involved in **,** bee / human **,** behaviour **Note:** 'both have dopamine receptors which are linked to adventurous behaviour' **= 1 mark** (mp 2 only) 'both have dopamine receptors and dopamine is linked to adventurous behaviour' **= 2 marks** (mps 2 & 1)
			Total	**18**	

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Question			Expected Answer	Mark	Additional Guidance
3	(a)	(i)	*seedlings / coleoptiles have same* **S1** age ; **S2** height / length ; **S3** mass ; **S4** genotype / genome ; **S5** species ; *procedure has same* **P1** same volume of solution applied ; **P2** (named) feature of growth medium ; **P3** watering regime ; **P4** light , intensity / wavelength / duration ; **P5** temperature ;	**3 max**	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **S2 IGNORE** size / surface area / width **S3 IGNORE** size / weight **S4 ACCEPT** same genetic makeup **IGNORE** same genes **For all P points IGNORE** light ***direction*** (as this is an independent variable) **P1 IGNORE** ref to concentration of solution **ACCEPT** *idea of* consistency in application of **J** and **K** **P2** e.g. type / pH / fertiliser (applied) / minerals / ions **IGNORE** nutrients **P3** e.g. volume of water / time of watering **P4** e.g. distance from light source

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Question			Expected Answer	Mark	Additional Guidance
3	(a)	(ii)	*idea that* shows the response without treatment **or** *idea that* allows the **,** effect of the treatment / results / groups **,** to be **,** compared **;**	**1**	**IGNORE** improves validity / fair test (as an explanation is required) 'to show the effects of J and K' is not enough **CREDIT** 'observations' for treatments
3	(a)	(iii)	***ONLY CREDIT mark points in context of results, and not in context of general roles of auxin and giberellin*** ***J** is auxin because* **A1** inhibition of development of (lateral) buds (in group 2) **;** **A2** growth of **,** coleoptiles / group 5 **,** towards light **;** ***K** is gibberellin because* **G1** greater increase in **,** height / stem length (in group 3) **;** **G2** causes growth of (lateral) buds (in group 3) **;**	**3 max**	**J must be identified correctly for A marks to be awarded** **K must be identified correctly for G marks to be awarded** **A1 CREDIT** (group2) results show apical dominance **A2 CREDIT** (group 5) results show positive phototropism **IGNORE** plant (as all are plants) **G1 CREDIT** greater elongation **G2 CREDIT** (group 3) results do not show apical dominance
3	(b)	(i)	protein **;**	**1**	**ACCEPT** glycoprotein **IGNORE** polypeptide / channel / carrier / transport
3	(b)	(ii)	(synaptic) cleft **;**	**1**	**IGNORE** gap **IGNORE** neuromuscular
3	(b)	(iii)	acetylcholine esterase / ACh esterase **;**	**1**	**ACCEPT** phonetic spelling and ignore upper/lower case **IGNORE** AChE

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Question			Expected Answer	Mark	Additional Guidance
3	(c)				**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			mitochondria ;		**ACCEPT** mitochondrion **DO NOT CREDIT** mitochondrial matrix
			oxidative phosphorylation ;		**IGNORE** electron transport chain (as not a stage)
			lactate ;		**ACCEPT** lactic acid
			creatine phosphate / phosphocreatine ;		**DO NOT CREDIT** creatinine
			(cross-)bridge / (cross-)link ; myosin (head) ;	6	**DO NOT CREDIT** bond **ACCEPT** phonetic spelling
			Total	**16**	

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Question			Expected Answer	Mark	Additional Guidance
4	(a)	(i)	3 ;	1	**IGNORE** triplet
4	(a)	(ii)	4^3 **or** 4 x 4 x 4 **or** 4 x 4^2 ;	1	
4	(a)	(III)	Several, triplet(s) / codon(s) , code for one amino acid ; (some are used as) start / stop / termination ; *idea that* mutation may , not result in change in amino acid / have a neutral effect / result in silent mutation ;	2 max	**Must be clear that base combination is a group of 3 bases** **IGNORE** degenerate **DO NOT CREDIT** makes/ produces/ creates , amino acids **DO NOT CREDIT** deletion / insertion (as would create frame shift)
4	(a)	(iv)	adenine / A **and** cytosine / C **and** guanine / G ;	1	**Mark the first 3 answers.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **DO NOT CREDIT** adenosine **DO NOT CREDIT** cysteine **DO NOT CREDIT** glycine

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Question			Expected Answer	Mark	Additional Guidance
4	(b)		*transcription* **1** DNA / gene **,** copied / transcribed **,** into mRNA **;** **2** free / activated **,** (RNA) nucleotides / (RNA) nucleoside triphosphates **;** **3** (line up by) complementary base-pairing / described **;** **4** (to) one / template / reference / sense , (DNA) strand ; **5** (catalysed by) RNA polymerase **;** *translation* **6** (mRNA moves to) ribosomes **;** **7** tRNA (molecules) bind to mRNA **;** **8** anticodon(s) **,** match / pair with / bind to **,** codons **;** **9** specific / correct **,** amino acid attached to tRNA **;** **10** formation of peptide bond between amino acids;	**6 max**	**Marks may be awarded from an annotated diagram** **1 IGNORE** 'used to make' **2 DO NOT CREDIT** DNA nucleotides **3 CREDIT '**A-T, C-G **and** A - U' **4 ACCEPT** 'non-coding' for 'template' **5 DO NOT CREDIT** in context of breaking H bonds **6 CREDIT** translation occurs at ribosomes **Note:** tRNA anticodons bind to mRNA codons **= 2 marks** (mps 7 & 8) **10 DO NOT CREDIT** dipeptide / polypeptide **,** bond
			QWC **;**	**1**	**Award** QWC if **two** mps from **1** – **5** have been awarded **before** **two** mps from **6** – **10** **Place a tick or a cross alongside the pencil icon to indicate whether or not the QWC mark has been awarded.**
			Total	**12**	

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<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>5</td><td>(a)</td><td>(i)</td><td>
1 lag phase / slow increase
(in , population / number / percentage) ,
at start / initially / day 0 - 1 / during day 1 ;

2 log phase / exponential increase / rapid increase ,
day 1 - 3 ;

3 <u>rate</u> <u>of</u> <u>increase</u> , slows / less steep ,
days 3 - 4 / during day 3 ;

4 stationary phase / population levels off /
population stays at 100% ,
at end / finally / remaining days / days 4 - 6 ;

5 comparative figures quoted with 2 x-y readings ;
</td><td>4 max</td><td>
IGNORE explanations
ACCEPT ‘the population grows’ or ‘it grows’
(rather than increase)
DO NOT CREDIT ‘yeast grow(s)’

1 ACCEPT days 0 - 0.9
ACCEPT lasts 1 day

2 ACCEPT days 0.9 - 3.5

3 ACCEPT days 3.3 - 3.6

4 ACCEPT after day 3.5 - 4

5 Each unit must be quoted at least once

<table>
<tr><th>Time (days)</th><th>Yeast (% final population)</th></tr>
<tr><td>0</td><td>24</td></tr>
<tr><td>1</td><td>32</td></tr>
<tr><td>3</td><td>90</td></tr>
<tr><td>3.5 - 6</td><td>100</td></tr>
</table>

Take care to distinguish between an increase in percentage (by either quoting the figures for the days or by calculating the difference) and a percentage increase.
</td></tr>
</table>

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Question			Expected Answer	Mark	Additional Guidance
5	(a)	(ii)	**1** sugar converted to ethanol **;** **2** in anaerobic respiration **;** **3** sugar **,** undergoes glycolysis / converted to pyruvate **;** **4** pyruvate **,** loses carbon dioxide / decarboxylated / forms ethanal **;** **5** reduced NAD giving hydrogen to ethanal **;** **6** *idea of* NAD being **,** regenerated / recycled , (so) glycolysis continues ; **7** correct ref to **,** pyruvate decarboxylase / ethanol dehydrogenase **;**	**3 max**	**CREDIT** glucose / maltose / maltotriose for 'sugar' **2** **IGNORE** fermentation **5** **CREDIT** $NADH_2$ / NADH ($+H^+$) / red NAD
5	(a)	(iii)	*ethanol is* produced in **, all** yeast growth phases / **all** of the time **or** production of ethanol increases as yeast population increases **or** *idea that* ethanol is a normal (metabolic waste) product (of yeast) **;**	**1**	**IGNORE** ref to ethanol not being a secondary product **CREDIT** 'produced during normal growth' **CREDIT** follows growth curve for yeast **IGNORE** waste unqualified

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Question			Expected Answer	Mark	Additional Guidance
5	(a)	(iv)	**1** sugar <u>conc</u>entration falls **too** low **;** **2** pH falls **too** low / conditions become **too** acidic / decrease in pH causes enzymes to denature **;** **3** high ethanol <u>conc</u>entration **,** damages / poisons / inhibits **,** yeast **;**	**2 max**	**1** **ACCEPT** very low sugar concentration / sugar concentration decreases as used up **2** **ACCEPT** very low pH / very acidic **DO NOT CREDIT** 'falls and rises' **3** **ACCEPT** high ethanol <u>concentration</u> kills yeast
5	(b)		**1** glucose can **,** be used / enters glycolysis **,** directly / without being broken down (first) **;** **2** maltose**,** must **,** be <u>hydrolys</u>ed / have <u>glycosidic</u> bonds broken ; **3** enzyme / maltase **,** only made when **,** needed / maltose present / glucose running out **;** **4** enzyme induced **/** gene(s) switched on **;** **5** transcription <u>and</u> translation / protein synthesis **,** takes time **;** **6** maltotriose requires, more (2) <u>hydrolysis</u> (reactions) / breaking of more (2) <u>glycosidic</u> bonds **or** enzyme to break down maltotriose made last **;**	**3 max**	**ACCEPT** 'monosaccharide' for glucose and 'disaccharide' for maltose and 'trisaccharide' for maltotriose throughout **1** **IGNORE** ref to glucose being used first / at start / immediately (as stated in Q)

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Question			Expected Answer	Mark	Additional Guidance
5	(c)		*advantages of using yeast* **A1** less energy required ; **A2** does not need , high temperature / 300°C / high pressure ; **A3** can use waste material (as a substrate) ; **A4** substrate is , sustainable / grown each year ; **A5** process does not use up , oil reserves / fossil fuels ; **A6** product is carbon neutral / no carbon footprint ; **A7** AVP ; *disadvantages of using yeast* **D1** time consuming / takes several days ; **D2** needs , downstream processing / purification of product ; **D3** is killed by product ; **D4** can (only) use batch method ; **D5** aseptic / sterile , conditions required ; **D6** AVP ;	**5 max**	**CREDIT** statements relating to yeast method only **IGNORE** statements relating to chemical method **IGNORE** ref to cost **A2** **ACCEPT** works well at low , temperatures / pressures **A3** **CREDIT** example e.g. sugar cane waste **A6** **IGNORE** ref to global warming / greenhouse gases **A7** e.g. yeast is readily available / easily accessible / yeast is in plentiful supply / yeast has simple growth requirements / process is less hazardous **D1** **ACCEPT** slower rate of reaction **D2** **ACCEPT** need to separate ethanol from yeast **D3** **ACCEPT** is inhibited by product **D5** **ACCEPT** more likely to become contaminated **D6** e.g. concentration of ethanol produced is limited
			QWC ;	**1**	**Award** if 2 **A** marks **and** 2 **D** marks have been awarded **Place a tick or a cross alongside the pencil icon to indicate whether or not the QWC mark has been awarded.**
			Total	**19**	

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<table>
<tr><th colspan="3">Question</th><th>Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td></td><td>
<table>
<tr><th>Explanation</th><th>Letter</th></tr>
<tr><td>One gene with two alleles.
The alleles show codominance.</td><td>A</td></tr>
<tr><td>One gene with two alleles, located on an autosome (gene not sex linked).
One allele is dominant and the other is recessive.</td><td>E</td></tr>
<tr><td>Two genes for two different characteristics on two different chromosomes.</td><td>D</td></tr>
<tr><td>A sex linked gene with a dominant and a recessive allele.</td><td>B</td></tr>
<tr><td>Epistasis, where two genes interact to affect one phenotypic character.</td><td>C</td></tr>
</table>
;
;
;
;
;
</td><td>5</td><td>Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks</td></tr>
</table>

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Question			Expected Answer	Mark	Additional Guidance
6	(b)	(i)	q^2 = 15 ÷ 60 or 0.25 ; q = $\sqrt{0.25}$ or 0.5 ; (p =) 0.5 ;	3	**Correct answer (0.5) = 3 marks** even if no working shown **No mark for incorrect q^2 value but apply ecf afterwards** **ALLOW** ecf from candidates q^2 value (likely to be 0.87 or 0.9 (if candidate's q^2 = 0.75)) **ALLOW** ecf for p from candidate's calculated q value, (if q value between 0 and 1) **IGNORE** % values given for p (e.g. 50 % for 0.5)
6	(b)	(ii)	*in the pet shop* **1** population is , small / not (sufficiently) large ; **2** not all members of the population are breeding ; **3** *idea that* mating is not random ; **4** *idea that* migration / emigration / immigration , is occurring ; **5** *idea that* the non-brown rabbits could be colours other than white ;	2	**IGNORE** ref to (natural) selection / mutation (as these do not apply to the 'artificial' population in the pet shop) **IGNORE** 'albinos are infertile'
			Total	**10**	

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Question			Expected Answer	Mark	Additional Guidance
7	(a)		**1** pioneers arrive **,** ***before*** climax / ***earlier*** **;** **ora** **2** pioneer communities subject to **,** ***greater*** / ***more*** **,** change / succession / replacement **;** **ora** **3** pioneer community (usually) has **,** ***less*** / ***lower*** **,** biodiversity **;** **ora** **4** *idea that* pioneer community is (often) ***less*** **,** stable / self-sustaining **;** **ora** **5** pioneer community has ***lower*** biomass **;** **ora** **6** AVP **;**	**2 max**	**Note: All mark points are comparative** **1** **CREDIT** pioneers arrive first / climax arrive last **6** e.g. species in pioneer community better adapted to (named) abiotic factor(s) **and** those in climax community better adapted to (named) biotic factor(s)

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Question			Expected Answer	Mark	Additional Guidance
7	(b)		**1** decomposition is break down **,** dead matter / waste **or** decomposition is conversion of organic matter to inorganic **;** **2** denitrification is conversion of nitrates to nitrogen (gas) **;** **3** decomposition increases **,** mineral / nitrate **,** supply **and** denitrification reduces **,** mineral / nitrate **,** supply **;**	**2 max**	**1 IGNORE** putrefication **1 CREDIT** for **inorganic:** carbon dioxide / CO_2 / water / H_2O / ammonium compounds / ammonium ions / NH_4^+ **IGNORE** ammonia / NH_3 **2 CREDIT** correct formulae (NO_3^- and N_2) **DO NOT CREDIT** nitrogen oxides **3 CREDIT** decomposition returns , mineral / nitrate, to soil **and** denitrification removes mineral / nitrate, to soil
7	(c)		**1** conservation maintains **,** ecosystem / biodiversity / species / habitats **or** conservation involves **,** active / sustainable **,** management of **,** ecosystem / resource / habitat **;** **2** preservation leaves **,** ecosystems / habitats **,** undisturbed **;**	**2**	**IGNORE environment for MP1 and 2** **ACCEPT** named resource **ACCEPT** unchanged/ not disrupted / no physical intervention **IGNORE** ref to preservation in any context other than that of conservation/preservation

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Question			Expected Answer	Mark	Additional Guidance
7	(d)		**1** nitrogen fixation is the conversion of (atmospheric) nitrogen into **,** ammonia / ammonium compounds / ammonium ions **;** **2** nitrification is the conversion of **,** ammonia / ammonium compounds /ammonium ions **,** into nitrite / nitrate **;** **3** correct ref to microorganisms involvement in both processes **;**	**2 max**	**1** **CREDIT** N_2 / NH_3 / NH_4^+ **2** **CREDIT** NH_3 / NH_4^+ **CREDIT** NO_2^- / NO_3^- **DO NOT CREDIT** nitrate to nitrite **3** e.g. nitrogen fixation involves **,** *Rhizobium* / *Azotobacter* / *Nostoc* **and** nitrification involves **,** *Nitrosomonas* / *Nitrobacter*
			Total	**8**	

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OCR
RECOGNISING ACHIEVEMENT

Tuesday 11 June 2013 – Morning

A2 GCE BIOLOGY

F215/01 Control, Genomes and Environment

Candidates answer on the Question Paper.

OCR supplied materials:
None

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

Duration: 2 hours

F21041061 3

F 2 1 5 0 1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- 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 **24** pages. 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 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.

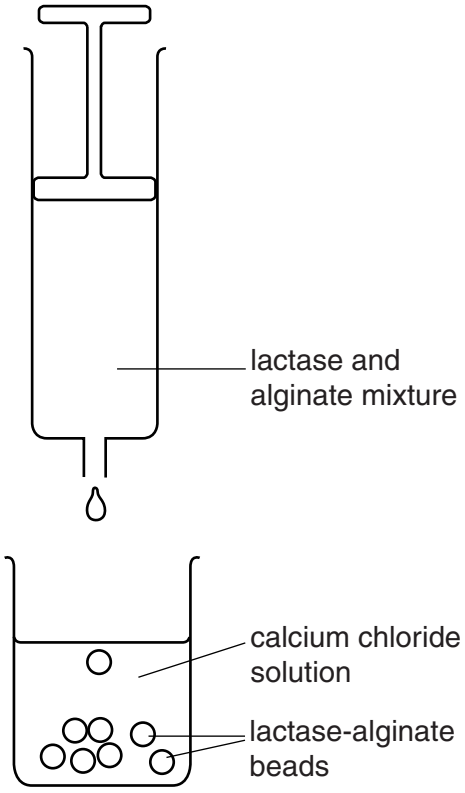


Fig. 1.1

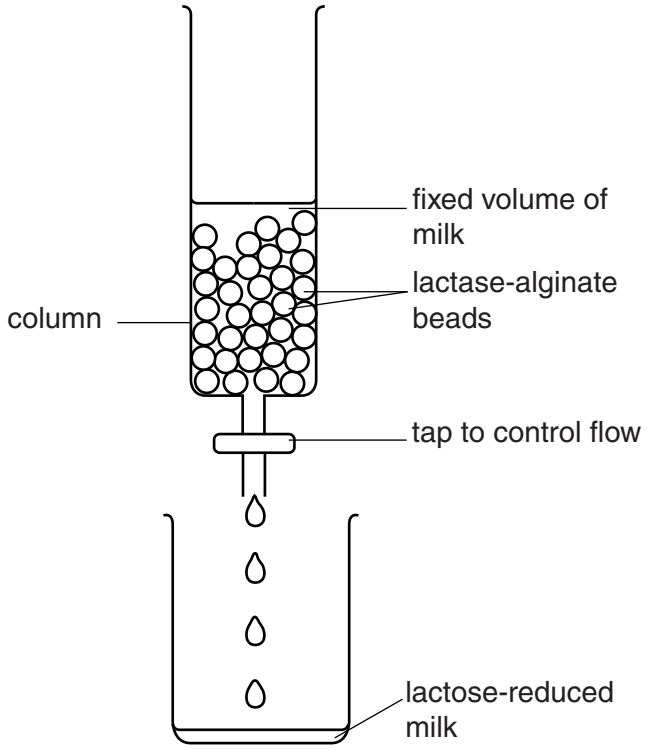


Fig. 1.2

(a) Suggest **and** explain how you might use the method shown in Fig. 1.2 to obtain milk that was **lactose-free**.

.....

.....

.....

.....

.....

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

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(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]

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

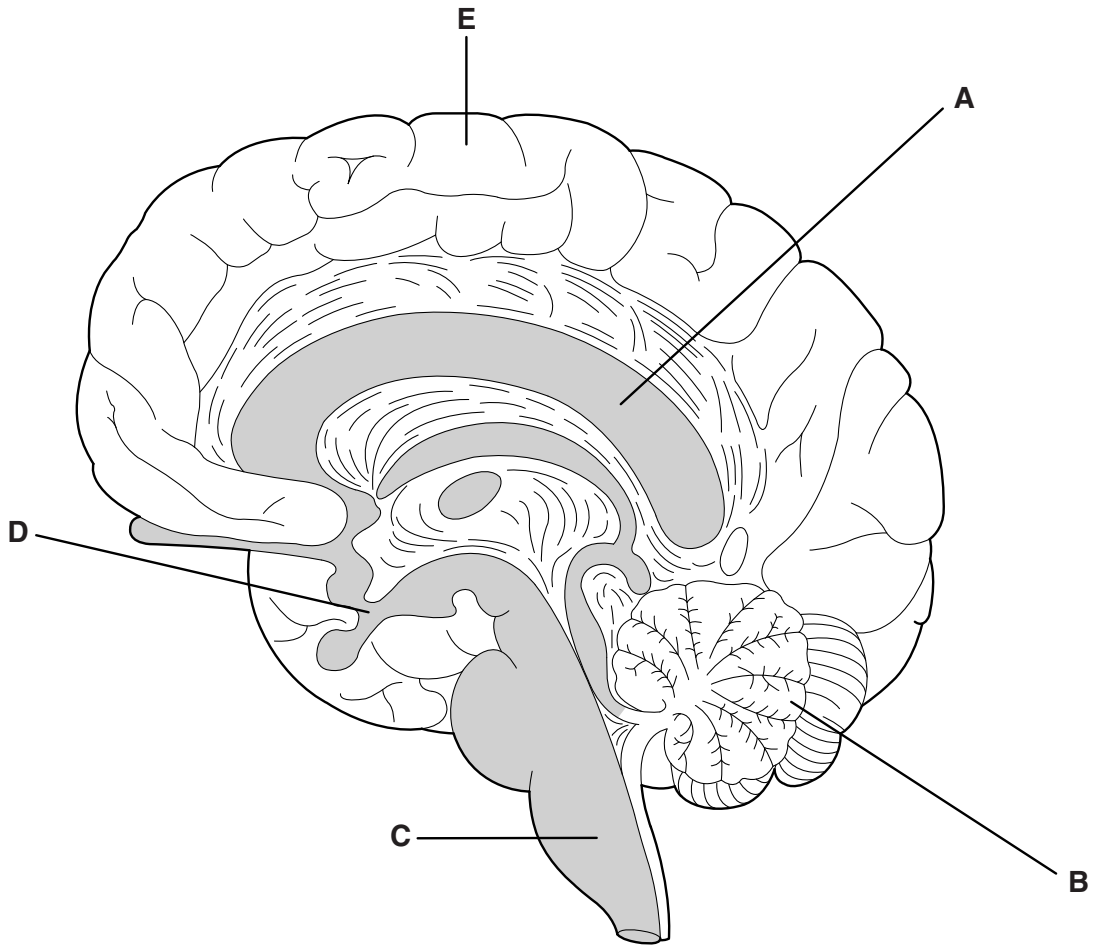


Fig. 2.1

(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]**

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

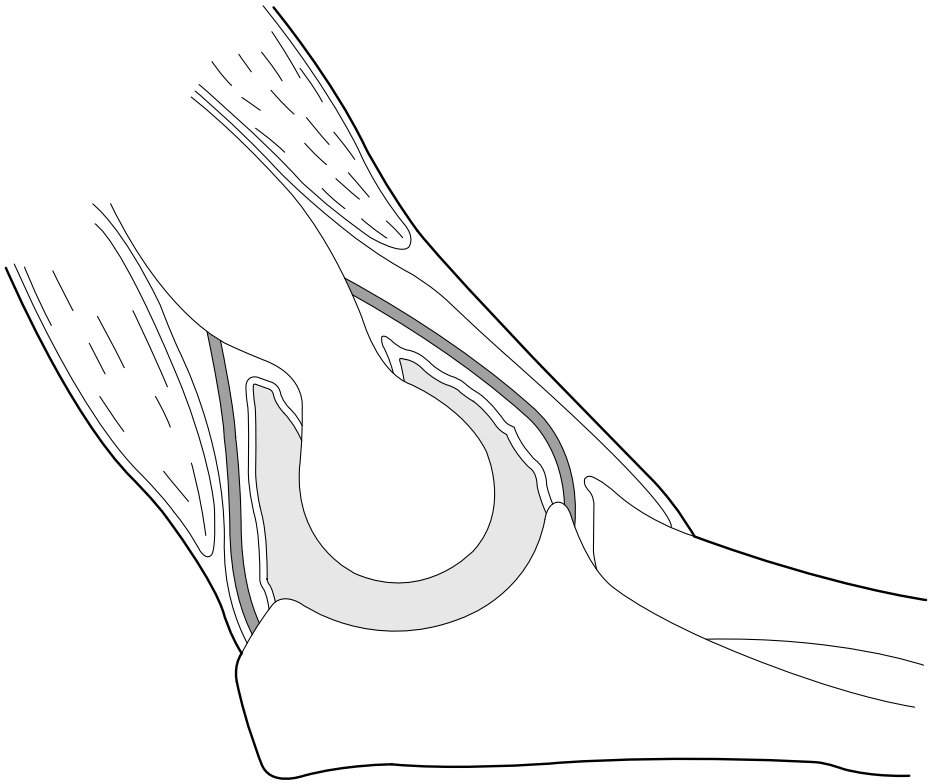


Fig. 2.2

(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]**

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(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]**

[Total: 15]

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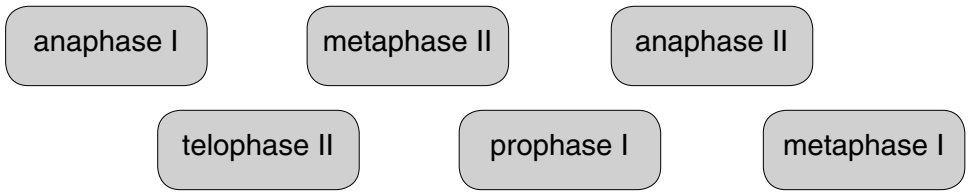
PLEASE DO NOT WRITE ON THIS PAGE

Question 3 begins on page 8

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



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.

.....

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.....

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.....

[2]

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(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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.....

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

[Total: 11]

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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]

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(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.

.....

.....

.....

..... **[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]**

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(ii) electrophoresis

.....

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.....

.....

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

(iii) digestion of DNA by restriction enzymes.

.....

.....

.....

.....

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

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

.....

.....

.....

.....

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

Question 5(d) begins on page 14

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(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]**

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(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?

.....

.....

.....

.....

.....

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

[Total: 18]

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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.

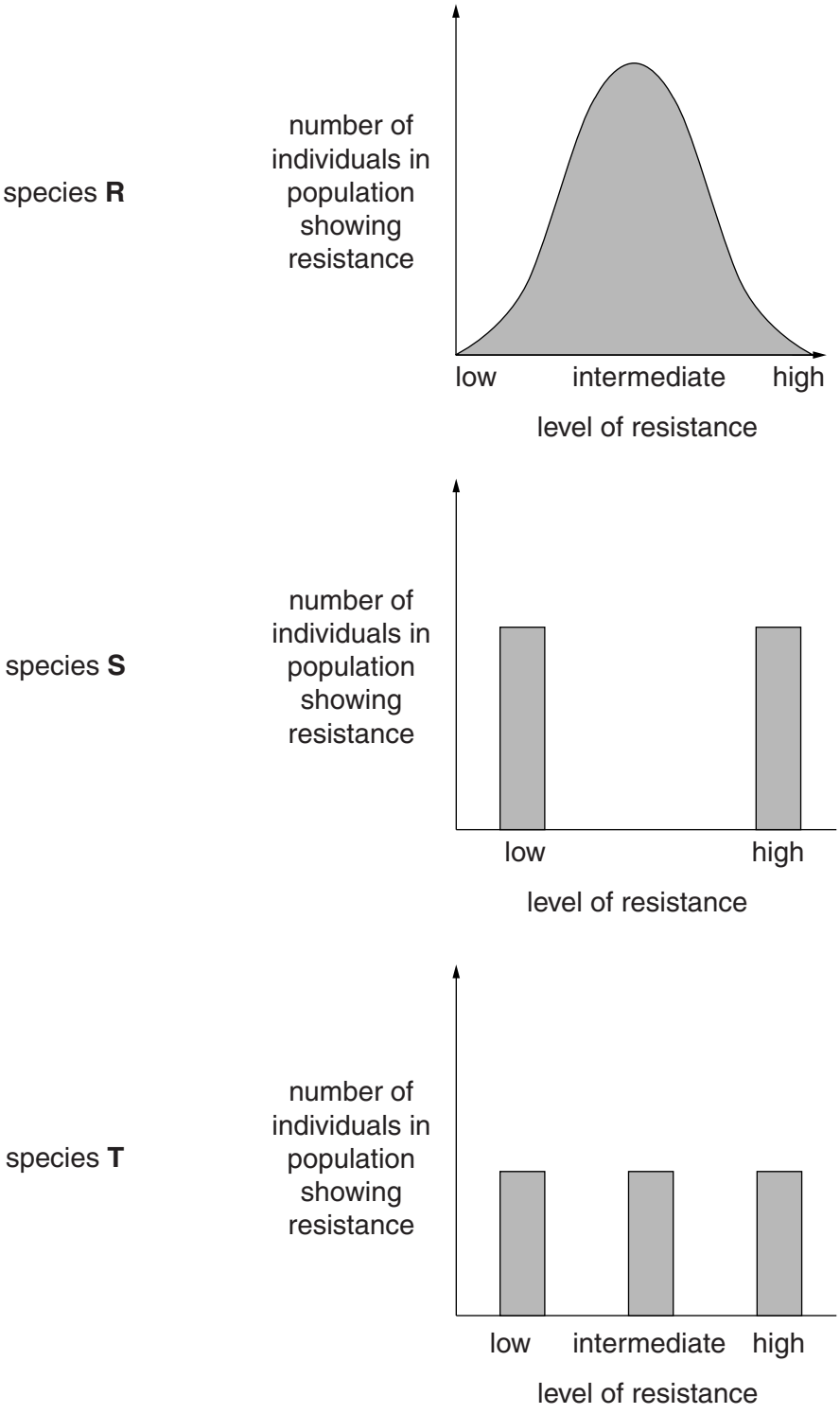


Fig. 6.1

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(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]

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(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.

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

[Total: 15]

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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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.....

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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]**

Question 7(b)(ii) begins on page 20

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(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]**

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(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

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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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RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE

Unit **F215:** Control, Genomes and Environment

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

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1. **Annotations**

Annotation	Meaning
	Correct answer
	Incorrect response
	Benefit of Doubt
	Not Benefit of Doubt
	Error Carried Forward
	Given mark
	Underline (for ambiguous/contradictory wording)
	Omission mark
	Ignore
	Correct response (for a QWC question)
	QWC* mark awarded
	First answer

**Quality of Written Communication*

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Question			Answer	Marks	Guidance
1	(a)		reduce / slow, flow rate ; repeat process / run milk through again ; test for (named) sugars in milk ;	2	**ACCEPT** close tap for a time period **CREDIT** glucose, galactose, lactose, Benedict's test
	(b)	(i)	*any two from* hydrophobic / ionic bond, to (named), solid / support ; covalent bond / cross-link to, (named) substance; membrane separation ; (en)trap / encapsulate / suspend, in (named), matrix ;	2	**Mark as prose.** **IGNORE** ref to cross-linking agents **ACCEPT** 'insoluble material for solid. Suitable solids = clay, carbon, resin, glass, gold, ceramic beads. **CREDIT** **ad**sorption (but not absorption) **CREDIT** carrier bound. **CREDIT** cross-link them together. Suitable substances = other enzymes, collagen, cellulose. **ACCEPT** microcapsules Suitable matrix materials = collagen, cellulose, silica gel, hydrogel, but **DO NOT CREDIT** entangled / alginate
		(ii)	**1** (enzyme) can be re-used so reduces cost ; **2** product, pure(r) / uncontaminated ; **3** reduced downstream processing costs ; **4** (immobilised enzyme) works at high(er) temperature ; **5** (immobilised enzyme) works in changed pH ; **6** reaction, can be faster / have higher yield , because can be done at higher temperature ;	4	**2 ACCEPT** product not mixed with enzyme **3 ACCEPT** save money on purifying product **4 CREDIT** enzymes not denaturing at increased temperature **CREDIT** immobilised enzymes thermostable **5 CREDIT** enzymes not denaturing in changed pHs **6** This explanation scores mp 4 and mp 6 (unless mp 4 already awarded).
			Total	**8**	

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Question			Answer		Marks	Guidance
2	(a)	(i)	**C ;**		1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
		(ii)	**D ;**		1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
		(iii)	**B / E ;**		1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
		(iv)	**E ;**		1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
	(b)		**1**	muscles <u>contract</u>, in antagonistic (pairs) **;**	3	**1 CREDIT** biceps and triceps **or** flexor and extensor contract **IGNORE** context of direction of movement
			2	tendons, pull on bone / connect muscle to bone **;**		
			3	ligaments, hold bones together / prevent dislocation **;**		
			4	cartilage, reduces**,** friction / wear **;**		**4 ACCEPT** 'prevents' for reduces
			5	synovial membrane secretes fluid **;**		**5 ACCEPT** makes, produces but not 'releases'
			6	<u>synovial</u> fluid, is a lubricant / allows smooth movement **;**		**6 ACCEPT** prevents / reduces, friction

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Question	Answer	Marks	Guidance
(c)	**1** (two parts are) sympathetic **and** parasympathetic **;**	7	**1** If BOTH names are wrong but begin with **S and P, DO NOT CREDIT** mp1 but allow ECF for mps 2-12
	2 **S** has, short preganglionic neurone / long postganglionic neurone / ganglia near(er) spinal cord, **but P** has, long preganglionic neurone / short postganglionic neurone / ganglia near(er) organ **;**		**2** **ACCEPT** tissue for organ
	3 **S** uses noradrenaline **but P** uses acetylcholine (at organ) **;**		**3** **CREDIT** norepinephrine for noradrenaline but **IGNORE** noradrenaline from adrenal gland and **IGNORE** references to ganglion here
	4 **S,** fight / flight / stress, **but P**, rest / relaxation / calm **;**		
	5 **S** increases, heart rate / cardiac output / blood pressure, **but P** reduces this **;**		
	6 **S** increases , speed / rate / depth, of breathing, **but P** reduces this **;**		**6** **CREDIT** **S** increases ventilation rate and **P** slows it
	7 **S** increases airway diameter **but P** reduces it **;**		
	8 **S** increases blood flow to skeletal muscle **but P** increases blood flow to gut (smooth muscle) **;**		**8** **CREDIT** voluntary or striated for skeletal **IGNORE** ORA
	9 **S** for orgasm **but P** for sexual arousal **;**		
	10 **S** dilates pupils **but P** constricts pupils **;**		
	11 **S** makes liver release glucose, **but P** makes liver**,** store / take up, glucose **;**		**11** **ACCEPT** correct reverse reasoning for glycogen **IGNORE** sugar 'liver' must be mentioned at least once
	12 **P** allows**,** <u>peristalsis</u> / digestion, **but S** reduces it **;**		**12** **IGNORE** **'**stops' for **S** but allow **S** inhibits
	QWC ;	1	Award **QWC** if **1 mark** awarded for organisation mps **1-3** and **2 marks** awarded for functions mps **4-11**
	Total	**15**	

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Question			Answer	Marks	Guidance
3	(a)		metaphase **I and** metaphase **II ;** prophase **I ;** anaphase **II ;** telophase **II ;** anaphase **I ;**	5	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
	(b)		to, **halve** chromosome number / **reduce from** 2n **to** n **;** to separate homologous pairs (of chromosomes) **and** sister chromatids **;** because, DNA (previously) replicated / chromosomes are two chromatids at start **;**	2	**IGNORE** all references to mitosis **CREDIT 'from** diploid **to** haploid' **ACCEPT 'from** 46 **to** 23 chromosomes' **IGNORE** halve, genetic material / DNA **ACCEPT** genetic, material / information
	(c)	**(i)**	sequence / order, of bases / nucleotides **;**	1	**CREDIT** base pairs **DO NOT CREDIT** amino acid sequence
		(ii)	different, primary / secondary / tertiary, structure **;** (protein) shorter due to, deletion / stop codon **OR** longer due to, insertion / duplication **;** (protein) unchanged due to, silent mutation / non-coding DNA altered **;** (function is) lost / worse / better **;**	3	**ACCEPT** different <u>sequence</u> or <u>order</u> of amino acids **ACCEPT** different 3D folding or 3D shape for 'silent' **CREDIT** 'neutral' or a description of more than one triplet coding for one amino acid **IGNORE** different / altered function **ACCEPT** idea that change is harmful
			Total	**11**	

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>
<table>
<tr><th>biological principle</th><th>letter</th></tr>
<tr><td>artificial selection</td><td>E</td></tr>
<tr><td>predator-prey interaction</td><td>G</td></tr>
<tr><td>apical dominance</td><td>B</td></tr>
<tr><td>nitrogen fixation and nitrification</td><td>D</td></tr>
<tr><td>reproductive cloning</td><td>A / F</td></tr>
<tr><td>positive chemotaxis</td><td>H</td></tr>
<tr><td>decomposition</td><td>C / D</td></tr>
<tr><td>commercial use of plant hormones</td><td>F</td></tr>
</table>
;
;
;
;
;
;
;
;
</td><td>8</td><td>Award 1 mark per row.

Mark the first answer in each box. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks</td></tr>
<tr><td></td><td>(b)</td><td></td><td>respiration / decomposition / decay / ripening ;

<u>interspecific competition</u> ;

(positive) <u>phototropism</u> ;

<u>succession</u> ;</td><td>4</td><td>Mark the first answer on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks

ACCEPT metabolism / metabolic reactions

DO NOT CREDIT negative phototropism
DO NOT CREDIT trophism (as ambiguous with trophic)</td></tr>
</table>

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Question			Answer	Marks	Guidance
	(c)		*animals = primary consumers* **1** keep animals, warm / indoors **;** **2** reduce animal movement **;** **3** feed animals high, protein / energy, food **;** **4** vaccination / (routine) antibiotics, for animals **;** **5** selective breeding / genetic engineering**,** for improved animals **;** **6** slaughter just before, mature / full size **;**	3	**2 ACCEPT** zero grazing idea **3 ACCEPT** growth-enhancing food additives **4 IGNORE** hormones **5 ACCEPT** description of improvement, e.g. disease resistant, faster-growing, higher yielding
			Total	**15**	

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Question			Answer	Marks	Guidance
5	(a)	(i)	*idea of* tentative / uncertain / developing / advancing / improving / dynamic **;**	1	**IGNORE** change(s), changing, changeable (as given in question)
		(ii)	**1** conservation / keep rare plants / save endangered plants **;** **2** gene bank **OR** genetic resource / store of alleles **;** **3** teaching / education **;** **4** leisure / amenity / visitor attraction / aesthetic value **;**	2	**Read as prose.** **1 ACCEPT** prevent extinction / maintain biodiversity **3 IGNORE** 'research' (as given in question)
	(b)	(i)	to**,** amplify / make (many) copies of**,** DNA **;** (range of) different lengths **;**	2	**IGNORE** refs. to single stranded / coding strand / template strand **CREDIT** idea of, chain terminating / dideoxy, nucleotides attaching at different points along sequence
		(ii)	to put DNA pieces in size order **;** to read, base sequence / order of bases **;**	2	**IGNORE** speed or rate of movement, look for distance or position or pattern, e.g. shortest / lightest / smallest**,** lengths first or lighter move further and heavier move less far **DO NOT CREDIT** 'put genome back in order'
		(iii)	to cut (genome DNA) into, small(er) / 750 bp, fragments **;** to cut, vectors / BACs / plasmids, (for gene library) **;**	2	**ACCEPT** fragment size in range 500-1000 base pairs

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Question			Answer	Marks	Guidance
	(c)		genome, too big / very large ; accuracy better / fewer errors (with small fragments) ; divide job over, time / different labs ;	2	**ACCEPT ORA** only, small sections / 750bp, can be sequenced (at a time) **CREDIT ORA** large sections sequenced less accurately **ACCEPT** otherwise would take too long / be unmanageable / be impractical **IGNORE** ref to efficiency
	(d)	(i)	1 160 000 ; ;	2	**Correct answer = 2 marks (no units)** **CREDIT** 1.16 million **or** 1.16 x 10^6 If answer incorrect, **award 1 mark** for 870 (million) ÷ 750 **AWARD** 1 max correct answer has inappropriate units (e.g. 1 160 000 Mbp = 1 mark)
		(ii)	(monkey flower) has, smaller genome / fewer Mbp DNA ; fewer lab hours / fewer staff needed / quicker / cheaper ;	2	**Read as prose.** **ACCEPT ORA** but must be comparative **IGNORE** refs to chromosome number **ACCEPT ORA** but must be comparative
		(iii)	larger (in size) ;	1	**ACCEPT** bigger / plumper / juicier

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Question			Answer	Marks	Guidance
	(e)		*phylogenetic approach* no need to test for interbreeding **;** ref. common ancestor / monophyletic groups **;** can apply to organisms that reproduce asexually **;** can apply to, extinct organisms / fossils **;**	2	**ORA** for biological species concept – (importance of members of same species) (inter)breeding to give fertile offspring **IGNORE** clades **ORA** for biological species concept – doesn't apply to asexually reproducing organisms **ORA** for biological species concept – doesn't apply to, extinct organisms / fossils
			Total	**18**	

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(a)</td><td>(i)</td><td>
<table>
<tr><th></th><th>Discontinuous</th><th>Continuous</th></tr>
<tr><td>Species identified by letter</td><td>S and T ;</td><td>R ;</td></tr>
</table>
</td><td>2</td><td></td></tr>
<tr><td></td><td></td><td>(ii)</td><td>statement 1 in S and T only ;
statement 8 in S and T only ;

statements 2 and 3 in R only ;
statement 5 in R only ;

statements 4 and 7 in T only ;
statement 6 in S only ;</td><td>6</td><td>
<table>
<tr><th>Species</th><th>Statement number(s)</th></tr>
<tr><td>R</td><td>2 3 5</td></tr>
<tr><td>S</td><td>1 6 8</td></tr>
<tr><td>T</td><td>1 4 7 8</td></tr>
</table>
</td></tr>
</table>

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Question			Answer	Marks	Guidance
	(b)		*collection* **1.** named equipment for collecting from, dogs / fields **;** **2.** get**,** large number / over 100 (fleas) **;** **3.** use several, dogs / fields **;** **4.** *idea of* random sampling (dogs / field) **;** *testing* **5.** (named) container **;** **6.** correct dose / range (of concentrations)**,** tested **;** **7.** control without flea killer **;** **8.** delivery method described **;** *processing* **9.** leave for set time **;** **10.** count number of, dead / live**,** fleas (after testing) **;** **11.** calculate percentage (frequency) of**,** alive / dead / resistant / non-resistant **;**	6	**1 CREDIT** pooter, forceps, tweezers, pipette, (flea) comb, sweep net, sticky traps, light traps (in correct context) **5 CREDIT** tank, jam jar, boiling tube, petri dish. **6 ACCEPT** 'dose according to manufacturer's instructions' **IGNORE** same, volume / concentration **8** e.g. flea-killer sprayed / left to evaporate from cotton wool / fed in blood or food **9 ACCEPT** leave for same amount of time **10 IGNORE** how many were left, how many were resistant **IGNORE** identify – must be counting number
			QWC ;	1	Award if the **first mark point awarded in each section** is ***in the correct section order***: collection **1 to 4** **then** testing **5 to 8** **then** obtaining and processing results **9 to 11** *e.g. if the first mark of each section is awarded in the wrong order (such as mp 1, then mp 10, with nothing from the testing section inbetween)* ***then do not award QWC***
			Total	**15**	

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Question			Answer	Marks	Guidance
7	(a)	(i)	(both) to, avoid / counter, (abiotic) stress **;**	2	**Mark the first 2 reasons** **CREDIT** to avoid named stressors e.g. cold, heat, dryness, humidity or unfavourable conditions **only CREDIT** descriptions relevant to both animals (avoiding a stressor) **and** to plants (closing stomata, wintering underground, etc). **IGNORE** survival and dangers unqualified
			(both) to avoid, being eaten / predation **;**		**only CREDIT** descriptions relevant to both animals (being consumed, being preyed upon) **and** to plants (being grazed, herbivory).
			(both) to access resources **;**		**only CREDIT** descriptions relevant to both animals (get food) **and** plants (obtain light, minerals, water)
		(ii)	*all points must show a clear comparison between mammals (M) and plants (P)* **1** (M) made in endocrine glands **versus** (P) made in many plant tissues **;** **2** (M) move in blood **versus** (P) move, in xylem / in phloem / from cell to cell **;** **3** (M) act on**,** a few / specific / target, tissues **versus** (P) act on most tissues / can act in cells where produced **;** **4** (M) act more rapidly **; ORA**	3	**2(P) ACCEPT** diffusion / through plasmodesmata, for 'from cell to cell'. **ACCEPT** by translocation / in transpiration stream **IGNORE** mass flow **4** must be comparative e.g. respond fast**er** in mammals
	(b)	**(i)**	inherited / passed to offspring / passed (down) from parents **;** (caused by) mutation / allele **;**	2	**ACCEPT** in context of condition or gene

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Question			Answer	Marks	Guidance
		(ii)	gene / allele ; (DNA) ligase ; transgenic / transformed ; antibiotic(s) ; (gene / DNA / fluorescent / radioactive) probe ;	5	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** recombinant / GE / GM **CREDIT** named antibiotic e.g. ampicillin, tetracycline
	(c)		fat soluble / non-polar / uncharged / hydrophobic ; (so can move directly through) phospholipid bilayer ;	2	**ACCEPT** through phospholipids / through phospholipid membrane **DO NOT CREDIT** through pores

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Question	Answer	Marks	Guidance
(d)	**EITHER** **1** *(lac)* repressor protein **;** **2** (repressor protein) changes shape when bound to lactose **;** **3** (with lactose) lifts off operator allowing, transcription / gene expression / binding of RNA polymerase to promoter **; ORA** **4** β-galactosidase / enzyme(s) / structural gene(s) **;** **OR** **5** homeotic / homeobox / hox (genes) **;** **6** gene product / protein / transcription factor, binds to DNA **;** **7** gene product / protein, starts transcription / is a transcription factor **;** **8** many genes affected / controls body plan **;**	4	**Mark the first example.** **3 ORA** without lactose the protein binds to the operator stopping, transcription / gene expression / binding of RNA polymerase to promoter **DO NOT CREDIT** mp 3 if ref. made to DNA polymerase or DNA replication **4 CREDIT** lactose permease **6 CREDIT** homeobox domain / homeodomain, binds to DNA **7 ACCEPT** controls **/** regulates **/** stops**,** transcription **8 CREDIT** controls**,** development / segmentation
	Total	**18**	

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Monday 21 January 2013 – Morning

A2 GCE BIOLOGY

F215/01 Control, Genomes and Environment

Candidates answer on the Question Paper.

OCR supplied materials:
None

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

Duration: 2 hours

F2381O113

F215O1

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- 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 page 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 **20** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Domestic chickens have been bred for many years to increase the number of eggs laid by the females. It is useful to be able to identify the young female chicks on the day after they hatch, as only the females need to be kept for laying eggs.

Unlike mammals, where the sex chromosomes are known as X and Y, in chickens the sex chromosomes are known as Z and W.

- Male chickens have two Z chromosomes (ZZ).
- Female chickens have one Z chromosome and one W chromosome (ZW).

(a) Some genes for feather colour and pattern in chickens are carried on the Z chromosome but not on the W chromosome. One such example is the gene for striped feathers (barring).

State the name given to this type of inheritance.

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

(b) Inheritance of the barring pattern can be used to identify female chicks when they are one day old.

The phenotypes associated with the two alleles of the barring gene are shown in Table 1.1.

Allele	Adult phenotype	Day-old chick phenotype
dominant **B**	black feathers striped with white bars (barred)	black body with a white spot on head
recessive **b**	black feathers (non-barred)	black body and head

Table 1.1

(i) State the **adult phenotypes and sex** of the following individuals:

Z^BZ^b .....

Z^BW .....

Z^bW .....

[3]

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(ii) A cross was carried out between a barred female and a non-barred male.

Complete the genetic diagram to show the parental genotypes, their gametes and the F1 genotypes. State the phenotypes of the offspring as **day-old chicks**.

Parent phenotypes	**Barred female**	**Non-barred male**
Parent genotypes	.....	.....
Gametes	.....	.....
F1 genotypes	.....	.....
F1 day-old chick phenotypes		

male .....

.....

female .....

.....

[5]

(c) The autosomal gene **I / i** shows epistasis over **all** other genes affecting feather colour in chickens.

Individuals carrying the dominant allele **I** have white feathers.

Chickens that are not white have the genotype **ii**.

(i) State the precise term used to describe the genotype **ii**.

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

(ii) Predict the colour(s) of the offspring of a cross between a male homozygous barred chicken and a white female chicken with the genotype **II**.

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

[Total: 11]

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2 The Galapagos Islands are 600 miles away from the nearest land mass, South America. They consist of 15 main islands, 3 smaller islands, and 107 rocks and islets. This collection of islands is home to many endemic species of animals and plants. This means that these species are found nowhere else in the world.

(a) Explain, using scientific terms, why a collection of small islands remote from the mainland provides optimal conditions for speciation.

.....

.....

.....

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

(b) In 1978, the United Nations (UN) declared the Galapagos Islands a World Heritage Site. This led to a rise in the resident human population and the number of visitors to the Islands.

Table 2.1 shows how the number of people living on and visiting the Galapagos Islands changed between 1980 and 2005.

Year	Resident population	Number of visitors
1980	5500	16 000
1985	7000	19 000
1990	9500	42 000
1995	12 500	58 000
2000	17 500	68 000
2005	27 500	125 000

Table 2.1

(i) Calculate the percentage increase in the number of visitors to the Galapagos Islands between 1980 and 2005.

Show your working. **Give your answer to the nearest whole number**.

Answer = ... % **[2]**

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(ii) Outline the main ways in which increased human presence and activity have put endemic species on the Galapagos Islands, and in the sea around them, at risk of extinction.

In your answer you should link the ecological pressures imposed by human activity to examples of Galapagos Island species that have been affected.

[7]

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(c) In 2007, the United Nations (UN) put the Galapagos Islands on its Red List of endangered sites. The Galapagos government's response to this action included making new laws and placing restrictions on human activity, issuing eviction orders and culling introduced species of animals.

Suggest **one** economic and **one** ethical problem that might have arisen from this 2007 UN decision.

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

[Total: 13]

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3 A student who was interested in animal behaviour did a day's work experience at a zoo. He made these notes about some examples of animal behaviour that he observed.

A When I approached the otter enclosure tapping a bucket of food, the otters made rapid squeaking noises and ran to the door to meet me!

B A mother duck escaped from her enclosure and all her baby ducklings followed her through a hole in the wire.

C I moved a log in one enclosure and noticed that the woodlice, which had been resting underneath the log, began to move around quickly once the log was lifted.

D A banana had fallen a short distance away from the chimpanzee pen. A chimpanzee used a stick to reach out and drag the banana towards her.

E The ring-tailed lemurs showed mutual grooming behaviour, taking it in turns to search through another lemur's fur for parasites.

F Cockroaches living in the dark in the house for nocturnal animals ran away from the light of my torch.

G Zoo deer are free to roam amongst the visitors. Although deer usually run away from humans, the zoo deer do not.

H When a chimpanzee threw an apple at the keeper, the keeper ducked his head very fast.

Match the examples **A**–**H** to the names of different **types of behaviour** by writing the correct letter beside the name. One has been done for you.

1 social behaviour ..... **2** kinesis .....

3 imprinting ..... **4** escape reflex **H**

5 taxis ..... **6** operant conditioning .....

7 habituation ..... **8** insight learning .....

[7]

[Total: 7]

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4 Rhubarb, *Rheum x hybridum*, is a plant that is grown for its edible stems. In Spring, the stems and leaves grow from fleshy roots which survive the Winter underground.

Growers have developed many new varieties of rhubarb by growing plants from seed, choosing the best young plants and then asexually reproducing them.

Seeds are produced by sexual reproduction and the rhubarb plants that grow from seed show variation in characteristics such as stem colour, dormancy period and the concentration of oxalic acid in their leaves.

(a) Outline the events that lead to genetic variation in gametes **and** in the plants grown from seed.

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..... **[5]**

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(b) Traditionally, rhubarb plants have been produced by vegetative propagation. The best young rhubarb plants are allowed to grow for three seasons until their underground root systems are large enough. They are then dug up in Winter, the roots are cut into pieces and the pieces are replanted. Each piece is then able to grow into a new rhubarb plant that is identical to the parent.

(i) State the biotechnological term for this type of vegetative propagation.

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

(ii) A gardener wished to multiply his rhubarb plants using the traditional method, but he discovered that his plants were infected by a virus.

Name the modern technique which allows commercial growers to produce large numbers of genetically identical plants that are also virus-free.

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

(iii) Rhubarb plants must spend seven to nine weeks at a temperature below 3 °C in order to break their winter dormancy and allow them to start growing stems and leaves again.

The length of the cold period that is required depends on the variety of rhubarb.

In the variety 'Timperley Early', the length of the cold period is shorter, so the plants grow and produce a crop earlier in the year than the variety 'Victoria'.

Suggest **two** ways in which the varieties may differ from one another **biochemically** to account for the difference in the length of the cold period required by each.

.....

.....

.....

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

Question 4(c) begins on page 10

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(c) Rhubarb leaves contain oxalic acid, a relatively strong acid which is soluble in water and alcohol. High concentrations of oxalic acid makes rhubarb leaves poisonous to humans and other animals.

(i) The amount of oxalic acid in the leaves varies according to the variety of rhubarb, the age of the plant and environmental factors.

Suggest and plan an experiment to compare how the variety of rhubarb affects the amount of oxalic acid in rhubarb leaves.

Include in your plan:

- the variables that you could control
- an outline of the experimental procedure you would use
- any measurements that you would make.



In your answer you should make clear which are the independent, dependent and controlled variables.

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..... **[6]**

(ii) As rhubarb leaves are poisonous, they are cut off when the stems are harvested and may be left to decompose on the compost heap.

Outline the role of **decomposers** in the decomposition of leaves.

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

(d) An early harvest of rhubarb stems can be obtained by placing an upturned bin over the root when it comes out of dormancy, so the emerging shoots are kept in the dark. The shoots then grow more quickly to a height suitable for picking.

Use your knowledge of **plant growth regulators** (plant hormones) to suggest why shoots kept in the dark grow taller than those left in the light.

.....

.....

.....

.....

.....

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

[Total: 21]

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5 Growth and development in organisms is controlled by a number of mechanisms that operate at the cellular level. The control elements involved in these mechanisms include hormones, the second messenger molecule cyclic AMP and regulatory genes.

- In eukaryotes the most important regulatory genes contain homeobox sequences and are called homeotic genes.

- The regulatory genes of the *lac* operon in prokaryotes are studied to help us to understand how regulatory genes and their products interact to switch structural genes on and off.

(a) Use your understanding of the biochemical identity and interactions of these control elements to complete Table 5.1 by putting a tick (✓) or a cross (✗) **in each box**.

Some of the boxes have been completed for you.

Control element	Made of protein	Binds with a protein	Codes for protein
insulin		✓	
cyclic AMP			✗
lac I (inhibitor) gene		✓	
lac O (operator) gene	✗		
homeotic gene product		✗	

[5]

Table 5.1

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(b) RNA polymerase and DNA polymerase are both enzymes. RNA polymerase is involved in the action of some control elements, whereas DNA polymerase is not.

Describe and explain the difference between the **functions** of these two enzymes.

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

(c) Another mechanism that can act to change the body plan of an organism during its development is **programmed cell death**.

Fill in the gaps in the following passage describing this process and the importance of its regulation.

Programmed cell death is known as ..... . Firstly, the fine network of protein filaments and microtubules known as the ..... , which gives structure to the cell, is broken down and digested by ..... .

The plasma (cell surface) membrane then changes, forming small bulges called 'blebs'. The cell breaks into membrane-bound fragments that are removed by the process of ..... so that harmful substances are not released into surrounding tissues.

Programmed cell death is a controlled process. However, mutation in a gene called p53 can prevent programmed cell death. When this occurs, the rate at which somatic cells are produced by the process of ..... becomes greater than the rate at which cells die, resulting in the formation of a mass of cells known as a ..... . **[6]**

[Total: 15]

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6 Microorganisms are often used in biotechnological processes.

Fig. 6.1 shows the standard growth curve for a culture of bacteria.

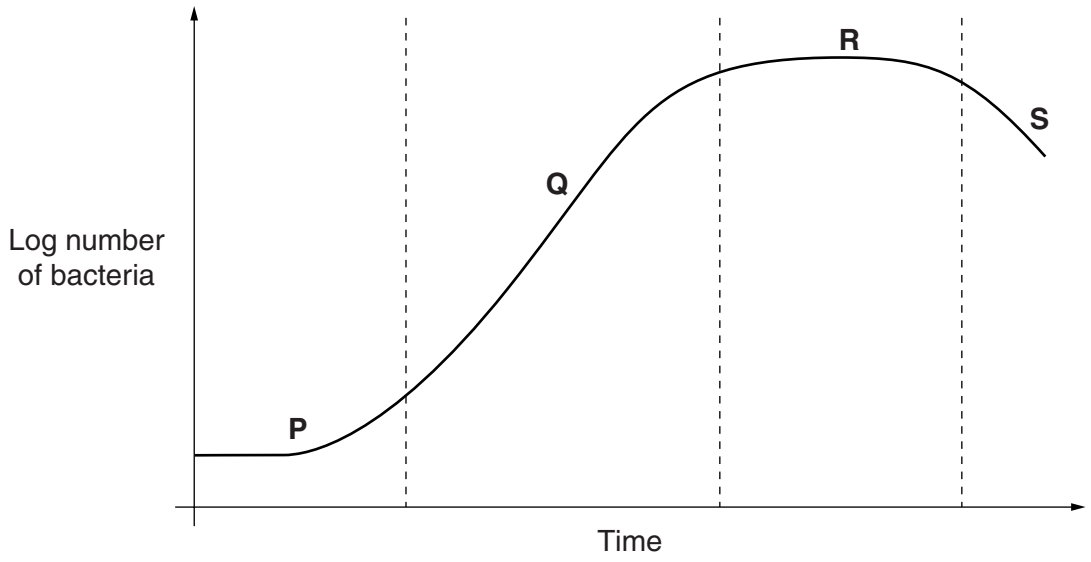


Fig. 6.1

(a) Identify the phases labelled **P**, **Q** and **R** in Fig. 6.1.

P .....

Q .....

R .....

[3]

Metabolic processes taking place in bacteria grown in a batch culture produce primary and secondary metabolites.

(b) Explain what is meant by a primary metabolite.

.....

.....

.....

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

(c) With reference to the information in Fig. 6.1, state the phase or phases, **P**, **Q**, **R** or **S**, when

(i) primary metabolite production is at its highest **rate**;

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

(ii) most secondary metabolites are produced;

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

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(iii) the concentration of secondary metabolites reach a maximum.

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

(d) Some aerobic recombinant bacteria were grown in a fermenter. They synthesised the protein human growth hormone (HGH).

(i) Suggest **two** ways in which named factors inside the fermenter could be adjusted in order to maximise the yield of HGH.

1 .....

.....

.....

2 .....

.....

.....

[4]

(ii) HGH made in this way is given by injection to some children who have a genetic mutation. The mutation means that they do not produce enough HGH to enable them to grow at the normal rate.

Explain why injecting recombinant HGH in this way is **not** an example of gene therapy.

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

[Total: 15]

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7 **(a)** A number of new techniques for manipulating cells and genomes are now available, and it is hoped this manipulation will allow cures for diseases to be developed.

Five goals that scientists would like to achieve are described below and are listed **A** to **E**:

A producing large numbers of genetically identical 'model' transgenic mice that show symptoms of diabetes

B growing a replacement kidney identically tissue-matched to an individual patient

C obtaining replacement hearts from transgenic pigs, partially tissue-matched to humans

D genetically manipulating cells of one adult to cure a genetic disease in that individual

E altering a prokaryotic pathogen for use as a vaccine.

The names of the procedures corresponding to **four** of the five goals **A** to **E** are written below.

Match the correct letters to the names. **No letter should be used more than once**.

xenotransplantation .....

somatic gene therapy .....

non-reproductive cloning .....

animal reproductive cloning .....

[4]

(b) Table 7.1 shows four different combinations of techniques used to achieve goals **A** to **E**.

Write the letters **A, B, C, D or E** in the first column of the table to match each goal to the appropriate combination of techniques needed to achieve it.

Use each letter only once.

	Technique			
Goal	**Vector used to transfer genes**	**Embryonic stem cells manipulated**	**Non-embryonic stem cells manipulated**	**Tissue designed for use in a different species**
	✓	×	✓	×
	✓	✓	×	×
	×	✓	×	×
	✓	✓	×	✓
	✓	×	×	×

[5]

Table 7.1

[Total: 9]

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8 Earthworms are abundant in fertile soil where they play an important role in the transfer of energy in the ecosystem. An example of a food chain involving earthworms is shown in Fig. 8.1.

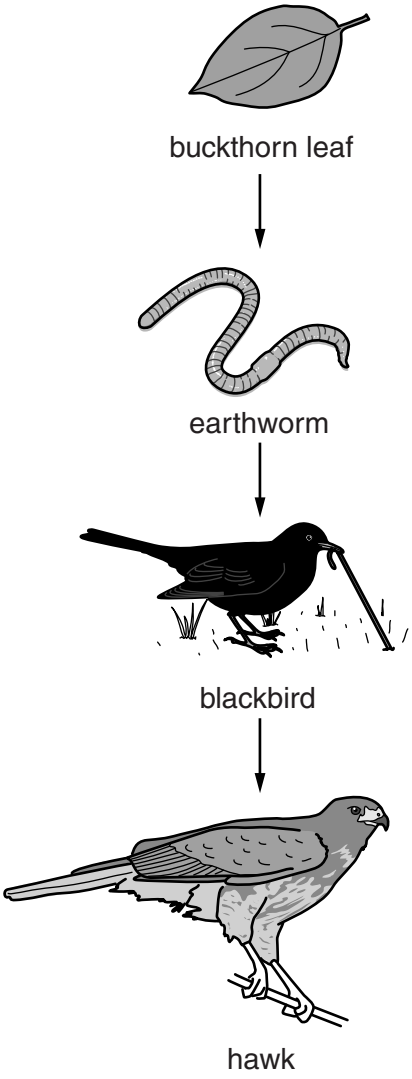


Fig. 8.1

(a) Define the following terms:

producer .....

.....

.....

consumer .....

.....

.....

trophic level .....

.....

.....

[3]

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(b) One way of measuring the abundance of earthworms is as follows:

- place quadrat frames of known area onto the ground
- pour a chemical solution onto the soil to cause the earthworms to come up to the surface
- wait and then count the earthworms.

Researchers used this technique in 2004 and 2006 to compare the abundance of earthworms in four areas of soil:

- soil underneath buckthorn plants
- soil underneath honeysuckle plants
- bare soil after the removal of buckthorn plants
- bare soil after the removal of honeysuckle plants.

The results are shown in Fig. 8.2.

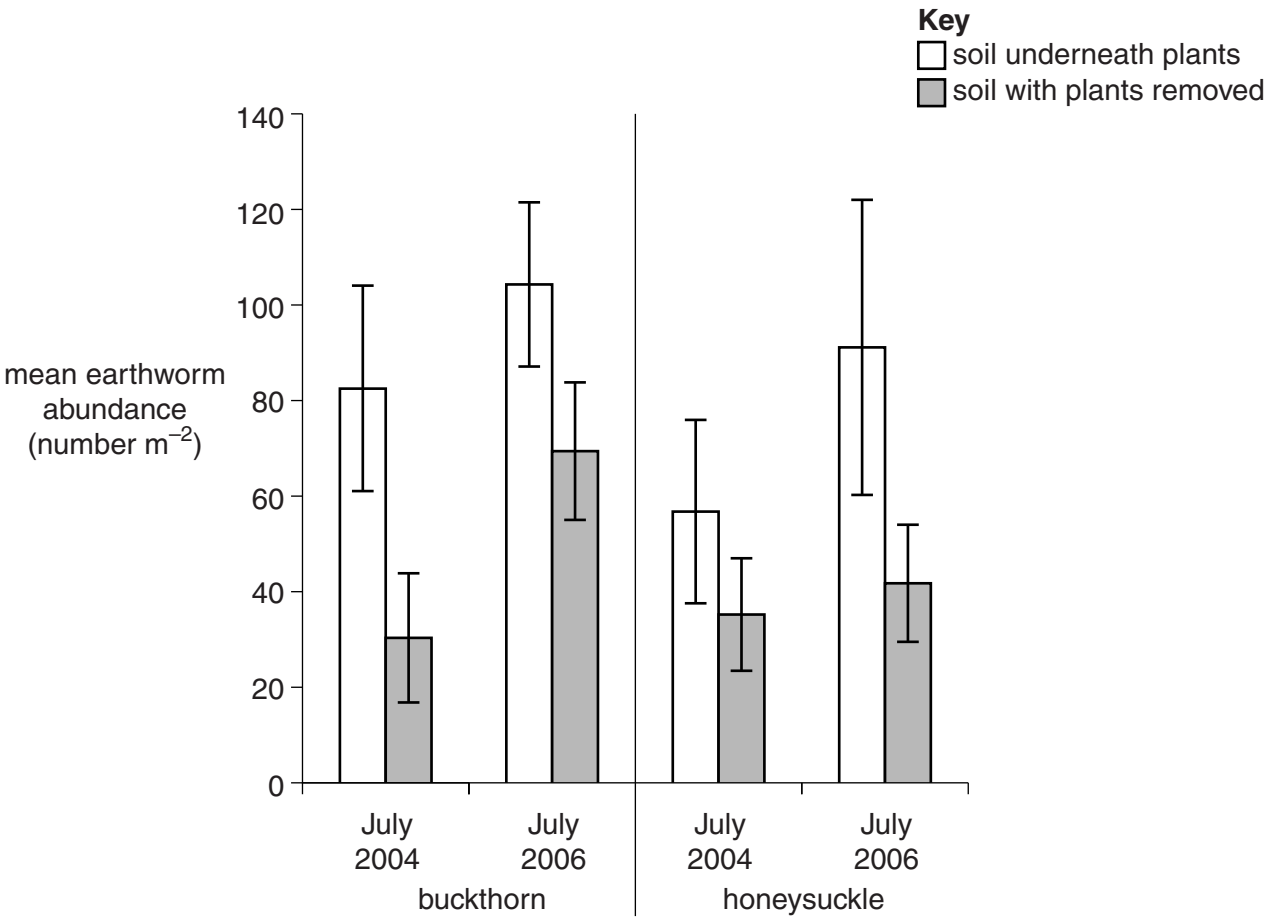


Fig. 8.2

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(i) Suggest **two** variables which the researchers should have controlled in order to make the results comparable.

1 .....

.....

2 .....

.....

[2]

(ii) Evaluate, with reference to the error bars in Fig. 8.2, whether the data show a valid difference in the abundance of earthworms between the 'soil underneath honeysuckle' and 'soil with honeysuckle removed' sites for July 2004.

.....

.....

.....

.....

.....

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

(iii) Ecosystems can be described as dynamic.

State **two** pieces of evidence from Fig. 8.2 that show that the ecosystem is dynamic.

1 .....

.....

2 .....

.....

[2]

[Total: 9]

END OF QUESTION PAPER

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ADDITIONAL ANSWER SPACE

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

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GCE

Biology

Advanced GCE

Unit **F215:** Control, Genomes and Environment

Mark Scheme for January 2013

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Annotations

Annotation	Meaning
	Correct answer
	Incorrect response
	Benefit of Doubt
	Not Benefit of Doubt
	Error Carried Forward
	Given mark
	Underline (for ambiguous/contradictory wording)
	Omission mark
	Ignore
	Correct response (for a QWC question)
	QWC* mark awarded
	First Answer

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Subject-specific Marking Instructions

CREDIT AW FOR ALL
i.e. credit any alternatively worded statement that conveys the same sense as the mark point.
If a particular word is essential and no other will do it is underlined.

IGNORE wrong or vague statements unless **they directly contradict** a mark point.

ACCEPT incorrect spellings if they are recognisable **and** sound the same when pronounced.

Question			Answer	Marks	Guidance
1	(a)		sex linkage / sex linked ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** non-autosomal linkage
1	(b)	(i)	Z^BZ^b barred male ; Z^BW barred female ; Z^bW non-barred female ;	3	If no gender given, **AWARD** one mark only if **all three** adult colours correct If no colours given, **AWARD** one mark only if **all three** genders correct **CREDIT AW** for 'barred' e.g. 'black (feathers) striped with white (bars)' **or** 'striped / stripey'. **CREDIT AW** for 'non-barred' e.g. (all) black / not striped.

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Question			Answer	Marks	Guidance
1	(b)	(ii)	<table><tr><td>parent phenotypes:</td><td>barred female</td><td>non-barred male</td></tr><tr><td>parent genotypes:</td><td>Z^BW</td><td>Z^bZ^b ;</td></tr><tr><td>gametes:</td><td>Z^B and W</td><td>Z^b (and Z^b) ;</td></tr><tr><td>F1 genotypes:</td><td>Z^BZ^b</td><td>Z^bW ;</td></tr></table> *F1 day-old chick phenotypes* *male* black (body) with a white spot (on head) ; *female* (all) black / black body and head / black with no white spot (on head) ;	5	If symbols other than those given (B and b) are used (e.g. A and a), penalise once and then apply ECF. If X and Y are used instead of W and Z, penalise once and then apply ECF. If alleles put onto the W, penalise once and then apply ECF. **ACCEPT** W written before Z, or other order change eg Z^BZ^b as Z^bZ^B. Gametes must apply to candidate's stated parent genotypes – apply ECF. **IGNORE** genotype repeated (i.e. no space between the gametes). **CREDIT** F1 genotypes in any order **IGNORE** repetitions such as each genotype stated twice. Apply ECF if genotypes match gametes given. F1 genotypes and phenotypes should match, including repetitions if given. Apply ECF **DO NOT CREDIT** adult phenotypes
1	(c)	(i)	homozygous recessive ;	1	**ACCEPT** reverse word order **IGNORE** double
1	(c)	(ii)	(all are) white ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**11**	

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Question			Answer	Marks	Guidance
2	(a)		**1** geographical, isolation / separation / barrier **;** **2** *idea of* reproductive isolation **;** **3** different **,** selection pressures / adaptations (on different islands) **;** **4** small **,** populations / gene pools **;** **5** *idea of mp 4* resulting in founder effect **;** **6** *idea of mp 4* resulting in greater genetic drift **;**	2	**1** **IGNORE** allopatric speciation **2** e.g. no / less **,** interbreeding between different **,** populations (early) / species (late) **3** **IGNORE** different to mainland **ACCEPT** in different environments or conditions they evolve or adapt differently **4** **DO NOT CREDIT** small species **5** **ACCEPT** *idea of mp 4* resulting in greater impact of **,** mutation / input of alleles (migration) / loss of alleles (accidents etc.)
2	(b)	(i)	681 **; ;**	2	**Correct answer = 2 marks** even if no working shown *Expected working* *125 000 – 16 000 = 109 000* *(109 000 ÷ 16 000) x 100 = 681 (%)* If answer not rounded or rounded incorrectly **ACCEPT** e.g. 682 **or** 681.3 **or** 681.25 for **1 mark** If the final answer is incorrect **and** no mark was awarded for a figure close to correct value, **ACCEPT** the figure 109 000 in the working **or** 125 000 – 16 000 for **1 mark**.

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Question			Answer	Marks	Guidance
2	(b)	(ii)	**1** habitat / ecosystem **,** disturbance / destruction **;**	6	
			2 (land used for) (named) building / roads **;**		**2** e.g. houses, schools, factories **ACCEPT** urbanisation and development for tourism
			3 (land used for) agriculture / farming **;**		
			4 deforestation **;**		**4** **ACCEPT** description e.g. cutting down trees / logging
			5 effect of (tourist) **,** boats / divers, described **;**		
			6 more / increased **,** pollution **;**		
			7 sewage / eutrophication **,** in sea / water **;**		
			8 oil / fuel **,** spill in sea **;**		
			9 (humans) hunting / collecting / (over-) fishing **;**		**9** **CREDIT** poaching / green sea turtles caught in fish nets
			10 competition from introduced species **;**		**10** **CREDIT** nest / egg **,** trampling by introduced species
			11 predation / overgrazing **,** by introduced species **;**		
			12 **(**new / named) **,** diseases / pathogens, introduced **;**		**12** **CREDIT** West Nile virus / avian malaria / bird flu
			QWC – linking **TWO** ecological pressures above to **TWO** examples of affected species **;**	1	**Two** Galapagos animals or plants named in context. e.g. ● (marine / land) iguana, (lava) lizard, (ground) finch (**mp11** predation by cats) ● rock purslane (**mp11** overgrazing by goats) ● (giant) tortoise (**mp9** hunting, **mp10** competition from goats) ● whale / seal / named fish / sea cucumber (**mp9** hunting) ● *Scalesia* tree (**mp4** deforestation, **mp10** competition from red quinine tree) ● (blue-footed) boobies (**mp11** predation by rats)

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Question			Answer	Marks	Guidance
2	(c)		*economic* fewer jobs / smaller profits / business closure / reduced tourism / less income / less revenue ; *ethical* question of , humane killing / animal suffering **or** people suffer through losing their , homes / friends / jobs ;	2	**IGNORE** economic loss **IGNORE** right to life arguments
			Total	**13**	

Question			Answer	Marks	Guidance
3			**1 E ;** **2 C ;** **3 B ;** **4** given **5 F ;** **6 A ;** **7 G ;** **8 D ;**	7	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**7**	

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Question			Answer	Marks	Guidance
4	(a)		**1** mutation **;**	5	**1** **CREDIT** in context of gene or chromosome mutation **ACCEPT** a suitable description e.g. change in DNA base sequence / non-disjunction
			2 meiosis **;**		**2** **DO NOT CREDIT** incorrect spelling of meiosis
			3 cross(ing)-over **;** **4** between non-sister chromatids **;**		**3** **ACCEPT** formation of chiasmata **4** **DO NOT CREDIT** sister here (CON) but **IGNORE** sister for mp 3 and mp 5
			5 (in) prophase I **;**		**5** needs to be in context of 3 or 4
			6 independent / random , assortment / segregation **;**		**6** **ACCEPT** description e.g. random alignment of bivalents
			7 (in) metaphase **;**		**7** needs to be in context of 6 metaphase I (chromosomes) or I I (chromatids) **IGNORE** anaphase
			8 *idea of* random **,** fertilisation / fusion of gametes **;**		**8** **CREDIT** description relating to plant (as Q states rhubarb) e.g. any pollen grain could land on any stigma / any pollen grain could reach any ovule
			9 AVP **;**		**9** ref. epigenetics

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Question			Answer	Marks	Guidance
4	(b)	(i)	reproductive ; cloning ;	2	**ACCEPT** 'whole organism'
4	(b)	(ii)	(callus / plant) tissue culture / micropropagation ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** tissue culturing / micropropagating **IGNORE** cloning
4	(b)	(iii)	*they have different (qualitatively or quantitatively)* **1** genes / DNA / alleles / genotypes ; **2** repressor proteins ; **3** enzymes ; **4** protein folding / tertiary structure / thermostability ; **5** (plant) growth regulators / hormones ;	2	**Mark the first 2 suggestions.** Must have 'different' idea at least ONCE e.g. higher / only one of them has x **3** **CREDIT** different enzymes or different amounts **4** **CREDIT** enzyme activity at different temperatures **5** **ACCEPT** PGRs / named hormones eg gibberellins
4	(c)	(i)	**1** (test) different varieties ; **2** several plants or leaves (of each) / repeat readings ; **3** same age ; **4** same soil , type / mineral content / pH ; **5** same light , exposure / conditions ; **6** same , watering regime / temperature / CO_2 concentration ;	5	**1** **ACCEPT** 'Timperley Early' and 'Victoria' **IGNORE** species **2** **ACCEPT** three or more **CREDIT** 'control / controlled' for 'same' in mps **3,4,5,6 & 7** **4** **IGNORE** soil nutrient level or content **5** **CREDIT** light intensity / wavelength / duration **IGNORE** amount of light *If none of mps 4-6 awarded*

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Question	Answer	Marks	Guidance
			ACCEPT *'grown under same conditions' for 1 mark and dot for QWC if stated as controlled*
	7 same, preparation or testing procedure detail **;** (e.g. leaf mass / volume of solvent / soaking time / temperature)		**7** **IGNORE** amount (of solvent / water / ethanol / alcohol) or size (of leaf). Procedure can be liquidising/pestle and mortar, stated same for each.
	8 test / measure**,** (oxalic) acid concentration / acidity / pH / H^+ ion concentration **;**		**8** **IGNORE** amount / content / how much (of acid or H^+ ions) except for QWC
	9 detail of measuring method **;**		**9** e.g. pH probe universal indicator (not litmus) titration **IGNORE** colorimetry
	QWC ;	1	**Award if** variables correctly identified as <u>independent</u> (**1** only) **and** <u>controll</u>ed (any of **3/4/5/6/7**) **and** <u>dependent</u> (**8** only).

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Question			Answer	Marks	Guidance
4	(c)	(ii)	**1** bacteria / fungi **;** **2** *idea of* external digestion **;** **3** by **,** enzymes / named enzymes **;** **4** absorption of breakdown products **;** **5** release of carbon dioxide and water **;** **6** (breakdown of protein) makes **,** ammonium **,** ions / compounds **or** NH_4^+ **;**	3	**1** **DO NOT CREDIT** wrong bacteria eg nitrogen fixing, nitrifying, denitrifying, *Rhizobium, Nitrosomonas, Nitrobacter* **2** **CREDIT** saprotrophic / saprophytic / saprobiotic **ACCEPT** **'**breaking down' for digestion **3** e.g. cellulase / lignase **6** **CREDIT** ammonification **IGNORE** ammonia / nitrates
4	(d)		auxin / IAA **;** not destroyed by light / more present in dark **;** moves down from shoot tip / uniformly distributed **;** (causes) <u>cell</u> elongation **;**	2	**IGNORE** gibberellins and references to phototropism and more light on one side
			Total	**21**	

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Question			Answer	Marks	Guidance
5	(a)			5	**Award** one mark for each correct row. **DO NOT CREDIT blank** spaces, **multiple answers** or **hybrid ticks** (a tick that has been crossed through, so it cannot be judged if it is a tick or a cross.)

control element	made of protein	binds to a protein	codes for protein	
insulin	✓	✓	×	;
c AMP	×	✓	×	;
lac I (inhibitor) gene	×	✓	✓	;
lac O (operator) gene	×	✓	×	;
homeotic gene product	✓	×	×	;

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Question			Answer	Marks	Guidance
5	(b)		*RNA polymerase* **1** makes (m / messenger / t / transfer / r / ribosomal) RNA ; **2** transcription ; **3** one strand (DNA) used / short section used / one strand formed ; *DNA polymerase* **4** DNA replication ; **5** semi-conservative / both strands used / whole length used / 2 strands formed ; **6** before , nuclear / cell , division ;	4	**2** **CREDIT** transcribes / transcribed **3** Must be a clear statement **4** **CREDIT** replicates / replicated **5** Must be a clear statement **6** **CREDIT** before , mitosis / meiosis / cytokinesis **CREDIT** in S phase (of interphase) **IGNORE** interphase unqualified
5	(c)		**1** apoptosis ; **2** cytoskeleton ; **3** enzymes ; **4** phagocytosis ; **5** mitosis / mitotic cell division ; **6** tumour ;	6	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **1** **ACCEPT** 'apotosis' as phonetic **2** **ACCEPT** cell skeleton **3** **CREDIT** proteases / lysosomes **6** **ACCEPT** cancer / carcinoma
			Total	**15**	

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Question			Answer	Marks	Guidance
6	(a)		**P** lag ; **Q** log(arithmic) / exponential ; **R** stationary ;	3	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **IGNORE** plateau
6	(b)		(molecule made in or needed for cell's normal) survival / function / growth / development / reproduction ; named example ;	2	**IGNORE** metabolism (as stated in Q) / phase e.g. glucose / sucrose / (named) amino acid / CO_2 / ethanol / (named) nucleotide / named named respiratory intermediate / (named) protein / (named) enzyme **DO NOT CREDIT** antibiotics
6	(c)	(i)	**Q** ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** log / exponential
6	(c)	(ii)	**R** ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** stationary
6	(c)	(iii)	**R** / **S** ;	1	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** stationary / decline / death (phase)

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>6</td><td>(d)</td><td>(i)</td><td>
<table>
<tr><th>factor (F)</th><th>change needed (C)</th></tr>
<tr><td>oxygen ;</td><td>increase it / more / high
or
stir / sparging ;</td></tr>
<tr><td>(named)
nutrient ;</td><td>increase it / more / high
or
stir ;</td></tr>
<tr><td>temperature ;</td><td>maintain at / control at /
change to , optimum
or
cool
or
ref. to using water jacket ;</td></tr>
<tr><td>pH ;</td><td>maintain at / control at /
change to, optimum
or
add, buffer / acid / alkali ;</td></tr>
<tr><td>(waste)
product / gas /
CO_2 ;</td><td>harvest / remove /
waste gas vent ;</td></tr>
<tr><td>other /
unwanted /
harmful /
competing ,
microbes ;</td><td>prevent entry / asepsis ;</td></tr>
</table>
</td><td>4</td><td>Mark the first suggestion on each prompt line. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks
C CREDIT idea of paddles distributing the available oxygen more evenly
C ACCEPT continuous, adding / supply, of oxygen
IGNORE aeration as named F but ACCEPT for C
C CREDIT idea of paddles distributing the available nutrients more evenly
C ACCEPT continuous, adding / supply, of nutrients
IGNORE food as named F but ACCEPT for C

C ACCEPT ‘suitable’ for ‘optimum’ temperature
ACCEPT prevent overheating / enzymes denaturing

C ACCEPT ‘suitable’ for ‘optimum’ pH
ACCEPT prevent enzymes denaturing

C CREDIT reduce pressure (for waste gases)

F CREDIT named microbes e.g. bacteria / fungi / pathogens
C CREDIT idea of use of filters or aseptic techniques</td></tr>
</table>

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Question			Answer	Marks	Guidance
6	(d)	(ii)	**1** (child's) cells / DNA / genes / alleles **,** not changed **;** **2** vector not used (in child) **;** **3** child / cells **,** not producing **,** HGH / hormone **;** **4** HGH / drug / injection **,** has to be given repeatedly / is a short term solution / not a cure **;**	3	**ACCEPT** reverse reasoning throughout e.g. **1** in gene therapy **,** the person's cells are altered / a functional allele is introduced. **1** **DO NOT ACCEPT** gene replacement **ACCEPT** genotype **2** **CREDIT** named vector **3** **CREDIT** (the) protein / polypeptide
			Total	**15**	

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Question			Answer	Marks	Guidance
7	(a)		**C ;** **D ;** **B ;** **A ;**	4	**Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
7	(b)		goal **D ;** **A ;** **B ;** **C ;** **E ;**	5	**Mark the first answer in each box.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**
			Total	**9**	

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Question			Answer	Marks	Guidance
8	(a)		*producer* (leaves / plants) fix carbon / photosynthesise / make food / autotroph(ic) / convert light energy to chemical energy / convert inorganic, C / CO_2, to organic molecules **;** *consumer* (bird) eat / derives energy from / feeds on **,** other organisms **or** heterotroph(ic) **;** *trophic level* stage / position / place / level **,** in a food **,** chain / web **;**	3	**IGNORE** 'first level in a food chain' **DO NOT CREDIT** 'produces energy' **IGNORE** 'consumes' **IGNORE** named levels / organisms e.g. eats producers **ACCEPT** animals, and / or, plants **IGNORE** step, feeding level
8	(b)	(i)	number of quadrats (per area) **;** method of placing quadrats (randomly) **;** time waiting **,** after solution added / for worms to rise **;** volume of solution **;** concentration of solution **;** AVP **;**	2	**CREDIT** any two correct answers **IGNORE** ref to quadrats being the same size (as given in Q) **IGNORE** amount e.g. method of applying solution length of time spent counting time of day / light intensity soil moisture / rainfall / humidity method to ensure no double counting

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Question			Answer	Marks	Guidance
8	(b)	(ii)	means different / mean less in soil with plants removed ; (but) error bars overlap ; (could have) mean trend reversed / equal numbers in some pairs of results ; difference, not / less , valid ;	2	**DO NOT CREDIT** if difference in mean stated to be valid **IGNORE** average **ACCEPT** cross (over) e.g. in any pair of results you could find that the number of earthworms in the cleared soil could be higher than in the uncleared soil **ACCEPT** introductory statement ' No it is not'.
8	(b)	(iii)	number / abundance , of earthworms varies , from year to year / from 2004 to 2006 / over the two years / over time ; number / abundance , of earthworms varies , before and after plant clearance / as vegetation changes / during succession ;	2	**Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** **ACCEPT** change described e.g. more worms in 2006 than 2004 If neither mark point awarded **ACCEPT** numbers of earthworms constantly , changing / fluctuating for **1 mark**
			Total	**9**	

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OCR
RECOGNISING ACHIEVEMENT

Friday 15 June 2012 – Morning

A2 GCE BIOLOGY

F215 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

F215

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of 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 page 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 **24** pages. Any blank pages are indicated.

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Turn over

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Answer **all** the questions.

1 This question is about the evolution, genetics, behaviour and physiology of cats.

Fig. 1.1 **(on the insert)** shows a Scottish wildcat, *Felis sylvestris*.

Modern domestic cats evolved from a wild ancestor of similar appearance to the Scottish wildcat.

Fig. 1.2 **(also on the insert)** shows a breed of domestic cat, *Felis cattus*. This breed is called the Colourpoint Persian cat.

(a) State **two** phenotypic differences between the Scottish wildcat in Fig. 1.1 and the Colourpoint Persian cat in Fig. 1.2.

.....

.....

.....

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

(b) Name the process that:

(i) has given rise to the modern domestic cat from its wild ancestor

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

(ii) has given rise to coat colour variation in cats.

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

(c) In Colourpoint Persian cats, interaction between two genes, **B**/**b** and **D**/**d**, causes the colour of the face, ears, paws and tail.

The dominant allele, **B**, gives a dark brown colour, known as 'seal'.
The recessive allele, **b**, gives a light brown colour, known as 'chocolate'.

The dominant allele, **D**, has no effect on coat colour.
However, the presence of two copies of the recessive allele, **d**, changes the colour 'seal' to a colour known as 'blue', and 'chocolate' to a colour known as 'lilac'.

(i) State the name given to this type of genetic interaction.

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

(ii) Suggest the possible **genotypes** of a 'seal' Colourpoint Persian cat.

....

[4]

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(iii) A 'lilac' Colourpoint Persian cat is homozygous at both the **B**/**b** and the **D**/**d** gene locus.

What is meant by the terms **homozygous** and **gene locus**?

homozygous

.....

.....

.....

gene locus

.....

.....

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

(iv) A cross was carried out between a 'seal' cat and a 'lilac' Colourpoint Persian cat. A Punnett square of the expected genotypes of the offspring of this cross is shown in Table 1.1.

Table 1.1

gametes	**BD**	**Bd**	**bD**	**bd**
bd	BbDd	Bbdd	bbDd	bbdd

Use Table 1.1 to state the **phenotypes** of the offspring and to predict the **phenotypic ratio**.

phenotypes

.....

phenotypic ratio

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

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(d) Breeders of Colourpoint Persian cats are advised to be present at the birth of the kittens. In this breed, the mother cat may not perform essential maternal behaviour such as licking the newborn kitten to free it from its amniotic sac (the membrane surrounding it at birth).

Wildcat mothers, even when they are first-time mothers, perform this behaviour naturally.

(i) State the type of behaviour shown by these wildcat mothers.

Give **one** characteristic of this type of behaviour.

type of behaviour .....

characteristic .....

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

(ii) Over time, the frequency of domestic cat mothers who perform essential maternal behaviour, such as licking the newborn kitten, has decreased.

Suggest and explain a reason for this change in frequency over time.

.....

.....

.....

.....

.....

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

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(e) Breeding pedigree cats, such as Colourpoint Persian cats, may involve crossing closely related individuals in order to obtain desirable characteristics.

Physiological problems are more common in pedigree animals than in wild animals.

(i) Suggest why physiological problems are more common in pedigree animals.

.....

.....

.....

.....

.....

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

(ii) An example of a physiological problem in Colourpoint Persian cats is that some of them cannot digest lactose sugar in milk. These cats can be fed lactose-reduced milk which is made by a biotechnological process using immobilised lactase enzyme.

State **two** methods of immobilising an enzyme.

.....

.....

.....

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

[Total: 21]

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2 Fig. 2.1 is an electron micrograph showing a longitudinal section of contracted striated muscle.

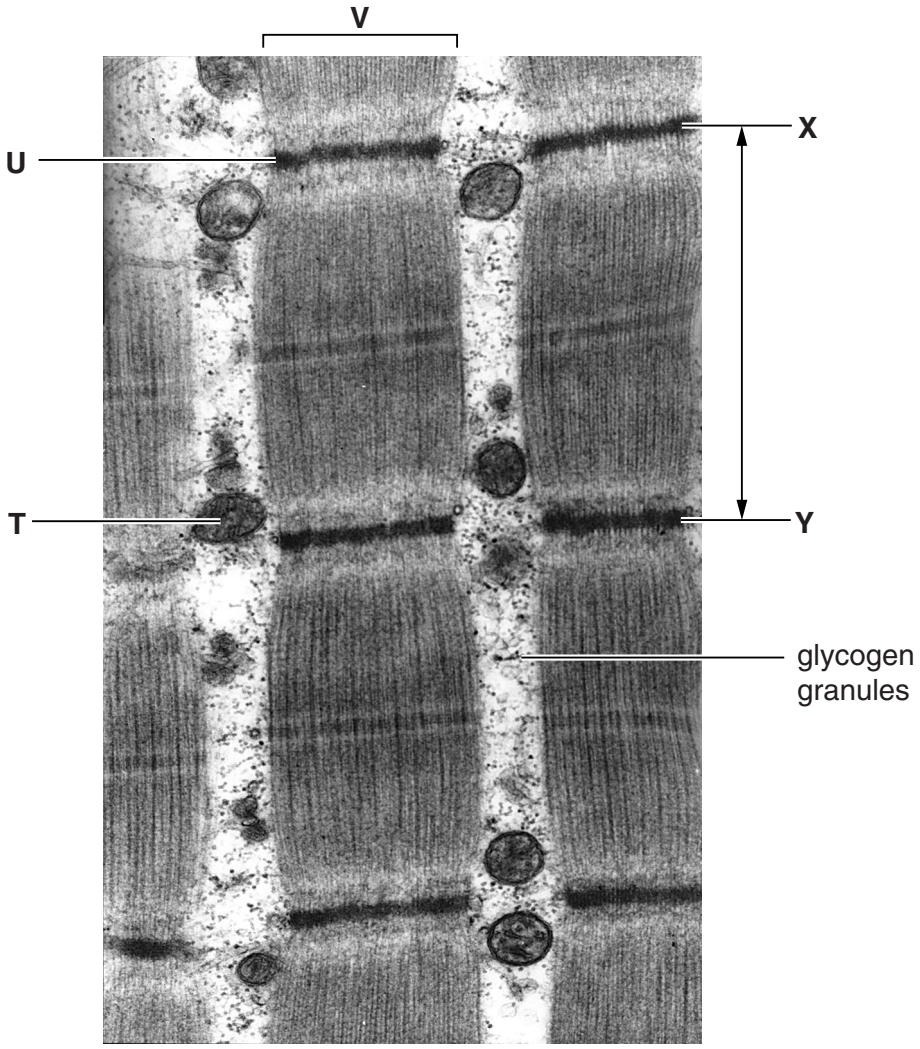


Fig. 2.1

(a) (i) Using Fig. 2.1, identify **T**, **U** and **V**.

T .....

U .....

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

(ii) Using Fig. 2.1, name the structure between positions **X** and **Y**.

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

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(iii) Explain why glycogen granules are present in striated muscle.

.....

.....

.....

.....

.....

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

(iv) Calculate the actual distance between positions **X** and **Y** on Fig. 2.1.

Show your working. **Give your answer to the nearest 0.1 of a micrometre (μm).**

Answer = ... μm **[2]**

(b) Fig. 2.2 below shows the arrangement of thick and thin filaments in striated muscle.

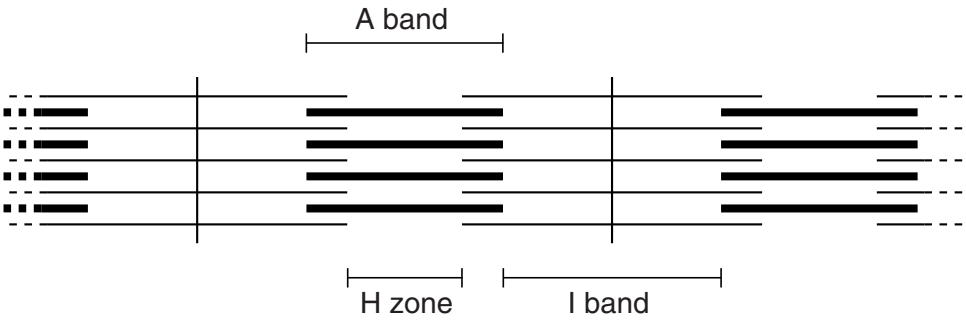


Fig. 2.2

State what happens to the lengths of the following when muscle contracts:

A band .....

H zone .....

I band ..... **[3]**

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(c) During strenuous exercise, the concentration of hydrogen ions in muscle tissue increases. A high concentration of hydrogen ions reduces the ability of calcium ions to bind to proteins in the myofibrils. This reduces the force with which a muscle can contract.

Use this information and your own knowledge of the proteins in muscle cells to explain how an increased concentration of hydrogen ions leads to a reduction in the force of contraction of a muscle.



In your answer you should make clear the link between the increased concentration of hydrogen ions and the reduction in the force of contraction of a muscle.

.....

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.....

..... **[6]**

[Total: 17]

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3 Transgenic goats, containing a gene from a spider that codes for spider web silk protein, have been produced by genetic modification. The silk protein can be harvested from the milk of the female transgenic goats.

Spider silk protein is lightweight but has very high tensile strength. It is used to make items such as bullet-proof vests.

(a) A vector containing recombinant DNA is needed to produce transgenic goats.

Define the term *recombinant DNA*.

.....

.....

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

(b) Complete Table 3.1 by suggesting **one** example of a suitable vector for each of the following applications of genetic modification.

Table 3.1

application of genetic modification	suitable vector
goats making spider silk protein	
somatic gene therapy for a recessive human genetic disorder	
plants that express a bacterial toxin that kills insects feeding on them	
bacteria that produce a human protein for therapeutic use	

[4]

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(c) In order to make spider silk protein on a commercial basis, many transgenic goats will be needed.

Outline the process by which an animal, such as the first transgenic goat, may be cloned to produce a population.

.....

.....

.....

.....

.....

.....

.....

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.....

.....

..... **[5]**

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(d) An alternative method for producing a population of more transgenic goats is to breed the transgenic goat with normal goats.

Discuss the advantages **and** disadvantages of cloning the transgenic goat compared with breeding the transgenic goat with normal goats.

advantages .....

.....

.....

.....

.....

.....

.....

disadvantages.....

.....

.....

.....

.....

.....

..... **[5]**

[Total: 15]

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4 **(a)** Microorganisms include fungi and bacteria. Fungi are eukaryotes. Bacteria are prokaryotes.

Describe **one** distinctive feature of the cell structure of each of these microorganisms.

fungal cell .....

.....

bacterial cell .....

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

(b) The use of microorganisms in biotechnology involves aseptic technique. Aseptic technique prevents pathogens contaminating products.

What is meant by the term pathogen?

.....

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

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(c) State what is meant by biotechnology using suitable examples from different areas of biotechnology **and** explain why microorganisms are used in biotechnological processes.

In your answer you should give examples of products and the microorganisms used to make them, as well as the advantages of using microorganisms.

.... **[8]**

[Total: 11]

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5 Peat bogs are large areas of waterlogged land that support a specialised community of plants. Peat bogs take thousands of years to form.

Fig. 5.1 lists the main stages in the formation of a peat bog.

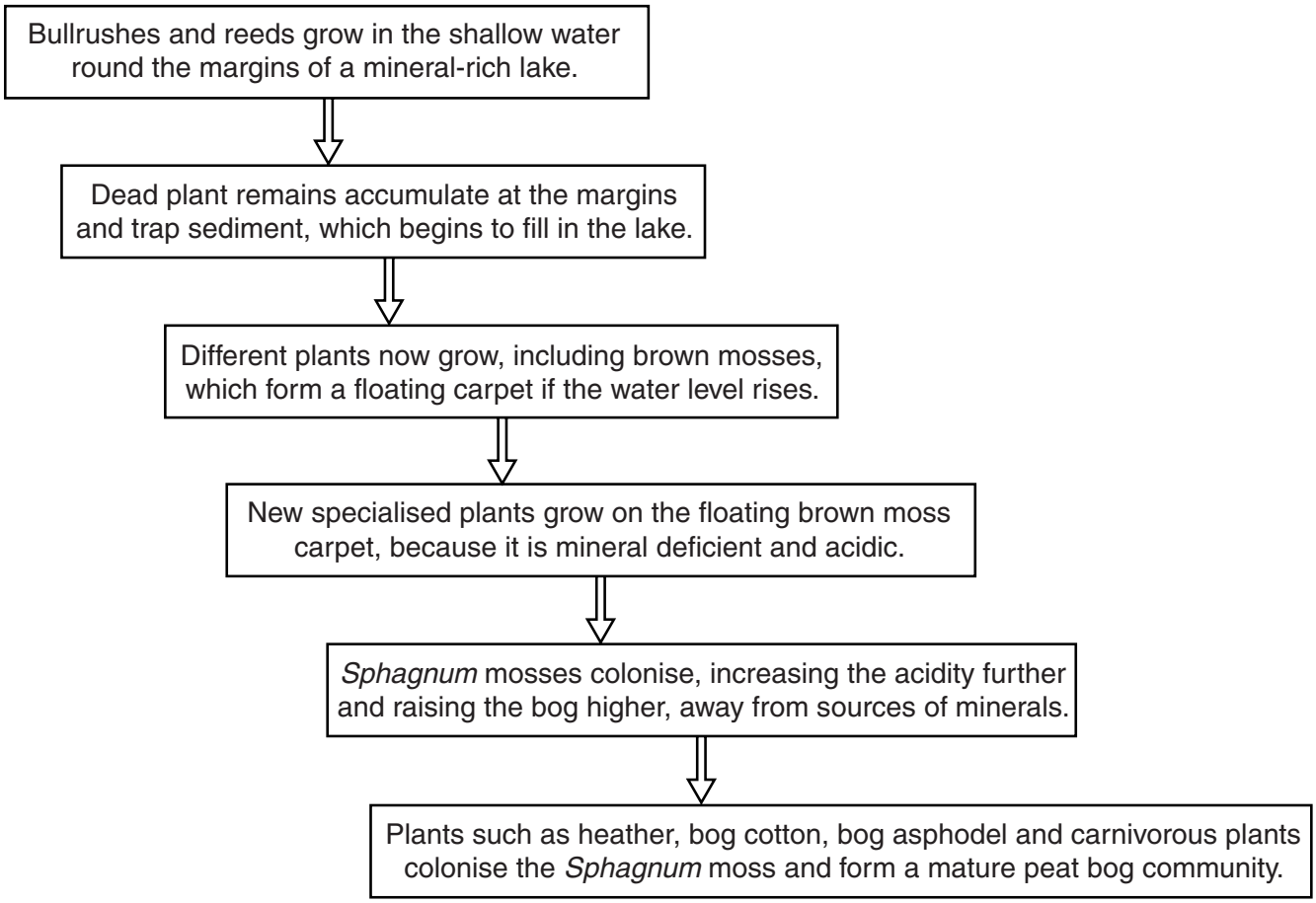


Fig. 5.1

(a) (i) Name the process summarised in Fig. 5.1 that changes a lake community into a peat bog community.

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

(ii) Using Fig. 5.1, list **two abiotic** factors that play a role in determining what species of plant can grow in an area.

1 .....

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

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(b) Most of the minerals in a peat bog are held within the living plants at all times, **not** in the soil.

- Plants like bog cotton and bog asphodel recycle the minerals they contain.
- The leaves of these plants turn orange as the chlorophyll within them is broken down.
- Minerals such as magnesium ions are transported from the leaves to the plants' roots for storage.

Describe **one** similarity and **two** differences in mineral recycling in a peat bog and in a **deciduous forest**.

similarity .....

.....

differences .....

.....

.....

.....

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

QUESTION 5(c) STARTS ON PAGE 16

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(c) In Ireland in 2002, two well-preserved Iron Age human bodies were found in peat bogs. Despite having been dead for over two thousand years, the bodies had not decomposed. They still had skin, hair and muscle.

Suggest why these bodies had not decomposed.

.....

.....

.....

.....

.....

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

(d) Suggest **two** reasons why the large scale removal of peat from bogs for use in gardens is discouraged by conservation groups.

.....

.....

.....

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

[Total: 10]

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6 **(a)** Great tits, *Parus major*, are birds that form male-female pairs. The male of each pair then establishes an area of territory, which he defends against other great tits by singing and threat displays.

The birds build a nest within the territory in which the eggs are laid and young chicks are reared. Weasels, *Mustela nivalis*, are predators which eat eggs and young chicks.

Fig. 6.1 shows how the territory size of great tits affects the risk of nest predation by weasels.

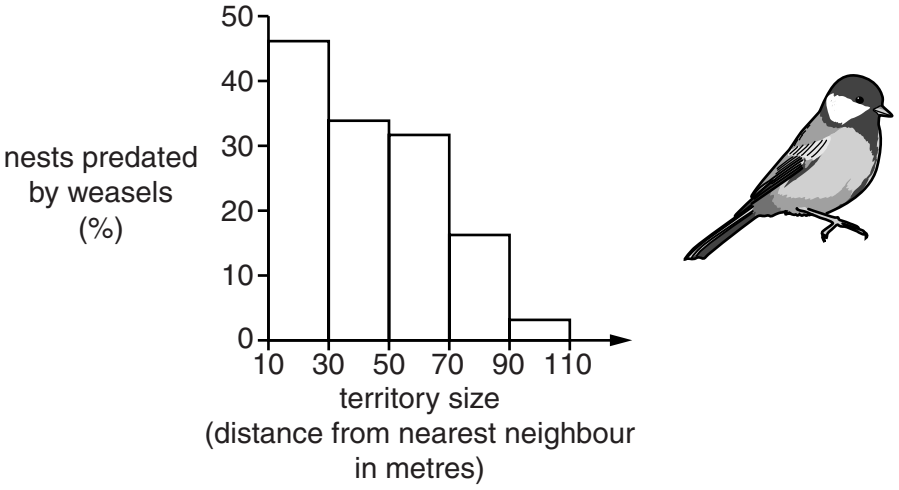


Fig. 6.1

(i) Describe the relationship shown in Fig. 6.1.

.....

.....

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

(ii) Suggest and explain what effect weasels may have on the population size of the great tit.

.....

.....

.....

.....

.....

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

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(b) The ochre starfish, *Pisaster ochraceus*, is a starfish that lives on rocky intertidal shores. It is the top predator in its habitat.

Fig. 6.2 shows part of the food web for this starfish.

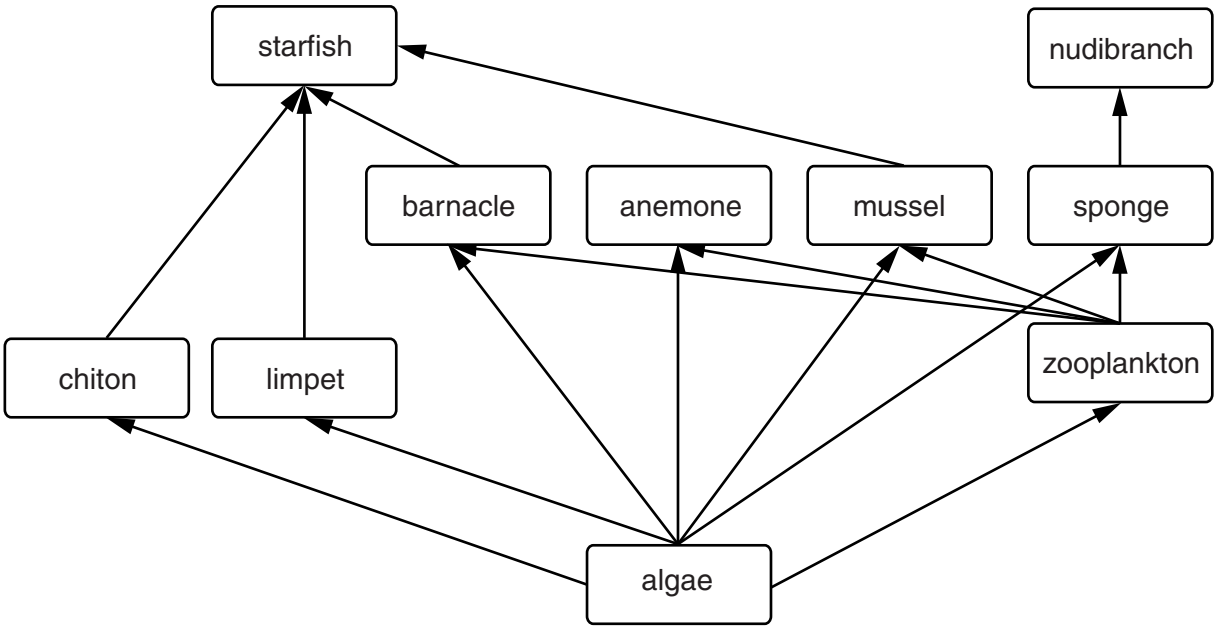


Fig. 6.2

An experiment was carried out in which all the starfish were removed from an 8 m × 2 m area of the shore. In an equivalent area of the same size, the starfish were not removed.

The population sizes of the other organisms in the food web were monitored at intervals. It was found that in the area in which starfish were removed:

- chitons and limpets disappeared
- anemones, sponges and nudibranchs decreased in abundance.

(i) Explain why two areas of the same size were monitored.

.....

.....

.....

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

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(ii) Using Fig. 6.2, explain why the chitons and limpets disappeared in the area from which starfish were removed.

.....

.....

.....

.....

.....

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

(iii) Using Fig. 6.2, suggest the sequence of events that led to the decrease in abundance in nudibranchs in the area from which starfish were removed.

.....

.....

.....

.....

.....

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

[Total: 9]

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7 **(a)** Fig. 7.1 shows a suggested evolutionary relationship between bears, raccoons and the two species of panda, the giant panda, *Ailuropoda melanoleuca*, and the red panda, *Ailurus fulgens*.

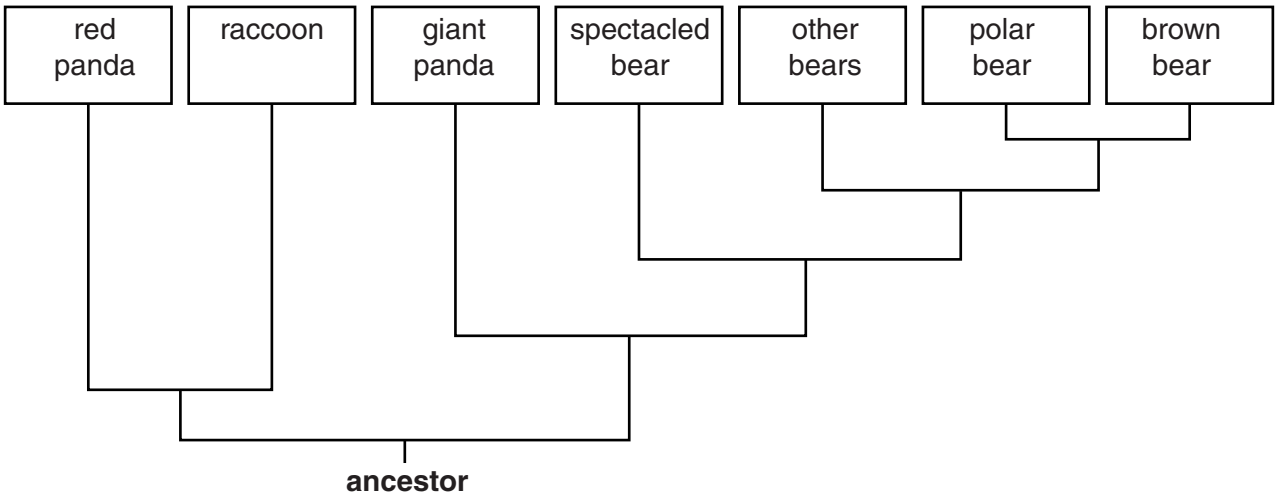


Fig. 7.1

(i) Using Fig. 7.1, name the **two** animals that share the most recent common ancestor.

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

(ii) State whether pandas form a distinct taxonomic group. Use information from Fig. 7.1 to justify your answer.

.....

.....

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

(b) The evolutionary relationship of the giant panda and red panda has been a matter of scientific debate for many years. It was hoped that molecular evidence would provide a definite answer. Some of the results of scientific studies are listed in Table 7.1.

Table 7.1

year	protein sequenced	conclusion
1985	albumen	Giant panda is more closely related to bears, and red panda is more closely related to raccoons, than pandas are to each other.
1986	haemoglobin	Giant and red panda are more closely related to each other than the giant panda is to bears or the red panda is to raccoons.
1993	cytochrome c	Giant panda is more closely related to bears, and red panda is more closely related to raccoons, than pandas are to each other.

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(i) Comment on what the results in Table 7.1 show about the nature of scientific knowledge **and** the role of the scientific community in validating new knowledge.

.....

.....

.....

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

(ii) The roles of the three proteins sequenced in the studies shown in Table 7.1 are as follows:

- albumen carries molecules such as hormones in the blood
- haemoglobin carries oxygen in the blood
- cytochrome c plays a role in oxidative phosphorylation in mitochondria.

Both the giant and the red panda live in mountain habitats and are physiologically adapted to living at high altitude. Oxygen partial pressure is lower at high altitude than it is at sea level.

Explain how these facts could provide an argument for rejecting the conclusion of the 1986 study.

.....

.....

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.....

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

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(c) Research on another protein from the giant panda was carried out in 2008. This protein, called crystallin, is found in the lens of the eye, and has a sequence that has been highly conserved in all mammals.

The steps in the procedure used in the study are summarised in Fig. 7.2.

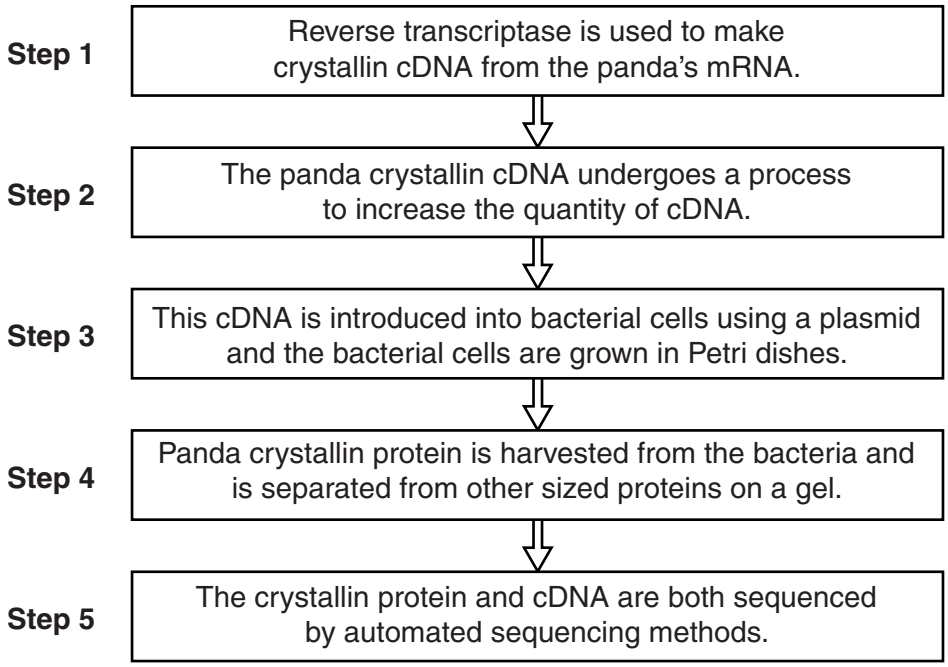


Fig. 7.2

Identify the **technique** used in each case to carry out steps **2**, **3** and **4**.

step **2** .....

step **3** .....

step **4** ..... **[3]**

(d) The panda crystallin protein obtained was 175 amino acids long, corresponding to a 528 base pair cDNA gene.

Explain why a protein that is 175 amino acids long is coded for by 528 base pairs of DNA.

.....

.....

.....

.....

.....

.....

.....

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

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(e) The crystallin protein and cDNA sequences of the giant panda were compared with those of three other mammals.

The results are shown in Table 7.2.

Table 7.2

	percentage of sequence that is the **same** in the giant panda and other mammal	
mammal	nucleotides in cDNA	amino acids in protein
human	93.9	98.3
mouse	91.5	97.1
ox	95.3	99.4

(i) Using the data in Table 7.2, name the mammal that is the closest relative of the giant panda.

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

(ii) Explain why the figures in Table 7.2 are higher for the protein sequences than for the cDNA sequences.

.....

.....

.....

.....

.....

.....

.....

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

[Total: 17]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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

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RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE

Unit **F215:** Control, Genomes and Environment

Mark Scheme for June 2012

Oxford Cambridge and RSA Examinations

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Annotations

Annotation	Meaning
	Correct answer
	Incorrect response
	Benefit of Doubt
	Not Benefit of Doubt
	Error Carried Forward
	Given mark
	Underline (for ambiguous/contradictory wording)
	Omission mark
	Ignore
	Correct response (for a QWC question)
	QWC* mark awarded
	First Answer

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Subject-specific Marking Instructions

FA in guidance column means**: Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks.** Apply the same reasoning where the instruction is to mark the first 2 suggestions.

ACCEPT incorrect spellings if they are recognisable **and also** sound the same when pronounced. This **includes** underlined words. If a wrong spelling does not pass these two criteria, read on and **IGNORE** it.
Example - in 1 (a) describing fur pattern, **ACCEPT** "wildcat is stryped" but **IGNORE** "wildcat is stripped" and read on in case other information about fur colour or pattern does get the mark. Similarly **IGNORE** "absorption" in 1 (e) (ii) but read on in case correct description (of adsorption) is given.

CREDIT AW FOR ALL, i.e., credit any alternatively worded statement that conveys the same sense as the mark point. If a particular word or term is essential and no other will do it is underlined.

IGNORE additional vague information or statements that are incorrect but irrelevant, and read on as if this information was not there, unless it **directly contradicts a listed mark point,** in which case the wrong 'statement' contradicts the right one, and negates the mark (use annotation **CON**). The exception to this rule is if the instruction is **FA** or **Mark first 2 answers.**

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Question			Answer	Mark	Guidance
1	(a)		*a **difference** is stated relating to* fur length ; pattern / colour, of fur ; eye colour ; temperament / tameness ; face shape ;	max 2	**Mark the first 2 suggestions (see point 12 above)** For **each** mark point **CREDIT** ***EITHER*** a paired comparison referring to **both** cats and identifying which has which feature, e.g. "the wildcat has green eyes and the Persian has blue" but allow top / bottom, Fig. 1.1 / 1.2, first and second cat, etc, as identifiers, ***OR*** a reference to only one cat but using a **comparative** adjective ending in '-er' such as "**shorter** fur on wildcat", "second one looks **tamer**" or "second one is **more** tame", or, conversely, "wildcat looks **less** fierce". **IGNORE** use of the word different. e.g. "they have different coloured fur" if there is no further statement about how they differ. **IGNORE** answers that do not attempt to describe a difference at all, e.g. "fur length". **IGNORE** albino

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Question			Answer	Mark	Guidance
	(b)	(i)	selective breeding / artificial selection ;	1	**FA (see guidance on page 2)** **IGNORE** evolution **DO NOT CREDIT** natural selection or speciation
		(ii)	(named type of) mutation / production of new alleles ; sexual reproduction / meiosis / independent assortment / crossing-over ;	1	**FA** **ACCEPT** substitution / insertion / base deletion / gene mutation / random mutation as named types of mutation **DO NOT ACCEPT** chromosome mutation, discontinuous variation
	(c)	(i)	(recessive) epistasis ;	1	**FA** **DO NOT ACCEPT** dominant epistasis or codominance
		(ii)	**BBDD ;** **BBDd ;** **BbDD ;** **BbDd ;**	4	**CREDIT** answers written in any order but look for and tick off answers in the order given
		(iii)	*homozygous* (individual / cat / genotype with) 2 identical, alleles / version of the gene / forms of the gene ; *gene locus* position / place / location, of, gene / allele, on chromosome ;	1 1	**ACCEPT** both, pair or idea of (same on) each for 2 idea **ACCEPT** same for identical and **CREDIT** description such as "both alleles either recessive or dominant" **DO NOT CREDIT** *genes* for alleles **DO NOT CREDIT** *similar* for identical or same **CREDIT** "where / whereabouts the gene is on the chromosome" **CREDIT** DNA molecule for chromosome and **ACCEPT** DNA strand

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Question			Answers	Mark	Guidance
		(iv)	seal : blue : chocolate : lilac **;** 1 : 1 : 1 : 1 **;**	2	**IGNORE** absence of colons (:) **CREDIT** phenotypes all correct in any order **ACCEPT** dark brown for seal **ACCEPT** light brown for chocolate **ACCEPT** ratio of 1 : 1 : 1 : 1 as stand alone mark, even if only one, two or three colours stated for phenotypes **DO NOT CREDIT** fractions, percentages or decimals **CREDIT** ecf for ratio **only** if four colours stated e.g. "seal, lilac, chocolate, chocolate" (no mark) followed by ecf "1:1:2"
	(d)	(i)	*type of behaviour* innate / instinct(ive) / reflex **;** *characteristic* automatic **;** stereotyped / always performed in the same way **;** no previous experience necessary / not learned **;** genetic(ally programmed) / AW **;**	1 max 1	**FA for each prompt line** **IGNORE** maternal (as given in question) **IGNORE** instinctive in characteristic section **ACCEPT** same in all members of the species **ACCEPT** unlearned, not taught **ACCEPT** inherited

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td></td><td></td><td>(ii)</td><td>1 whether kittens, survive / breed ;

2 whether <u>alleles</u>, change in frequency / passed on / kept ;

3 correct reference to selection / how selection acts ;

4 AVP ;

5 AVP ;</td><td>max 2</td><td>Markpoints 1–3 are linked within 4 possible contexts. ‘It’ refers to good mothering behaviour in the domestic environment (with people helping at the birth of kittens). Or candidates might say what would happen to the good behaviour patterns in the wild. Alternatively, the answer might focus on bad mothering behaviour (not licking the kittens), in either environment.
<table>
<tr><th></th><th>domestic</th><th>in the wild</th></tr>
<tr><td>good mothering</td><td>1 kittens do, survive / breed

2 alleles not necessarily, passed on / kept

3 not selected for</td><td>1 kittens do, survive / breed

2 alleles, increase / passed on / kept

3 selected for</td></tr>
<tr><td>bad mothering</td><td>1 kittens do, (still) survive / breed

2 alleles, increase / passed on / kept

3 not selected against</td><td>1 kittens do not, survive / breed

2 alleles, decrease or alleles not, passed on / kept

3 selected against</td></tr>
</table>
e.g. linkage (4) of poor mother, genes / alleles, with desirable alleles selected for in domestic cats (5)
OR
<u>genetic drift</u> (4) in small population (5)
OR
pleiotropic / multi-effect genes (4) with a desirable effect and this side effect (5)</td></tr>
</table>

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Question			Answer	Mark	Guidance
1	(e)	(i)	**1** inbreeding **/** small or decreasing, gene pool **;** **2** homozygous recessive (genotypes) **;** **3** gene / allele **,** for desired characteristic on same chromosome as problem, gene / allele **;** **4** selecting for one trait (unintentionally) selects for another **;** **5** breeders select for looks not health **;** **6** weaker selection against less healthy animals (than in wild) **;**	max 2	**ACCEPT** decreasing genetic variation **IGNORE** interbreeding **CREDIT** good and bad genes, linked / show linkage
		(ii)	**1** entrapment / alginate beads / cellulose network **;** **2** a**d**sorption / carrier bound **or** stuck to **,** porous carbon / clay / resin / glass **;** **3** covalent bonding **or** cross-linking enzymes to each other and to clay (using glutaraldehyde) **;** **4** membrane separation **or** enzyme and substrate either side of partially permeable membrane **;**	max 2	**Mark the first 2 answers** **ACCEPT** encapsulation, inclusion **IGNORE** a**b**sorption
			Total	**21**	

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Question			Answer	Mark	Guidance
2	(a)	(i)	**T** mitochondrion / mitochondria **;** **U** Z line **;** **V** myofibril**;**	3	**FA** for each line **ACCEPT** nucleus **CREDIT** zwischenscheibe line **CREDIT** myofilaments **ACCEPT** actin **and** myosin
		(ii)	sarcomere **;**	1	**FA** **DO NOT CREDIT** '*sacromere*' (section 12 spelling rules apply)
		(iii)	energy storage **;** hydrolyses / breaks down **,** to glucose **;** (glucose / glycogen, for) respiration / to make ATP **;** glycogen insoluble / glucose would exert osmotic effect **;**	max 2	**IGNORE** just 'provides energy' or source **ACCEPT** converted to glucose, provides glucose
		(iv)	1.2 / 1.3 **; ;**	2	**Correct answer = 2 marks** If answer is incorrect then **ALLOW 1 mark** for correct working - 52 mm **or** 52 000 µm **or** 5.2 cm ÷ 42 000 If answer is not correctly rounded to 1dp **ALLOW 1 mark** for unrounded answers, e.g.for 52 mm - 1.238095 **or** 1.23 **ACCEPT** measurements in range 51–53 mm and corresponding unrounded figures - 1.21428 or 1.21 or 1.261904 **or** 1.26

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Question			Answer	Mark	Guidance
2	(b)		*A band* stays the same / no change **;** *H zone* decreases / shorter / smaller **;** *I band* decreases / shorter / smaller **;**	3	**ACCEPT** disappears
	(c)		**1** (***fewer***) Ca^{2+} / calcium ions, bind to troponin **;** **2** (***fewer***) troponin (proteins) change shape **;** **3** (***fewer***) tropomyosin (proteins) move aside **;** **4** (***fewer***) binding sites on actin available **;** **5** (***fewer*** actin-myosin) cross bridges / links, form / AW **;** **6** power stroke ***reduced*** / AW **;** **7** actin filaments pulled past myosin with ***less*** force **;** **8** ref. pH and denaturing of proteins **;** **QWC** – at least **two** given mark points also indicate idea in bold italics **;**	max 5 1	'Fewer' not needed to award mps 1 to 5 but is required twice for QWC. **ACCEPT** less / decreased for 'fewer'. **ACCEPT** mps 1-5 if event described said not to occur at all but don't award QWC green spot for this. **1 IGNORE** 'reduced ability of Ca^{2+} to bind' for QWC **2** "Troponin does not change shape as much" gets mp 2 but not QWC **4 ACCEPT** thin filament for actin **ACCEPT** actin-myosin binding sites or binding sites for myosin heads, available / exposed **6 IGNORE** reduction in force of contraction **DO NOT ACCEPT** fewer power strokes **7 IGNORE** reduction in force of contraction **8 ACCEPT** description e.g. "H^+ changes protein's 3D structure" and allow reference to enzyme or to ATPase
			Total	**17**	

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Mark</th><th>Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td>DNA (combined) from (two) , sources / organisms ;</td><td>1</td><td>ACCEPT DNA, contains / has inserted in it, DNA or gene from, other / another, organism / species
ACCEPT foreign for idea of other source</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><th>application of genetic modification</th><th>vector</th><th></th></tr>
<tr><td>goats making spider silk protein</td><td>BAC /
YAC /
virus /
liposome</td><td>;</td></tr>
<tr><td>somatic gene therapy for a recessive human genetic disorder</td><td>virus /
liposome</td><td>;</td></tr>
<tr><td>plants that express a bacterial toxin that kills insects feeding on them</td><td>Agrobacterium tumefaciens/
(Ti) plasmid /
liposome</td><td>;</td></tr>
<tr><td>bacteria that produce a human protein for therapeutic use</td><td>BAC /
(bacterio)phage /
plasmid</td><td>;</td></tr>
</table>
</td><td>4</td><td>FA in each box

DO NOT CREDIT microinjection / electroporation / gene gun (as they are not vectors)

IGNORE tumour forming bacterium</td></tr>
</table>

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Question			Answer	Mark	Guidance
3	(c)		**1** somatic / adult, cell / nucleus **;** **2** fused with / injected into **;** **3** empty / enucleate **,** egg cell **;** **4** from another goat **;** **5** *idea of* electric shock / electrostimulation **;** **6** this cell or embryo, grown on **,** in vitro / in tied oviduct **;** **7** (early) embryo / blastocyst **,** split **;** **8** *idea that* embryos replaced in **,** surrogate mothers / other females **;** **9** AVP **;**	max 5	**1 ACCEPT** differentiated or body cell or example, e.g. skin cell, udder cell **2 ACCEPT** inserted / placed. If term use is "electrofused" gets mp 2 and mp 5 **4 ACCEPT** named (A, B) or numbered goats **5** "electrofused" gets mp 2 and mp 5 **6 ACCEPT** in petri dish / test tube culture **7 ACCEPT** description of an embryo being split, even if produced by wrong method (IVF) **8 IGNORE** host mothers **9** e.g. further detail of any stage of process correct ref. to haploid / diploid **,** nuclei

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Question			Answer	Mark	Guidance
3	(d)		*advantages* **A1** all offspring will inherit the, (silk) gene / foreign DNA **;** **A2** all offspring female **;** **A3** certain / all make **,** silk / milk / product **;** **A4** faster / many obtained in a short time **;** **A5** avoid mating risks **;** **max 3 advantages** *disadvantages* **D1** no genetic variability (in population) / AW **;** **D2** (so makes goats) more susceptible to**,** environmental factors / (infectious) disease **;** **D3** cloned animals may, have shorter life spans / be less healthy **;** **D4** *idea that* cloning success rate is very poor **;** **D5** (more) expensive / needs (more) technology / (more) labour intensive **;** **max 3 disadvantages**	5 max	**IGNORE** disadvantages of breeding given in the first (advantages of cloning) section, i.e. **DO NOT CREDIT** reverse arguments **A5 ACCEPT** idea of physical damage or disease transfer **IGNORE** advantages of breeding given in the second (disadvantages of cloning) section, i.e. **DO NOT CREDIT** reverse arguments **D1 ACCEPT** they are all genetically identical **D2 IGNORE** disease if stated to be genetic
			Total	**15**	

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Question			Answer	Mark	Guidance
4	(a)				**FA for each microorganism** **IGNORE** prokaryotic / eukaryotic (as given in question)
			fungal long cells / hyphae OR multinucleate OR chitin cell wall **;**	1	
			bacterial free DNA / DNA not in a nucleus OR circular DNA (molecule) OR naked DNA / no histones OR peptidoglycan / murein, cell wall OR smaller / 70S / 18nm, ribosomes **;**	1	**ACCEPT** no nucleus / nuclear envelope **IGNORE** loop, plasmids, nucleoid
	(b)		disease-causing (organism) **;**	1	**IGNORE** harmful, infection

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Question			Answer	Mark	Guidance
4	(c)		*What is biotechnology?* **1** large-scale / industrial / commercial use (of living organisms / enzymes) **;** **2** to produce **,** food / named example **;** **3** detail of **,** microbe / enzyme **,** involved **;** **4** to produce **,** drugs / named example **;** **5** detail of **,** microbe / enzyme **,** involved **;** **6** to make **,** (useful) enzymes / biogas / calcium citrate / for bioremediation / for water treatment / for microbial mining **;** *Advantages of microorganisms* **7** fast, growth / reproduction / products **;** **8** microbes can be genetically engineered **;** **9** processes occur at low **,** temperatures / pressures **;** **10** low **,** temp / pressure **,** cheaper / safer **,** to maintain **;** **11** products **,** pure / easy to separate **;** **12** grow on unwanted, food / nutrients **;** **13** AVP **;** **QWC** – balanced account **;**	7 max 1	**2** e.g. cheese / yogurt / beer / wine / cider / vinegar / soya sauce / mycoprotein / etc. **3** e.g. *Lactobacillus* / yeast / *Fusarium* / etc. **IGNORE** wrong kingdom **4** e.g. antibiotic / penicillin / augmentin / insulin **5** e.g. *Penicillium* **IGNORE** wrong kingdom **6** e.g. detergent enzymes, pectinase, sewage treatment, blue technology **8** **ACCEPT** in context of example mps **1 - 6** **10** **CREDIT** less energy used for low, temp /pressure **11** **ACCEPT** little downstream processing **12** **ACCEPT** named e.g. whey, starch waste. **13** e.g. no animal welfare issues Award QWC if 2 marks awarded from mps **1** – **6** **and** 2 marks awarded from mps **7** – **13**
			Total	**11**	

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Question			Answer	Mark	Guidance
5	(a)	(i)	succession ;	1	**FA** **IGNORE** primary / secondary
		(ii)	mineral content ; acidity / pH ; water depth;	2	**FA**
	(b)		*similarity* chlorophyll breaks down / leaves change colour ; *differences* (bog) minerals stay in plant / (forest) minerals in soil ; **ora** decomposers / fungi / bacteria , not, present / active in bog ; **ora for forest**	1 2	**FA for similarity** **Mark first two answers for differences** **ACCEPT** named mineral ions in words or correct symbols **ACCEPT** decomposers / fungi / bacteria, break down leaves in forest
	(c)		decomposers / named decomposers, not, present / active ; waterlogging reduces, air / oxygen ; acidity / low pH , stops (decay) enzymes working ;	2 max	**ACCEPT** (soil), bacteria / fungi / microbes can't survive or few can survive **CREDIT** waterlogging produces anaerobic conditions
	(d)		bog / habitat / ecosystem, takes a long time to form / hard to replace ; loss of, biodiversity / rare species ;	2	**ACCEPT** peat bogs maintain biodiversity
			Total	**10**	

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Question			Answer	Mark	Guidance
6	(a)	(i)	larger territory / greater distance between neighbours = lower predation ;	1	**ACCEPT** ora - smaller territory / smaller distance = higher predation **DO NOT CREDIT** descriptions wrong way round
		(ii)	**1** great tit numbers, oscillate / rise and fall ; **2** (weasel predation) helps keep great tit numbers stable ; **3** predation (by weasels) is density–dependent ;	2 max	**IGNORE** weasel population size **ACCEPT** keeps great tit numbers moderate
	(b)	(i)	*two areas* as a control / for comparison / to see the effect of removal of starfish ; *same size* to make test, valid / fair / unbiased ;	2	**IGNORE** reliable, precise, accurate **CREDIT** *'as a valid control'* = 2 marks
		(ii)	interspecific competition ; (competition from) , barnacles / mussels ; for, algae / space ; barnacles / mussels , no longer eaten by starfish ;	2 max	**IGNORE** intraspecific competition **ACCEPT** description e.g. barnacles / mussels, eat food of, limpets / chitons **IGNORE** food
		(iii)	sponges outcompeted (by , barnacles / mussels) ; less, prey / food / sponges, for nudibranchs to eat ; *idea of* specialist feeder ;	2 max	**IGNORE** *'sponge population decreases'* alone (as given in question) **CREDIT** nudibranchs **only** feed on sponges
			Total	**9**	

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Question			Answer	Mark	Guidance
7	(a)	(i)	polar **and** brown bear **;**	1	
		(ii)	*no because* one, more closely related to / in same group as **,** raccoons **and** one **,** to / with**,** bears / AW **;**	1 max	**DO NOT CREDIT** answer if in context of yes
	(b)	(i)	knowledge **,** tentative / uncertain / subject to change **;** to re-test / check, hypotheses / results **;**	2	**IGNORE** incomplete, new technology **IGNORE** to validate
		(ii)	**1** *idea that* haemoglobin could be **,** an adaptation (to the environment) / an adaptive feature **;** **2** *idea that* low oxygen partial pressure is selective agent **or** both subject to the same selection pressure **;** **3** (haemoglobin of both) has high oxygen affinity / dissociation curve shifted to left **;** **4** convergence / similarity not due to shared ancestry **;**	3 max	**3** **ACCEPT** haemoglobin can uptake O_2 at low partial pressure **4** **ACCEPT** description e.g. "changes happen to both independently" **IGNORE** "red and giant panda may not be closely related" (as given in question)

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Question			Answer	Mark	Guidance
	(c)		**step 2** PCR / polymerase chain reaction **;** **step 3** genetic modification / genetic engineering **;** **step 4** electrophoresis **;**	3	**FA on each line** **ACCEPT** gene cloning / transformation **ACCEPT** (gel) chromatography
	(d)		triplet code **or** 3 bases = 1 amino acid **;** 525 **;** 3 bases are **,** stop / (chain) termination **,** codon **;**	3	**DO NOT CREDIT** triplet makes amino acid
	(e)	(i)	ox **;**	1	**FA**
		(ii)	**1** genetic code is degenerate **;** **2** more than 1**,** triplet / codon**,** for same amino acid **;** **3** silent / neutral, mutations **;** **4** *idea that* DNA, changes more than / is more different to, protein **;**	3 max	**1** **ACCEPT** redundant **2** **DO NOT CREDIT** 'make' the same amino acid **4** **ACCEPT** polypeptide / amino acid sequence **ACCEPT** nucleotide sequence for DNA
			Total	**17**	

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Tuesday 31 January 2012 – Afternoon

A2 GCE BIOLOGY

F215 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

F215

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- The Insert will be found in the centre of 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 **24** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Fig. 1.1 shows a metabolic pathway involving the amino acid, phenylalanine. One of the products of this pathway is melanin, the pigment that gives a brown colour to hair, skin and the iris of the eyes. This metabolic pathway also produces thyroid hormones.

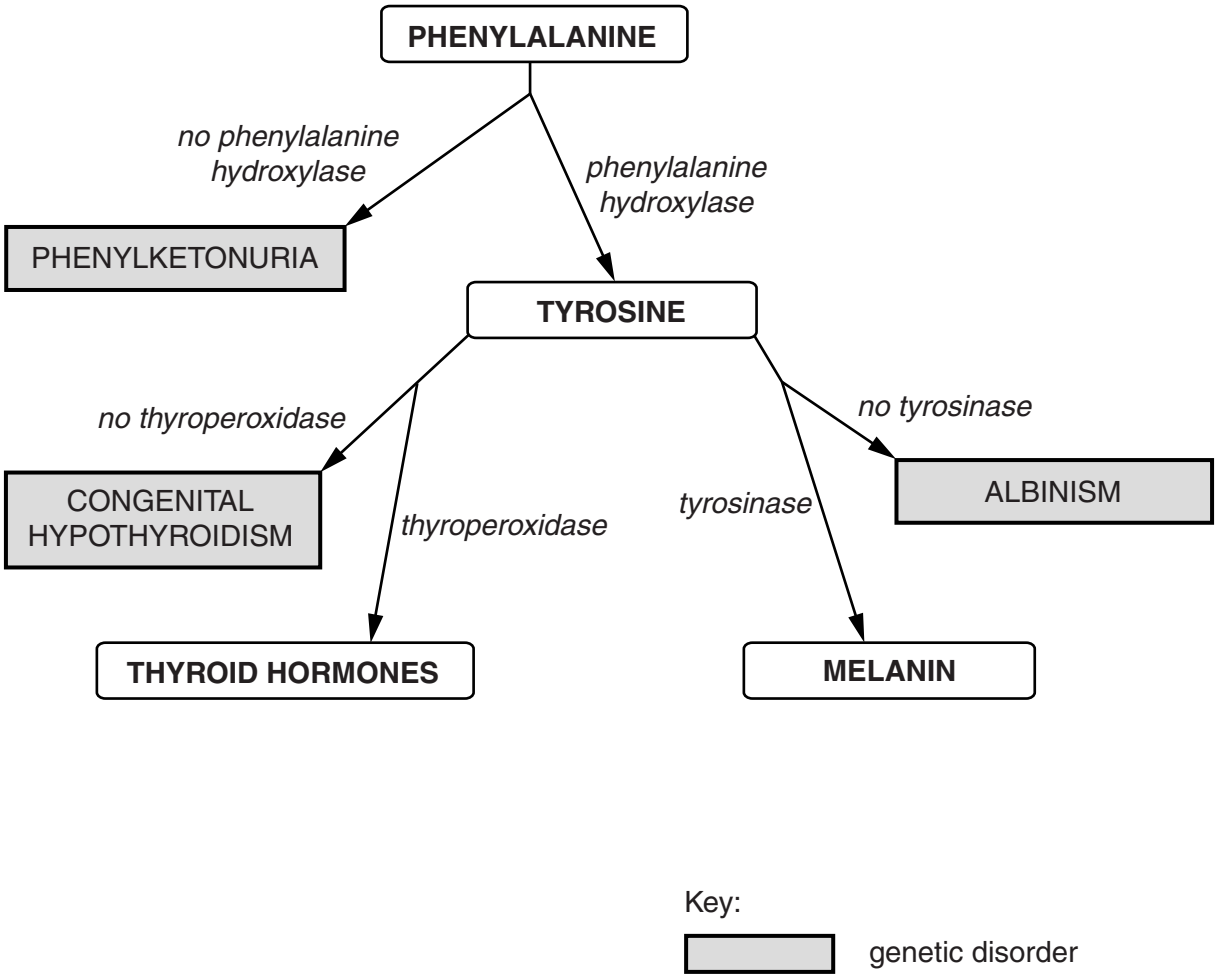


Fig. 1.1

(a) Use Fig. 1.1 to name:

(i) the **enzyme** that catalyses the last step in melanin production

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

(ii) the **genetic disorder** resulting from the absence of the enzyme at the start of the metabolic pathway for melanin production.

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

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(b) Phenylalanine and tyrosine are both amino acids.

Explain why phenylalanine and tyrosine are classified as amino acids.

.....

.....

.....

.....

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

(c) One effect of thyroid hormones is to increase the activity of mitochondria within cells. Suggest how the metabolism of a person with the condition congenital hypothyroidism might differ from that of a person who does not have this condition.

.....

.....

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

(d) Albinism is a genetic disorder in which a person lacks melanin pigment in their skin, hair and the iris of their eyes. A person with this disorder is called an albino. The genotype of an albino has two copies of a recessive allele of the gene for an enzyme involved in melanin production.

(i) State the term used to describe a genotype that has two copies of the same allele at a particular gene locus.

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

(ii) Explain what is meant by the following terms:

genotype .....

.....

.....

allele .....

.....

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

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(e) The Hardy-Weinberg principle can be used to predict the expected frequencies of albino and non-albino alleles in a population. However, this principle can only be applied to populations which fulfil all of the following criteria:

- sexually reproducing organisms
- diploid organisms
- large populations
- randomly-mating populations.

The tiger, an endangered species of mammal, is undergoing a worldwide captive breeding programme in zoos.

Suggest why the Hardy-Weinberg principle cannot be used to predict the expected frequencies of albino and non-albino alleles in the worldwide zoo population of tigers.

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

(f) A change in allele frequencies in a population is described as an evolutionary change.

List **two** factors that might cause allele frequencies to change from generation to generation in a population that meets the Hardy-Weinberg criteria.

.....

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

[Total: 16]

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QUESTION 2 STARTS ON PAGE 6

PLEASE DO NOT WRITE ON THIS PAGE

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2 Animals respond to frightening or stressful stimuli in their environment.

This question is about the 'fight or flight' response in mammals.

Fig. 2.1 (**on the insert**) shows a husky dog in a calm state.

Fig. 2.2 (**on the insert**) shows a different husky displaying external signs of the 'fight or flight' response.

(a) Describe **three** features in the external appearance of the husky in Fig. 2.2 that are due to the 'fight or flight' response.

1 .....

.....

2 .....

.....

3 .....

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

(b) The 'fight or flight' response is brought about by the hormone adrenaline and the autonomic nervous system working together. As well as causing external differences in appearance, the 'fight or flight' response causes numerous changes in the functioning of the internal organs.

Complete Table 2.1 to describe how **two** internal organs would function differently in a calm mammal compared to a frightened mammal.

Table 2.1

internal organ	calm mammal	frightened mammal

[6]

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(c) The differences you described in part **(b)** are coordinated by the **autonomic** nervous system. The autonomic nervous system has two divisions, each of which uses a different neurotransmitter to bring about effects in the internal organs.

In the table below, state which division of the autonomic nervous system will be active in each case, and name the **neurotransmitter** that will be secreted by neurones into the organs.

	calm mammal	frightened mammal
division of the autonomic nervous system activated		
name of neurotransmitter secreted by neurones		

[4]

(d) State precisely where in the body adrenaline is produced.

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

QUESTION 2(e) STARTS ON PAGE 8

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(e) The adrenaline molecule is not lipid-soluble, therefore it cannot pass directly through the cell surface membrane. In order to bring about changes inside the cell, adrenaline relies on a second messenger system.

(i) Describe the events that occur after adrenaline reaches the cell surface membrane that then result in changes in metabolism inside the cell cytoplasm.

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

(ii) The second messenger system is a multi-step mechanism. It enables large changes in cell metabolism to occur rapidly, although only relatively small numbers of adrenaline molecules are involved.

Suggest how having a number of steps in the signalling pathway enables a small number of adrenaline molecules to rapidly cause large effects.

.....

.....

.....

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

[Total: 21]

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QUESTION 3 STARTS ON PAGE 10

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3 **(a)** Organisms do not live in isolation, but interact with other organisms and with their physical environment.

State the word used to describe:

(i) the study of the interactions between organisms and their environment

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

(ii) the physical (non-living) factors in the environment

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

(iii) a physical area that includes all the organisms present **and** their interactions with each other **and** with the physical environment.

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

(b) State and describe **two types** of ecological interaction that can occur between different species in a habitat.

As part of each description, you should **name** the two species involved in your chosen example.

1 .....

.....

.....

.....

.....

2 .....

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..... **[6]**

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(c) Plants are able to respond to changes in their environment.

(i) Describe **two** ways in which hormones may alter a plant's growth in response to overcrowding by other plants.

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

(ii) Suggest how hormones alter a plant's growth if the top of the plant shoot is eaten by an animal.

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.....

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

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(d) The distribution and abundance of plants in a habitat can show how a physical factor varies across the habitat.

Describe how you would measure the distribution and abundance of plants over a distance of 100 metres.

In your answer you should make clear the sequence of procedures you would follow.

[6]

[Total: 22]

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4 **(a)** Genetic modification of organisms uses a "toolkit" that includes:

- enzymes that cut DNA
- enzymes that join sections of DNA together
- vectors that introduce DNA into new host cells.

Some of the enzymes and vectors that are important in genetic modification are given an identifying letter in Table 4.1.

Table 4.1

	enzymes
A	reverse transcriptase
B	DNA polymerase
C	DNA ligase
D	restriction endonuclease
E	RNA polymerase

	vectors
J	plasmid
K	virus
L	*Agrobacterium tumefaciens*
M	BAC
N	bacteriophage

Select **one** correct letter from Table 4.1 to fit each of the following statements.

An enzyme that cuts DNA .....

An enzyme that joins sections of DNA together .....

A vector to introduce foreign DNA into bacteria .....

A vector to introduce foreign DNA into plant cells .....

A vector to introduce foreign DNA into animal cells ..... **[5]**

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(b) Discuss the **potential benefits** to mankind and the **ethical concerns** raised by the following examples of genetically modified organisms:

- rice modified for increased vitamin A content (‘Golden Rice™’)
- humans having somatic gene therapy treatment for a genetic disease.

In your answer you should give a balanced account of the benefits and concerns for each example of genetic modification.

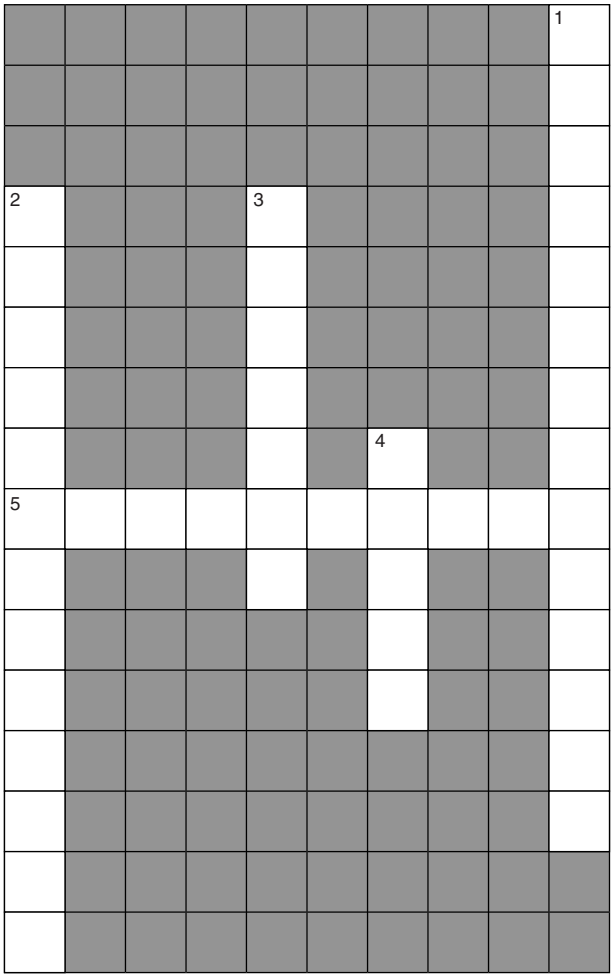
[9]

[Total: 14]

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5 Fig. 5.1 is a crossword that should contain five words relating to the use of microorganisms by humans.



[5]

Fig. 5.1

Use the clues below to write the five appropriate words in the correct spaces on Fig. 5.1.

ACROSS

5 Microbial culture method in which nutrients are added and the product harvested throughout the fermentation process.

DOWN

1 Technique that makes enzymes more thermostable and allows them to be re-used.

2 The industrial use of living organisms to produce food, drugs or other products.

3 Sterile technique that prevents the growth of undesirable microorganisms.

4 Kingdom of eukaryotic microorganisms with cell walls made of chitin.

[Total: 5]

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6 A long-term breeding experiment to investigate the **genetic** basis of tame (friendly) behaviour was carried out in a population of silver foxes. The foxes were bred each year and the resulting young foxes assessed each month between the ages of 1 and 8 months to see how tame they were.

Table 6.1 shows how the foxes were put into categories according to their tameness.

Table 6.1

tameness class	description of behaviour towards humans
3	Not tame – these foxes run away from humans or bite when handled.
2	Neutral – these foxes allow handling by humans but show no emotionally friendly response.
1	Tame – these foxes are friendly to humans. They wag their tails and whine for attention.
elite	Very tame – these foxes are eager for human contact. They whimper to attract attention and sniff and lick humans.

The tamest 5% of the male foxes and the tamest 20% of the female foxes in each generation were used for breeding to produce the next generation. This was repeated for over forty generations.

(a) (i) State the name given to the process in which only a certain percentage of adult foxes were chosen by humans to breed in each generation.

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

(ii) Suggest why 20% of the female foxes were used for breeding but only 5% of the male foxes.

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

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(b) Table 6.2 shows the number of foxes in the elite tameness class during the long-term experiment.

Table 6.2

number of generations	foxes in elite class (%)
10	18
20	35
35	75

Discuss what the results shown in Table 6.2 suggest about the **causes of the variation** in tameness behaviour in silver foxes.

.....

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

QUESTION 6(c) STARTS ON PAGE 18

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(c) As tameness increased in the silver fox population over the years, it was noticed that other phenotypic traits also became more common.

Table 6.3 compares the frequency of these traits in a control group of silver foxes that had not been used in this long-term breeding experiment and in the tame population of foxes.

Table 6.3

phenotypic trait	animals showing trait (per 100 000)		percentage increase in trait
	control population	tame population	
white patch of fur on head	710	12 400	1 646
floppy ears	170	230	35
short tail	2	140	6 900
curly tail	830	9 400	1 033

Students were asked to suggest a variety of genetic hypotheses to explain why these traits become more common in tame foxes. Their suggestions were:

linkage **epistasis** **inbreeding** **genetic drift**

Select **one** hypothesis from the list and explain how it could account for the data in Table 6.3.

.....

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.....

.....

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

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(d) Similar changes in tameness, colour and body shape are believed to have occurred in the 11 000 year period during which the grey wolf species, *Canis lupus*, evolved into the domesticated dog species, *Canis familiaris*.

Suggest how different types of isolating mechanism allowed dogs to evolve separately to wolves.

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

(e) Interbreeding between members of the wolf species and some dogs has been reported. However, there are some large breeds of dogs that cannot breed successfully with small dog breeds.

Use this information and your own knowledge to explain the problems of classifying wolves and different dog breeds according to:

- the biological species concept
  and
- the phylogenetic species concept.

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

[Total:15]

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7 Homeobox genes show astonishing similarity across widely different species of animal, from fruit flies, which are insects, to mice and humans, which are mammals. The sequences of these genes have remained relatively unchanged throughout evolutionary history and the same genes control embryonic development in flies and mammals.

(a) State what is meant by a homeobox gene.

.....

.....

.....

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

(b) Homeobox genes show 'astonishing similarity across widely different species of animal'.

Explain why there has been very little change by mutation in these genes.

.....

.....

.....

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

(c) Frogs reproduce by laying eggs in water. Each egg develops into a tadpole, which has external gills to extract oxygen from the water, and a tail to help it swim. The tadpole gradually changes into an adult frog as it grows. During this time its gills and tail disappear.

List **two** cellular processes that must occur during the development of a tadpole into a frog.

.....

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

(d) Name another kingdom of organisms, other than animals, that have similar homeotic genes.

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

[Total: 7]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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ADDITIONAL PAGE

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GCE

Biology

Advanced GCE

Unit **F215:** Control, Genomes and Environment

Mark Scheme for January 2012

Oxford Cambridge and RSA Examinations

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Annotations

Annotation	Meaning
/	alternative and acceptable answers for the same marking point
(1)	separates marking points
not	answers which are not worthy of credit
reject	answers which are not worthy of credit
ignore	statements which are irrelevant
allow	answers that can be accepted
( )	words which are not essential to gain credit
__	underlined words must be present in answer to score a mark
ecf	error carried forward
AW	alternative wording
ora	or reverse argument

Scoris Annotations

Annotation	Meaning
✓	correct response
×	incorrect response
bod	benefit of the doubt
nbod	benefit of the doubt **not** given
ECF	error carried forward
^	information omitted
I	ignore
R	reject

Highlighting is also available to highlight any particular points on the script.

The following questions should be annotated with ticks to show where marks have been awarded in the body of the text:	**2 (e) (i), 3 (c) (i), 3 (d), 4 (b), 6 (e)**

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1. The Comments box
   The comments box will be used by your PE to explain their marking of the practice scripts for your information. Please refer to these comments when checking your practice scripts.
   You should only type in the comments box yourself when you have an additional object of the type described in Appendix B of the Handbook for Assistant Examiners and Subject Markers.
   Please do not use the comments box for any other reason.
   Any questions or comments you have for your Team Leader should be communicated by phone, SCORIS messaging system or e-mail.

2. Please send a brief report on the performance of the candidates to your Team Leader (Supervisor) by the end of the marking period. The Assistant Examiner's Report Form (AERF) can be found on the Cambridge Assessment Support Portal. This should contain notes on particular strengths displayed, as well as common errors or weaknesses. Constructive criticisms of the question paper/mark scheme are also appreciated.

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Question			Answer	Marks	Guidance
1	(a)	(i)	tyrosinase ;	1	**First Answer (**Mark the **first answer**. If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = 0 marks)**.**
		(ii)	phenylketonuria / PKU ;	1	**Mark the First Answer**
	(b)		*both have an* amine / amino / NH_2 ; COOH / carboxyl / carboxylic ;	2	**DO NOT CREDIT** if formula given does not match name **DO NOT ACCEPT** ammonia, amide
	(c)		**1** low / less / no, thyroid hormones ; **2** less (aerobic) respiration ; **3** less, ATP produced / energy ; **4** slow(er) metabolism / low(er) (B)MR ; **5** low body temperature ; **6** AVP ;	3 max	**DO NOT CREDIT** no respiration / ATP eg sleep more, get tired quickly, poor muscle tone, mental retardation
	(d)	(i)	homozygous ;	1	**Mark the First Answer** **IGNORE** dominant / recessive
		(ii)	*genotype* combination of alleles ; possessed by organism ; *allele* alternative / mutant, form / version ; of, a gene ;	4	**ACCEPT** *idea of* **all** alleles or '**the**' alleles (suggesting all) **ACCEPT** *idea of* eg that a, person has / you have / of an individual / cell *'all my alleles'* = 2 marks **ACCEPT** altered, different (form / version) **CREDIT** DNA if qualified, eg at a locus / codes for X

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Question			Answer	Marks	Guidance
	(e)		population, not large / (too) small ; not randomly-mating / matings arranged ;	2	
	(f)		natural / artificial / directional, selection ; genetic drift ; mutation ; migration / AW ;	2 max	**Mark the first two suggestions only** **ACCEPT** selection pressure, selective breeding, selective advantage
			Total	**16**	

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(a)</td><td></td><td>husky in Fig. 2.2 has
ears, laid back / held low / not upright ;
pupils, dilated / bigger ;
different / tensed / lower, posture ;
hair (on neck) standing up / hackles raised ;
mouth open / showing teeth / teeth bared / snarling / tongue withdrawn ;
tail standing up / held high ;</td><td>3 max</td><td>CREDIT correct non-subjective visible differences wherever they appear (read as prose)
IGNORE causes

DO NOT CREDIT eyes dilated</td></tr>
<tr><td></td><td>(b)</td><td></td><td>
<table>
<tr><td>organ</td><td>calm mammal</td><td>frightened mammal</td></tr>
<tr><td>heart ;</td><td>rate slow / small force ;</td><td>rate fast / great force ;</td></tr>
<tr><td>lungs ;</td><td>breathing, slow / shallow ;</td><td>breathing, fast / deep ;</td></tr>
<tr><td>(skeletal) muscle / arteries to muscle ;</td><td>less, active / blood flow ;</td><td>more, active / blood flow ;</td></tr>
<tr><td>liver ;</td><td>glucose → glycogen / glucose taken up ;</td><td>glycogen → glucose / glucose released ;</td></tr>
<tr><td>gut / named part of gut ;</td><td>peristalsis / secretions / digestion / blood flow to gut, occurring ;</td><td>no / less, peristalsis / secretions / digestion / blood flow to gut ;</td></tr>
</table>
</td><td>6 max</td><td>CREDIT first correct answer per box if not contradicted later. No requirement for calm and frightened comments to be opposites.

IGNORE steady, regular, normal with respect to calm mammal
CREDIT reasonable figures for heart and breathing rates
CREDIT AW such as stroke volume, cardiac output (of heart), tidal volume, ventilation rate (of lungs).
ACCEPT named muscle(s)
ACCEPT ecf across table for structures that are not organs, eg bronchioles

CREDIT brain, bladder in first column for 1 mark

CREDIT arterioles constricted for less blood flow (context gut in frightened mammal)

CREDIT named secretions, eg saliva, gastric juice.</td></tr>
</table>

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<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td></td><td>(c)</td><td></td><td>
<table>
<tr><th></th><th>calm mammal
Fig. 2.1</th><th>frightened mammal
Fig. 2.2</th></tr>
<tr><td>division</td><td>parasympathetic ;</td><td>sympathetic ;</td></tr>
<tr><td>neuro-transmitter</td><td>acetylcholine / ACh ;</td><td>noradrenaline / NA
norepinephrine / NE ;</td></tr>
</table>
</td><td>4</td><td>First Answer in each box (0 marks if additional answer contradicts)

DO NOT CREDIT adrenaline for noradrenaline
CREDIT ecf for second line if name matches NS division stated</td></tr>
<tr><td></td><td>(d)</td><td></td><td>adrenal (glands) ;
(adrenal) medulla ;</td><td>2</td><td>First Answer (0 marks if additional answer contradicts)
DO NOT CREDIT medulla oblongata or medulla alone</td></tr>
<tr><td></td><td>(e)</td><td>(i)</td><td>1 adrenaline binds to receptor ;

2 complementary / specific, fit / shape ;

3 G protein activated ;
4 adenyl(ate) cyclase activated ;

5 ATP converted to cAMP ;

6 cAMP activates, proteins / enzymes ;
7 by, altering 3D structure / phosphorylation ;</td><td>4 max</td><td>IGNORE neurones
ACCEPT attaches to
DO NOT ACCEPT detected by, recognised by

IGNORE stimulated (mps 3, 4 6)
CREDIT AW eg made active, caused to work (3,4,6)

ACCEPT named enzymes eg kinases</td></tr>
<tr><td></td><td>(e)</td><td>(ii)</td><td>idea that one / named, molecule causes, production / activation of, many others ;

idea that this multiplying effect is repeated at, next / every / later step ;
idea of recycling / temporary binding, of cAMP ;</td><td>2</td><td>ACCEPT 1 adrenaline → many cAMP molecules
1 molecule causes many responses (in cell)
CREDIT idea of amplification / cascade effect
IGNORE chain reaction, domino effect</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>21</td><td></td></tr>
</table>

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Question			Answer	Marks	Guidance
3	(a)	(i)	ecology ;	1	**First Answer**
		(ii)	abiotic ;	1	**First Answer**
		(iii)	ecosystem ;	1	**First Answer**
	(b)		(interspecific) competition ; species 1 and species 2 named ; description of interaction ; trophic / predator-prey / predation / parasitism / grazing / herbivory ; species 1 and species 2 named ; description of interaction ; mutualistic / mutualism ; species 1 and species 2 named ; description of interaction ;	6	**Mark the first suggestion on each numbered line only, max 3 for each, therefore max 6 overall.** **ACCEPT** English or scientific names for species (genus name alone acceptable and does not need capital letter) and accept phonetic spelling. **DO NOT ACCEPT** intraspecific eg eat, same / named, food OR occupy same niche *'Red and grey squirrels compete for the same food'* = 3 marks **IGNORE** grass, worms, **ACCEPT** symbiosis / symbiotic / commensalism **IGNORE** legumes and nitrogen-fixing bacteria if no species identified eg could include pollination, seed dispersal

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Question			Answer	Marks	Guidance
	(c)	(i)	auxin / IAA ; (positive) phototropism ; plants / shoots, bend towards light ; etiolation / plants grow taller ; climbing plants climb, up / over, other plants ; (positive) thigmotropism / sense of touch ; grow roots towards, water / minerals ; allelopathy / description ;	4 max	**IGNORE** other named hormones **IGNORE** apical dominance **DO NOT ACCEPT** phototrophic / thigmotrophic (but penalise once) **IGNORE** move, grow **IGNORE** nutrients
		(ii)	less auxin / auxin production stopped ; apical dominance, stopped / removed ; side shoots grow / lateral buds develop / ora ; plant becomes bushy ;	3 max	 **CREDIT** axillary buds **IGNORE** side leaves

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Question			Answer	Marks	Guidance
	(d)		**1** tape measure / rope, laid **;** **2** line / belt, <u>transect</u> **;** **3** continuous / interrupted / AW **;** **4** (use quadrat to) record percentage cover of plants **;** **5** (use quadrat with) ACFOR scale **;** **6** point quadrat use described **;** **7** use of key to identify species **;** **8** data recording sheets prepared in advance **;** QWC – sequencing of steps in procedure **;**	5 max 1	**3** record all species touching line = continuous line quadrats end to end = continuous belt OR at selected intervals only = interrupted **4 ACCEPT** description = number of squares with species (>half covered) **5 DO NOT ACCEPT** record abundance One point from **1 - 3** before a point from **4** to **8**
			Total	**22**	

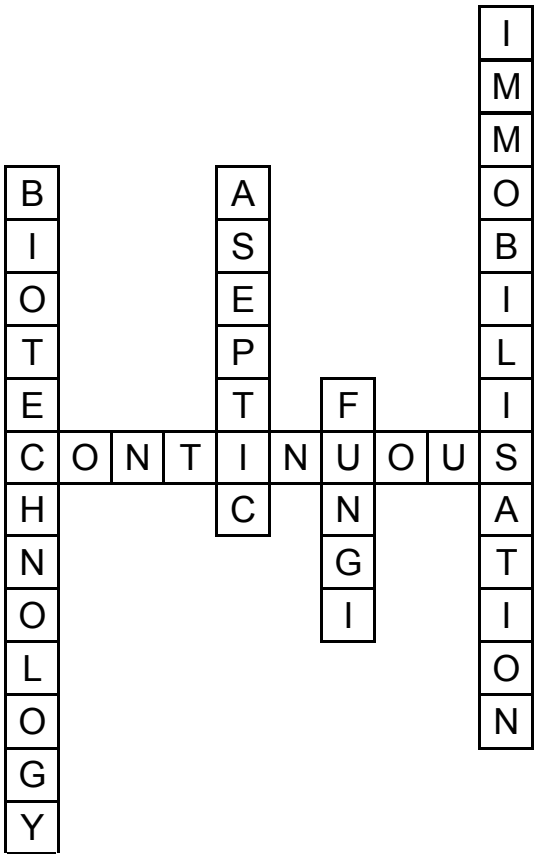
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Question			Answer	Marks	Guidance
4	(a)		**D ;** **C ;** **J / M / N ;** **J / K / L ;** **J / K / M ;**	5	**First Answer**

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Question	Answer	Marks	Guidance
(b)	*'Golden Rice™'* **B1** reduce vitamin (A) deficiency in named area / ora **;** **B2** reduce, eye problems / blindness **;** **C1** reduce rice genetic, diversity / variation **;** **C2** clone may suffer from one, disease / environmental change **;** **C3** hybridisation with wild rice / spread genes to wild populations **;** **C4** seeds expensive / need to be bought each year **;** **C5** rice may not grow in all areas where needed **;** **C6** *idea of* doubts whether vitamin A content sufficient **;** **4 max** *Somatic Gene Therapy* **B3** cure / reduce symptoms / better quality of life / less medication**;** **B4** cystic fibrosis / SCID / Parkinson's / thalassaemia / LCA **;** **B5** extend lifespan / saves lives **;** **C7** virus vector may cause (viral) disease **;** **C8** procedure may be, invasive / dangerous / painful / stressful **;** **C9** temporary / needs to be repeated / limited success **;** **C10** immune system / rejection, problems **;** **C11** animal testing concerns **;** **4 max** *Either Section* **C12** antibiotic resistance gene transfer to pathogenic bacteria **;** **C13** unknown effects / cause mutation **;** **QWC** – balanced account **;** **1 max**	9 max	**B1** eg Asia / developing world / area where rice is staple diet **C1 ACCEPT** contributes to genetic erosion **C3 ACCEPT** superweeds idea **C4 CREDIT** idea of economic exploitation **B3 DO NOT ACCEPT** treat (as in question) **B4** eg single gene recessive conditions, cancer *concerns* **IGNORE** references to embryo research, designer babies and germline gene therapy **C8** eg bone marrow removal and replacement **C12 IGNORE** idea of resistant viruses **C13 ACCEPT** cause cancer (in context of gene therapy) Award if 1 **C** mark and 1 **B** mark have been awarded for **both** examples
	Total	**14**	

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Question	Answer	Marks	Guidance
5		5	**CREDIT** asepsis for aseptic (3 down)
	Total	**5**	

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Question			Answer	Marks	Guidance
6	(a)	(i)	artificial selection / selective breeding ;	1	**First Answer**
		(ii)	*idea that* males can father many offspring / mate several females ; *idea that* females produce only a few offspring ; (so) more females (than males) needed to maintain numbers (each generation) ; (20% females chosen as) inbreeding / genetic problems, if breeding population is too small ; (5% males chosen as) selection pressure stronger if fewer (tamest) are used ;	2 max	**IGNORE** artificial insemination eg one litter at a time
	(b)		**1** (mostly) genetic ; **2** as can be selected for / selective breeding increases frequency ; **3** allele(s) for tameness ; **4** (from) mutation ; **5** query role of environment / learning ; **6** ref. DRD4 / dopamine receptor ;	3 max	**DO NOT CREDIT** if environment also given as cause **IGNORE** genetic drift **DO NOT CREDIT** if environment given as main cause **ACCEPT** query about experimental method, eg was environment controlled for?

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Question			Answer	Marks	Guidance
	(c)		*linkage* tameness genes and genes for these traits <u>on same chromosome</u> **;** (so) inherited together **;** *epistasis* (product of) one gene affects expression of another **;** via enzyme pathway **;** *inbreeding* (hidden / masked) recessive alleles **;** selected for, as well / unintentionally **;** more chance homozygous as, small gene pool / parents related **;** *genetic drift* random / chance (which alleles, present / passed on) **;** (effect stronger because) small breeding population **;**	2	**First Answer** Look for the two mark points relevant to the first word of the four on offer that the candidate has chosen. **ACCEPT** idea of (recessive)allele inherited from both parents because, they are closely-related / small gene pool / reduced genetic diversity
	(d)		**1** <u>geographic</u> **;** **2** wolves avoid human settlements / dogs confined by humans **;** **3** <u>behavioural</u> **;** **4** detail / description **;** **5** <u>mechanical</u> **;** **6** idea of different size of wolves and some small dogs **;** **7** gamete incompatibility **;** **8** possibility of different chromosome numbers **;** **9** <u>seasonal / temporal</u> **;** **10** different breeding, seasons / times **;**	3 max	**IGNORE** reproductive isolation **4** eg differences in, pheromones / courtship **6 ACCEPT** different genitalia **10 CREDIT** *the idea that* dogs breed all year round / wolves breed once a year

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Question			Answer	Marks	Guidance
	(e)		*biological species concept* **1** (members of same species) need can interbreed to produce fertile offspring **;** **2** not all dog breeds can do this therefore not same species **;** **3** dog and wolf can so they should be same species **;** *phylogenetic species concept* **4** *idea that* dogs and wolves monophyletic group / tip of phylogeny **;** **5** genetic differences, between dogs and wolves small **;** **6** gene flow between wolves → big dogs → little dogs / analagous to ring species **;** **7** (PSC) one species (with a lot of phenotypic variation) **;**	4 max	**4 ACCEPT** share a common ancestor **5 CREDIT** question of how much DNA difference needed to classify as separate species
			Total	**15**	

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Question			Answer	Marks	Guidance
7	(a)		homeotic / regulatory, (gene) ; contains, 180 bp / homeobox, sequence ; that codes for homeodomain (on protein) ; (gene product) binds to DNA ; initiates transcription / switch genes, on / off ; control of, development / body plan ;	2	**IGNORE** *hox* **CREDIT** controls gene expression, ref. transcription factor(s) **ACCEPT** description, eg polarity, segmentation, position of limbs
	(b)		these genes very important ; mutation would, have big effects / alter body plan ; many other genes would be affected / knock-on effects ; mutation likely to be, lethal / selected against ;	2 max	**ACCEPT** example, eg no arms **CREDIT** selected against in context of survival, not reproduction **DO NOT CREDIT** ora, not beneficial so not selected for
	(c)		protein synthesis / transcription and translation ; respiration ; DNA replication ; mitosis ; cytokinesis ; apoptosis ; differentiation / gene switching ;	2 max	**Mark the first two suggestions only** **IGNORE** growth **ACCEPT** programmed cell death
	(d)		fungi / plants ;	1	
			Total	**7**	

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OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Control, Genomes and Environment

F215

F2160701611

Candidates answer on the question paper.

OCR supplied materials:
None

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

Monday 13 June 2011
Afternoon

Duration: 1 hour 45 minutes

F215

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- 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.
- Answer **all** the questions.
- 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 **24** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Knowledge of the nitrogen cycle can be used to make decisions about management of farmland. A farmer uses her grass meadow to raise sheep. In a separate field she grows cabbages.

(a) Fig. 1.1 shows part of the nitrogen cycle. The four boxes on the bottom line of the diagram refer to substances in the soil.

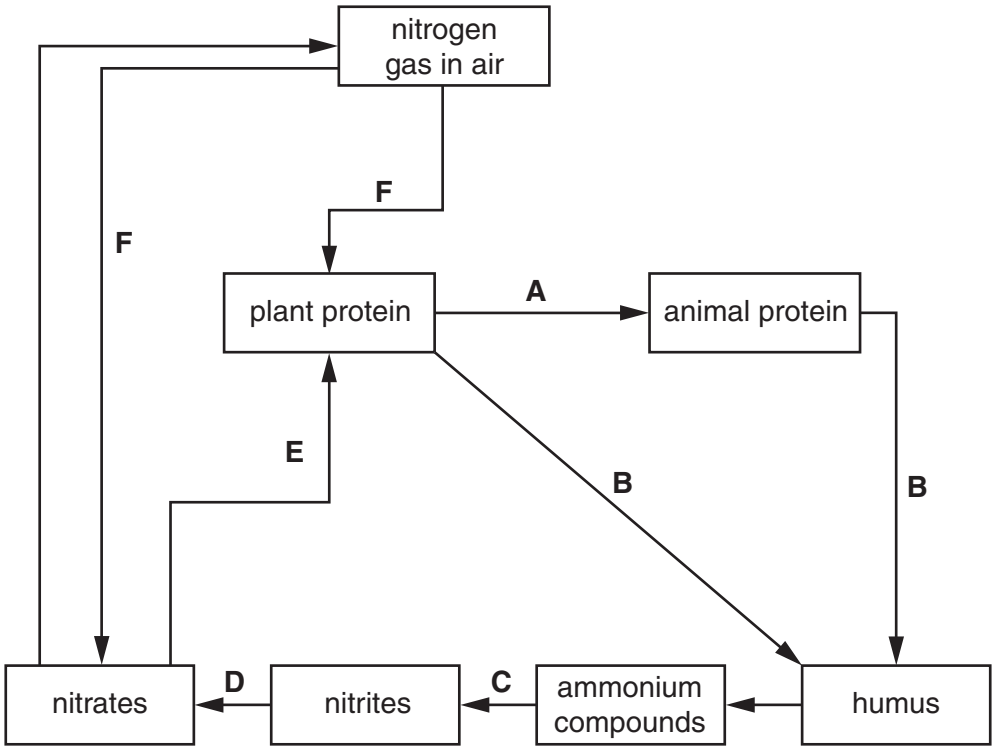


Fig. 1.1

(i) Briefly describe the steps that must occur for plant protein to be converted to animal protein in the farmer's sheep, as shown by arrow **A** on Fig. 1.1.

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

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(ii) List the processes which contribute to **B** in the meadow where sheep are raised.

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

(iii) Name the bacteria that carry out processes **C** and **D, and** explain the significance of these bacteria for the growth of plants.

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

(iv) Use the letters on Fig. 1.1 to explain why the soil nitrate concentration will decrease in the cabbage field if it is used to grow repeated crops of cabbages year after year.

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

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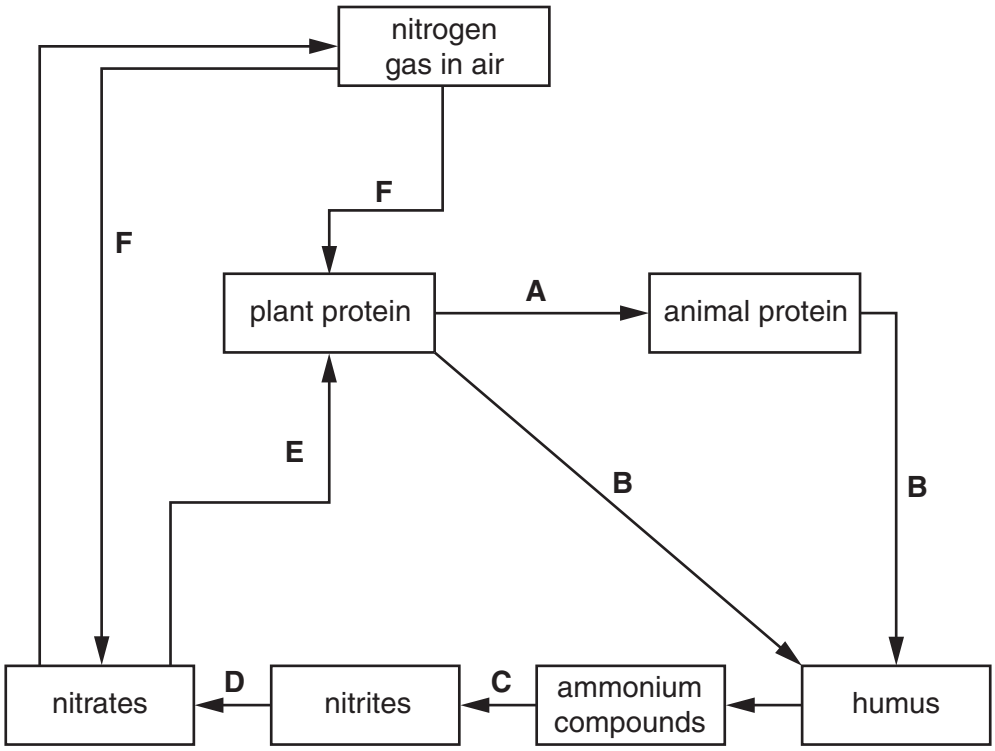


Fig. 1.1

(v) The farmer does not wish to use inorganic fertiliser to replace the nitrate in the soil of the cabbage field. She wishes to make use of process **F**.

Suggest a crop she could plant that would allow process **F** to occur **and** explain how this would add nitrate to the soil.

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

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(b) The sheep on this farm belong to a rare breed called Greyface Dartmoor. The Rare Breeds Survival Trust (RBST) gives advice on looking after these sheep and keep records to monitor the breeding of these sheep, in order to maintain a healthy population.

Why is the continued existence of rare breeds of farm animals desirable?

.....

.....

.....

.....

.....

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

(c) North Ronaldsay sheep are listed as 'endangered' by the Rare Breeds Survival Trust. These sheep were raised on a small Scottish Island where they were kept along the seashore for most of the year. The sheep developed an unusual metabolism that allowed them to survive by eating seaweed. They are, however, susceptible to copper poisoning when fed on grass.

(i) State the **two** essential steps that must have occurred for a breed to develop a distinctive metabolism, such as the ability to eat mainly seaweed.

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

(ii) Suggest what particular problems make the North Ronaldsay breed one of the most endangered sheep breeds in the United Kingdom.

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

[Total: 20]

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2 Animals behave in ways that enhance their survival and reproductive capacity. This behaviour may be innate or learned.

(a) Describe what is meant by:

(i) innate behaviour

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

(ii) learned behaviour.

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

(b) Describe the advantages to animals of innate **and** learned behaviour, with reference to specific examples of each type of behaviour.



Your answer should include both types of behaviour and make clear the advantages to the animals of your chosen examples.

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[11]

[Total: 15]

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3 Molecular evidence has shown that all specimens of the English Elm tree, *Ulmus procera*, form a genetically isolated clone. English Elms developed from a variety of elm brought to Britain from Rome in the first century A.D.

Although English Elm trees make pollen, they rarely produce seeds. Instead they spread by developing structures known as suckers from their roots. Each sucker can grow into a new tree.

This tendency of elms to create suckers has been exploited by humans, who have separated the suckers, with roots attached, and used them to plant hedges and establish new woodlands.

(a) (i) Suggest a technique that could be used to provide **molecular** evidence that all English Elm trees form a clone.

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

(ii) State why the English Elm clone is genetically isolated from other varieties of elm.

.....

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

(iii) State the name given to the process in which plants reproduce asexually by means such as suckers.

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

(b) In 1967, a new, virulent strain of an elm disease fungus arrived in Great Britain on imported timber. Beetles that lived under the bark of elm trees spread the fungus.

The saws used to cut down dead branches were not sterilised after use. When the saws were used to prune healthy trees, these trees became infected. Approximately 25 million elm trees, most of the English Elm population, died within a few years of the arrival of this fungus.

Explain why there was such a rapid loss of elm trees in Britain as a result of this elm disease.

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

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(c) Elm trees respond to fungal infection by plugging their xylem vessels. The leaves on the upper branches of the tree then turn yellow and die. When most of the branches have lost their leaves and died, the roots are weakened and may also die.

(i) Explain why the plugging of xylem vessels will result in the leaves of the upper branches turning yellow.

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

(ii) Explain why the loss of leaves from the tree may result in the death of the tree's roots.

.....

.....

.....

.....

.....

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

QUESTION 3(d) STARTS ON PAGE 10

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(d) Many ornamental plants for gardens can be cloned by tissue culture.

Describe the process of cloning plants by tissue culture.

In your answer you should make clear the order in which the steps of the process occur.

[7]

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(e) List **two** advantages and **two** disadvantages of cloning plants by tissue culture.

advantage 1 .....

.....

advantage 2 .....

.....

disadvantage 1 .....

.....

disadvantage 2 .....

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

[Total: 22]

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4 Wading birds (waders) are birds that feed in shallow water. Table 4.1 shows changes in the population size of four species of wader in two areas of the Western Isles off the coast of Scotland.

- Area 1 is an area that has remained free of hedgehogs.
- Area 2 is an area where four hedgehogs were introduced from the mainland in 1974. Since then, they have established a large population.

Hedgehogs eat the eggs of ground-nesting birds like waders.

Table 4.1

	number of breeding pairs of wader birds			
	area 1 (hedgehogs absent)		area 2 (hedgehogs present)	
year / species of wader	1983	2000	1983	2000
lapwing	1104	1364	1869	1287
redshank	486	733	1288	760
dunlin	803	558	2016	884
snipe	172	154	655	280

(a) (i) Calculate the percentage decrease in the number of breeding pairs of **snipe** in **area 2** between 1983 and 2000.

Show your working.

Answer = ... % **[2]**

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(ii) Use the data in Table 4.1 to describe **and** explain the effect of the introduction of hedgehogs on the number of breeding pairs of waders in **area 2**.

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.....

..... **[6]**

(iii) Suggest **two** factors that might have allowed a large population of hedgehogs to increase from just four individuals in **area 2**.

Explain how each factor has led to an increase in the hedgehog population.

1 .....

.....

.....

.....

2 .....

.....

.....

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

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(b) Three suggested methods to reduce the effect of hedgehogs on the numbers of waders in area 2 were considered. These were:

- trapping and moving hedgehogs to the mainland
- trapping hedgehogs and keeping them in captivity indefinitely
- trapping of hedgehogs followed by humane killing.

The third method was judged to be the most effective and likely to succeed in reducing hedgehog numbers.

Comment on the ethical issues involved in making this decision.

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

[Total: 15]

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QUESTION 5 STARTS ON PAGE 16

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5 Fig. 5.1 is a circular representation of the genetic code.

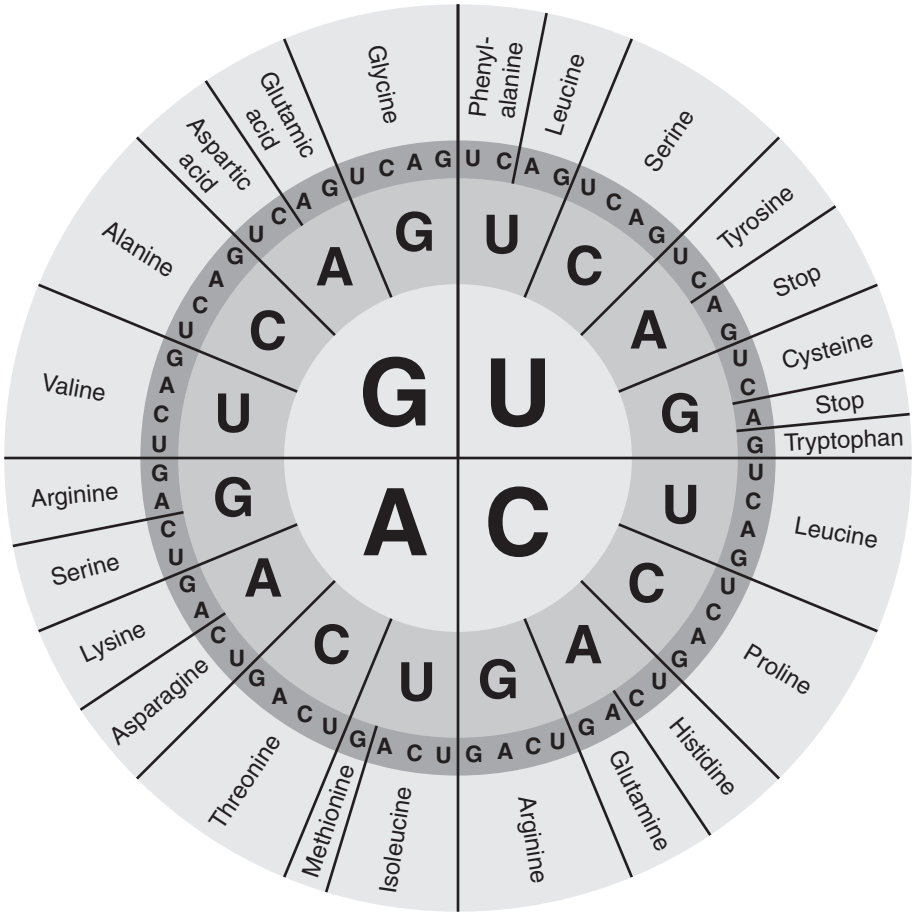


Fig. 5.1

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(a) **Fig. 5.2** shows a sequence of bases coding for a sequence of amino acids. The name of the third amino acid in the sequence has been filled in.

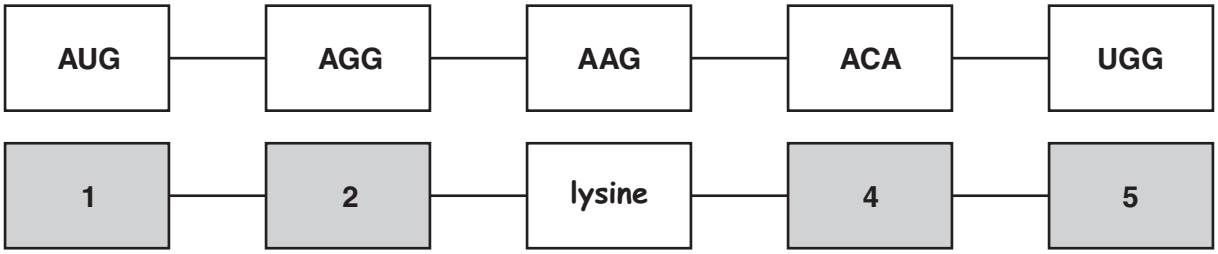


Fig. 5.2

Identify the remaining amino acids in the sequence.

1 .....

2 .....

3 lysine

4 .....

5 ..... **[2]**

(b) State the name of the stage of protein synthesis represented in Fig.5.2 **and** name the organelle in the cell where this takes place.

.....

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

(c) Identify the type of nucleic acid that holds the sequence of bases shown in Fig. 5.2.

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

(d) Using the information in **Fig. 5.1**, list the **three** triplet codons that would cause termination of a polypeptide chain (stop codons) **and** explain why these codons have this effect.

.....

.....

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

(e) What name would be given to a mutation that resulted in a change of the codon **UUU** to **UUC**?

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

[Total: 9]

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6 Describe the differences between:

(a) somatic cell gene therapy and germ line cell gene therapy

.....

.....

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

(b) the central nervous system and the peripheral nervous system

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

(c) prophase 1 of meiosis and prophase 2 of meiosis.

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

[Total: 8]

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7 Two-spot ladybirds, *Adalia bipunctata*, show a colour polymorphism. They are normally red with two black spots. However, melanic individuals occur which are black with two red spots.

A student investigated the proportion of these colour forms in the ladybird population along a transect going up a hill near his school.

(a) (i) Suggest a suitable technique by which the student might have collected his samples of ladybirds along this transect.

.....

.....

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

(ii) The student's teacher suggested he should make several transects up the hill rather than just one transect.

Explain why this is good experimental design.

.....

.....

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

QUESTION 7(b) STARTS ON PAGE 20

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(b) The student's results are shown in Table 7.1.

Table 7.1

height above sea level (m)	total number of red form of ladybird	total number of black form of ladybird
100	93	7
200	78	13
300	71	16
400	54	14

(i) Suggest a method of processing this data to make comparisons between the frequency of the red form and black form of ladybird at the different altitudes more valid.

Explain why your method is an improvement.

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

(ii) Evaluate whether the student was correct to conclude as follows:

"My data showed a positive correlation between increasing altitude and the frequency of the black form of the ladybird. I therefore concluded that high altitude causes the black form to survive better."

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

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(c) The black, melanic, form of the ladybird is caused by an allele (**B**) that is dominant.

The red form of the ladybird is therefore homozygous recessive at this locus (**bb**).

(i) State what is meant by the term *recessive*.

.....

.....

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

(ii) The data in Table 7.1 give the total number of the red form of ladybird found as 296, and the total number of the black form of ladybird as 50.

The Hardy-Weinberg principle states that:

$$p + q = 1$$

$$p^2 + 2pq + q^2 = 1$$

Use the Hardy-Weinberg principle and the figures given above to calculate the frequency of the dominant allele, p, and the recessive allele, q, in the two-spot ladybird population.

Show each step in your working. **Give your answers to 2 decimal places**.

p = ...

q = ... **[3]**

[Total: 11]

END OF QUESTION PAPER

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ADDITIONAL PAGE

If additional space is required, you should use the lined pages below. The question number(s) must be clearly shown.

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ADDITIONAL PAGE

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OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE

Unit **F215:** Control, Genomes and Environment

Mark Scheme for June 2011

Oxford Cambridge and RSA Examinations

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Question	Expected Answers	Marks	Additional Guidance
In ALL questions	**CREDIT AW FOR ALL** i.e. credit any alternatively worded statement that conveys the same sense as the mark point. If a particular word is essential and no other will do it is underlined. **IGNORE** wrong or vague statements unless **they directly contradict** a mark point. e.g. in Q1(a)(i) mark point 1: Therefore penalise *''plants eat sheep'* **(CON)** but ignore *'sheep absorb plants by phagocytosis'* (wrong) or *'sheep make use of plants'* (vague). **ACCEPT** incorrect spellings if they are recognisable **and** sound the same when pronounced, **even for underlined terms**.		

Question			Expected Answers	Marks	Additional Guidance
1	(a)	(i)	**1** (sheep / animals) ingest / consume / eat / feed on (grass / plants) **;** **2** digest / hydrolyse **,** (protein) to amino acids **;** **3** amino acids move **into ,** blood / cells **;** **4** synthesis of <u>proteins</u> / <u>translation</u> **;**	**3 max**	**2 ACCEPT** break down **IGNORE** enzymes **3 ACCEPT** amino acids are absorbed into **,** blood / cells **CREDIT** AW description of movement e.g. diffusion / active transport but **DO NOT CREDIT** movement by osmosis
1	(a)	(ii)	**1** death / leaf loss **;** **2** decomposition / decay **;** **3** excretion / urination / described **;** **4** egestion / defaecation / described **;**	**2 max**	**3 IGNORE** faeces in the context of mp3 but do not then credit mp4 as a description therefore *'excretion of faeces'* scores mp3 only **IGNORE** waste matter **4 IGNORE** waste matter

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Question			Expected Answers	Marks	Additional Guidance
1	(a)	(iii)	**1 C** is *Nitrosomonas* **;** **2 D** is *Nitrobacter* **;** **3 C and D** are nitrifying bacteria **;** *for mps 1 , 2 and 3* **internal max 2** **4** plants need nitrates to make **,** amino acids / protein(s) / enzymes / DNA / RNA / nucleic acids / chlorophyll / cytoplasm / new cells **;**	**3**	**Full marks can only be awarded if mp 4 awarded** **1 & 2 ACCEPT** "*they are 'Nitrosomonas and Nitrobacter'* = **2 marks** (correct order) *'they are Nitrobacter and Nitrosomonas'* = **1 mark** (wrong order) **4 IGNORE** plants need nitrates to grow (as given in Q) .
1	(a)	(iv)	**1 E** continues / plants use nitrate **;** **2** less / no **, B** / decay **;** **3** less / no **, C** / **D** / recycling of nitrogen / nitrification **;** **4** (cabbages) harvested / removed **;**	**3 max**	**IGNORE** references to other letters throughout **2 ACCEPT** cabbages do not rot down

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Question			Expected Answers	Marks	Additional Guidance
1	(a)	(v)	**1** legume / any named leguminous plant **;**		**1 CREDIT** English or Latin name. Examples include but are not limited to: pea (*Pisum*) / bean (*Phaseolus* or *Vicia*) / vetch (*Vicia*) / soya (*Glycine*) / chickpea (*Cicer*) / peanut (*Arachis*) / alfalfa, lucerne or medick (*Medicago*) / clover or trefoil (*Trifolium*) / lupin (*Lupinus*) / *Leucaena / Cyamopsis / Sesbania* **IGNORE** names of non-leguminous plants, therefore *'plant legumes such as cucumbers'* scores mp 1
			2 *Rhizobium* / nitrogen-fixing bacteria (in root nodules) **;** **3** *idea of converting* nitrogen gas / N_2 **,** into **,** compounds / ammonium / ammonia / amino acids / protein (in plants) **;** **4** plants ploughed in / plants left to decay / ref **B** / ref **C** / ref **D ;**	**3 max**	**3** the nitrogen must be clearly gaseous **IGNORE** nitrite / nitrate (because not made in plant)
1	(b)		**1** genetic resource / gene bank / have (different) alleles **;** **2** for **,** genetic engineering / genetic modification / artificial selection / selective breeding / described **;** **3** if conditions change / in the future **;** **4** example of useful trait **;** **5** to maintain **,** biodiversity / genetic diversity / (large) gene pool **;**	**2 max**	**IGNORE** biotourism **1 IGNORE** source of genes **3 IGNORE** unless context is genetic **4** e.g. disease resistance (**not immunity**) / hardiness / more or better quality wool or meat An animal need **not** be named but if it is it should be a **farm animal** e.g. sheep / cows / goats / pigs / poultry **5 CREDIT ORA** to prevent loss of genetic diversity **IGNORE** to prevent extinction / to increase biodiversity

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Question			Expected Answers	Marks	Additional Guidance
1	(c)	(i)	mutation / described ; selection / selection pressure / selective advantage ;	2	1 **ACCEPT** new or different allele formed / DNA changed 2 **IGNORE** type of selection
1	(c)	(ii)	1 small , population / gene pool ; 2 ref. inbreeding / genetic drift ; 3 unusual diet / cannot eat grass / poisoned by grass / must eat seaweed ; 4 may not be commercially viable / expensive to keep ;	2 max	1 **CREDIT** lack of genetic , variability / variety 2 **CREDIT** founder effect 3 Mark point must relate to diet
				20	

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Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	**1** instinctive **;** **2** genetic / genetically determined / inherited **;** **3** rigid / fixed pattern / inflexible **;** **4** stereotyped / stereotypical **;** **5** automatic / does not require thought / does not require learning **;**	**2 max**	**2** **IGNORE** born with it / present from birth **3** **ACCEPT** description. Same in all members of species or performed the same all the time
2	(a)	(ii)	**1** (behaviour) changed / altered / learnt **,** by experience **;** **2** ref. memory / association / reinforcement / practice **;** **3** variable **;**	**2 max**	**1** **ACCEPT** taught by parents / learnt by watching others 'due to experience' is not enough. They need to refer to ***past*** experience. **3** **ACCEPT** description. Varies or is different in different members of a species or in one animal at different times

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Question			Expected Answers	Marks	Additional Guidance
2	(b)				***Note* - The question relates to animal behaviour that is, in broad terms, advantageous for survival.**
			general innate behaviour advantages		
		A1	rapid / automatic / correct **,** behaviour / response **;**		**A marks** can be awarded in the context of an example
		A2	*idea that* simple nervous system is enough **;**		
		A3	suits species with **,** short lifespan / no parental care / solitary lifestyle **;**		
					E marks the **name** of the type of behaviour is **not needed**.
					Odd E numbers require the **animal to be identified** and the **behaviour described**. **Even E numbers** require an explanation of how the behaviour is **advantageous** e.g. to keep the animal in a suitable environment / to avoid predation or damage / to find food or a mate. Can be awarded even if corresponding odd **E** number has not been awarded.
			innate behaviour examples with specific advantages		
		E1	an escape reflex described in a named animal **;**		
		E2	advantage of this escape reflex explained **;**		
		E3	a taxis described in a named animal **;**		**E3 ACCEPT** motile protoctist e.g. *Euglena* / *Paramecium*
		E4	advantage of this taxis explained **;**		
		E5	a kinesis described in a named animal **;**		
		E6	advantage of this kinesis explained **;**		
			continued		***continued***

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Question			Expected Answers	Marks	Additional Guidance
2	(b)		***continued***		
			general learned behaviour advantages		
		A4	flexible / adaptable to **,** change / environment **;**		**A mark** can be awarded in the context of an example
			learned behaviour examples with specific advantages		**E marks** the **name** of the type of behaviour is **not needed**.
		E7	habituation described in a named animal **;**		**Odd E numbers** require the **animal to be identified** and the **behaviour described**.
		E8	advantage of this habituation explained **;**		**Even E numbers** require an explanation of how the behaviour is **advantageous** e.g. to conserve energy (habituation) / access care (imprinting) / access food / safety or other reward or survival need
		E9	imprinting described in a named animal **;**		
		E10	advantage of this imprinting explained **;**		
		E11	conditioning described in a named animal **;**		**E11** **ACCEPT** description of Pavlov's dogs for conditioning
		E12	advantage of this conditioning explained **;**		**E12** **IGNORE** ref. to Pavlov's dogs
		E13	latent learning described in a named animal **;**		
		E14	advantage of this latent learning explained **;**		
		E15	insight learning described in a named animal **;**		
		E16	advantage of this insight learning explained **;**		
				10 max	
			QWC – relating types of behaviour to advantages ;	**1**	**QWC =** any **description** mp **(odd E)** **PLUS** any **advantage** mp **(even E or A)** from **both** sections
				15	

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Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)	DNA / gene / genetic , fingerprinting / profiling / analysis ; DNA / protein / gene , sequencing ; electrophoresis ;	1 max	**IGNORE** gene testing / gene probing / gene mapping / genome sequencing
3	(a)	(ii)	rarely / do not , produce seed / cross-pollinate / interbreed ; only reproduce asexually ;	1 max	
3	(a)	(iii)	vegetative propagation ;	1	**IGNORE** asexual reproduction (as given in the question)
3	(b)		**1** genetically identical / little genetic variation ; **2** all susceptible / none resistant , to this disease ; **3** beetles , move / fly , from tree to tree **or** beetles are vector ; **4** trees grow , in clonal patch / close together **or** disease spreads through , suckers / roots **or** connected by , suckers / roots ; **5** the beetles only , live on / target , elm trees ; **6** attempts at control contributed to spread ; **7** as **more** trees became diseased then **more** tree surgery was necessary (contributing to spread of problem) ; **8** as **more** trees became infected then **more** , saws / equipment , were contaminated ;	4 max	**1 IGNORE** clone **2 IGNORE** all susceptible to 'disease' in general. Only credit if **one particular** disease is implied e.g. the / new / fungus / same , disease **DO NOT CREDIT** immune instead of resistant **3 IGNORE** simple repetition of text 'beetles spread disease'

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Question			Expected Answers	Marks	Additional Guidance
3	(c)	(i)	**1** less / no **,** movement of water **or** less / no **,** water reaches leaves **;** **2** less / no **,** minerals / nitrate / phosphate / magnesium / iron **;** **3** less / no **,** chlorophyll formation **;** **4** chlorophyll breakdown / leaf senescence **;**	**2 max**	**2** **CREDIT** correct symbols NO_3^-, PO_4^{2-}, Mg^{2+}, Fe^{2+}, Fe^{3+} **IGNORE** nutrients **IGNORE** reference to other substances such as sugars
3	(c)	(ii)	**1** less / no **,** photosynthesis **;** **2** less / no **,** sugar(s) / amino acid(s) / assimilates / organic molecules **;** **3** <u>roots</u> cannot **,** respire / do active transport / metabolise **;** **4** the falling leaves carry the fungus **;**	**2 max**	**2** **CREDIT** named sugars, e.g. sucrose **,** glucose **,** hexose **IGNORE** nutrients / food

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Question			Expected Answers	Marks	Additional Guidance
3	(d)	1	cut plant material into **,** explants / small pieces **;**		1 **DO NOT CREDIT** a single cutting
		2	example of part of plant used e.g. leaf / stem / root / bud / meristem / dividing region at tip of plant **;**		
		3	sterilise explant **;**		
		4	(with) bleach / sodium hypochlorite / alcohol **;**		
		5	place on **,** agar / growth medium **;**		5 **CREDIT** place in aerated solution
		6	containing **,** glucose / amino acids / nitrates / phosphates **;**		6 **IGNORE** polymers / carbohydrates
		7	callus **or** mass of **,** undifferentiated / totipotent **,** cells **;**		7 **DO NOT CREDIT** description of single cell
		8	high auxin **and** cytokinin (for callus formation) **;**		
		9	subdivide callus / sub-culturing **;**		9 **IGNORE** ref. single cells
		10	treat to induce **,** roots / shoots **;**		
		11	change plant hormone ratio **;**		11 **CREDIT** description **,** e.g. high auxin to give roots or (relatively) high cytokinin to give shoots (auxin : cytokinin ratio = 100 : 1 for roots, 4 : 1 for shoots, or similar figures)
		12	transfer to **,** greenhouse / soil / less controlled environment / non-sterile environment **;**		
		13	ref. aseptic conditions (anywhere within stages 5-11) **;**	**6 max**	13 Do not award for sterilising explant (which is mp3)
			QWC – described in logical sequence of steps ;	**1**	**Award QWC for sequence of marks as follows:** either mp 1 or 2 **then** 1 mark from mps 5 – 8 **then** 1 mark from mp 9 - 12

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Question			Expected Answers	Marks	Additional Guidance
3	(e)		*advantages* **1** quick **;** **2** disease-free / virus-free **,** stock created **;** **3** plants have same feature / uniform plants created **;** **4** can reproduce infertile plants **;** **5** can reproduce plants that are hard to grow from seed **;** **6** create whole plants from GM cells **;** **7** production **,** not determined by seasons / at any time / anywhere in the world **;** **8** (plantlets small) can be transported easily / grown in small space **;** **9** can save rare species from extinction **;** *disadvantages* **10** expensive / labour intensive **,** process **;** **11** process can fail due to microbial contamination **;** **12** all offspring susceptible to *same* **,** pest / disease / named environmental factor (e.g. drought) **;** **13** no / low / little **,** genetic variation **;**	**4**	**CREDIT** the first answer on each prompt line **1 IGNORE** ref. large numbers alone **3** refers to plant phenotype e.g. plants **,** grow at same rate / grow to same height **12 IGNORE** all are susceptible to disease in general (as in 3b) **13 IGNORE** loss of alleles
				22	

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Question			Expected Answers	Marks	Additional Guidance
4	(a)	(i)	57 / 57.3 ; ;	2	**Award 2 marks for a correct answer** **ACCEPT** 57.25 for 2 marks If answer is incorrect then allow 1 working mark for 655 – 280 or for seeing 375 anywhere in the working
4	(a)	(ii)	*description (D)* **D1** number of , waders / birds , decrease (in area 2) ; **D2** (numbers decrease) in , all / four , species ; **D3** unlike / different to , area 1 / where hedgehogs absent ; **D4** (area 1) two species increase / only two species decrease ; **D5** quote any two % change figures ; *explanation (E)* **E1** hedgehogs are , secondary consumers / 'predators' ; **E2** hedgehogs , stop birds breeding / reduce offspring (one year) ; **E3** *idea of* fewer , new adults / breeders (next year) ; **E4** *idea of* more deaths than 'births' ;	6 max	**D1** **CREDIT** 'it' as number **ACCEPT** 'amount' **D2** **CREDIT** the four names if all said to decrease **D4** **CREDIT** lapwing and redshank increase / only dunlin and snipe decrease **D5** Percentage change figures: area 1 area 2 lapwing +24 -31 redshank +51 -41 dunlin -31 -56 snipe -10 -57 Look for ecf from 4(a)(i) if snipe in area 2 incorrect **E1** **IGNORE** hedgehogs eat eggs as given in question **E3** Look for idea of future / knock-on effect

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Question			Expected Answers	Marks	Additional Guidance
4	(a)	(iii)	**1** plenty of / enough **,** food / birds' eggs / space **;** **2** breed rapidly / breed successfully / young survive **;** **3** no / few **,** predators **;** **4** few die (young / before breeding) **;** **5** *idea that* hedgehogs are introduced species **;** **6** invasive / fill vacant niche / not reached carrying capacity **;** **7** these hedgehogs restricted to island **;** **8** cannot **,** emigrate / leave island (so numbers build up) **;**	**4 max**	**Mark the first suggestion on each numbered line. Award 1 mark for a factor and a further mark for a related explanation** **1 CREDIT** little competition for food
4	(b)		*idea that the following may be ethically wrong* **1** killing hedgehogs **;** **2** letting hedgehogs **,** kill / decrease number of **,** waders **;** **3** introducing hedgehogs to island (upset the ecosystem) **;** **4** catching / moving **,** hedgehogs might cause suffering **;** **5** doing nothing **;**	**3 max**	**CREDIT ORA** *idea preventing these is ethically right* **IGNORE** 'right to life' and 'playing God' **2 CREDIT ORA** need to conserve waders **4** *'the other methods are cruel'* = 1 mark (mp 4) *'moving hedgehogs elsewhere causes problem somewhere else'* = 1 mark (mp 4) **5 CREDIT ORA** idea of human responsibility
				15	

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Question			Expected Answers	Marks	Additional Guidance
5	(a)		1 methionine 2 arginine 4 threonine 5 tryptophan ; ;	2	**AWARD** 2 marks if all four correct **AWARD** 1 mark if two or three correct **AWARD** 0 marks if only one correct **IGNORE** incorrect spelling if meaning is clear
5	(b)		translation ; ribosome / rough ER / RER ;	2	 **IGNORE** ER alone **DO NOT CREDIT** smooth ER
5	(c)		 messenger / m ; RNA / ribonucleic acid ;	2	*mRNA'* = 2 marks **IGNORE** incorrect 'r' or 't' prefix for 2nd mark
5	(d)		UAA **and** UAG **and** UGA ; do not code for an amino acid / no matching tRNA ;	2	**NEED** all 3 for one mark **ACCEPT** do not code for anything **ACCEPT** no , matching / complementary , anticodon
5	(e)		neutral / silent / substitution / point ;	1	
				9	

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Question	Expected Answers	Marks	Additional Guidance
6 (a)	*somatic* changes / uses , body cells ; change cannot be passed to offspring ; cures / alleviates , genetic disease in one individual ; short-lived / repeat treatments needed ; *germ line* changes / uses , gametes / zygote / embryo / reproductive tissue ; banned ;	2 max	**ORA** germ line changes could be passed to offspring **ACCEPT** sperm / eggs
6 (b)	*central* **CI** brain and spinal cord ; **C2** intermediate neurones ; **C3** has , coordinating role / many synapses ; *peripheral* ***max 3*** **P1** nerves , from sense organs / to muscles / to glands ; **P2** sensory **and** motor , neurones / nerve cells ; **P3** role in , sensing stimuli / controlling effectors **or** conducting impulses, to / from , CNS / brain / spinal cord ; **P4** includes , somatic / autonomic / sympathetic / parasympathetic ;	4 max	**For full marks needs at least 1 C mark** **C2** **CREDIT** relay / internuncial / bipolar **C3** **IGNORE** processing **P1** **IGNORE** effectors **P2** **DO NOT CREDIT** if intermediate included **DO NOT CREDIT** nerves **P3** **IGNORE** messages / signals / information
6 (c)	*prophase 1* homologous chromosomes pair up / bivalents form ; chiasmata / crossing-over / recombination ;	2	**CREDIT** reverse arguments for prophase 2 **ACCEPT** description e.g. non-sister chromatids exchange , (matching sections of) DNA / alleles / genetic material
		8	

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Question			Expected Answers	Marks	Additional Guidance
7	(a)	(i)	**1** sweep netting / sweep vegetation with a net **;** **2** beating / beat trees and bushes **;** **3** pooter / pooting / described **;**	**1 max**	**2** **ACCEPT** fogging **3** **ACCEPT** pitfall traps / described
7	(a)	(ii)	*idea of* ladybirds not evenly distributed / some parts of hill different / more representative **;** lets <u>reliability</u> be assessed / anomalies identified **;**	**1 max**	**ACCEPT** description e.g. could be more ladybirds one side than another **ACCEPT** increases reliability **IGNORE** accuracy / precision / removes anomalies
7	(b)	(i)	**M1** (calculate) % / proportion / ratio **;** **E1** as different total numbers at each site **;** **or** **M2** (draw) bar chart / kite diagram **;** **E2** pictorial data easier to understand **;**	**2 max**	**M1** **IGNORE** χ^2 **M2** **IGNORE** histogram / line graph

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Question			Expected Answers	Marks	Additional Guidance
7	(b)	(ii)	*yes (for first statement)* **1** first statement true / correlation exists **;** **2** number of black ladybirds increase **,** from 100m to 300m / until 300m **;** **3** 400m number decrease **but** % black increases **;** *no (for second statement)* **4** correlation not proof of causation / no proof of causal link / second statement not (necessarily) true **;** **5** another (named) factor could be involved **;**	**3 max**	**If candidates argues 'yes' exclusively, can only be awarded mps 1-3** **If candidate answers 'no' exclusively, can only be awarded mps 4 & 5** ***Note*** *percentage of black ladybirds increases as you go up the hill* = 2 marks (mps 2 & 3) **5** **CREDIT** could be due to distance from town / more **or** less predation high up / camouflage / warning colours
7	(c)	(i)	only expressed , when homozygous / in absence of dominant (allele) **;** not expressed when heterozygous / expression masked by dominant (allele) **;**	**1 max**	**DO NOT CREDIT gene** **IGNORE letters / genotypes** **ACCEPT only seen in phenotype when it is present in 'double dose'**

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Question			Expected Answers	Marks	Additional Guidance
7	(c)	(ii)	**1** q^2 = 296 / 346 or 0.85 / 0.855 / 0.86 ; **2** q = √previous answer or 0.92 / 0.93 ; **3** p = 1 – previous answer or 0.08 / 0.07 ;	3	**1** **DO NOT CREDIT** calculation or figure unless it has been indicated as q^2 **2** **ACCEPT ecf** **3** **ACCEPT ecf** ***Note*** **If both p and q are correct = 3 marks** *If p and q not given to 2 decimal places* then penalise 1 mark and then apply ecf • If the 2 final answers add up to 1 give mp 3, then look for evidence of mps 1 or 2 in the working • If the 2 final answers do not add up to 1, look for evidence of mps 1, 2 & 3 in the working • Award the working mark(s) if method correct, even if subsequent calculation incorrect (e.g. $1 - 0.54 = 0.56$ could get mp 3 for '1 – previous answer' even though 0.56 is the incorrect answer for the calculation) *e.g. if black allele wrongly assumed to be recessive* $q = 0.38$ or $q = \sqrt{0.1445}$ give mp 2 as ecf $p = 0.62$ or $p = 1 - 0.38$ give mp 3 as ecf *e.g. if answer given as* $q = 0.85$ *and* $p = 0.15$ give mp 3 They will not get mp 1 as they think that 296/346 = q (rather than q^2) and so will not square root it so they won't get mp 2
				11	

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RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Control, Genomes and Environment

F215

Candidates answer on the question paper.

OCR supplied materials:
None

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

Thursday 27 January 2011
Morning

Duration: 1 hour 45 minutes

F215660111

F 2 1 5

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. Pencil may be used for graphs and diagrams only.
- 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 page at the end of this booklet. The question number(s) must be clearly shown.
- Answer **all** the questions.
- 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 **20** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 **(a)** Human populations have herded cattle for milk for around 9 000 years. Artificial selection over this time has resulted in the modern dairy cow.

(i) State **three** phenotypic traits (characteristics) that have been selected for in dairy cows.

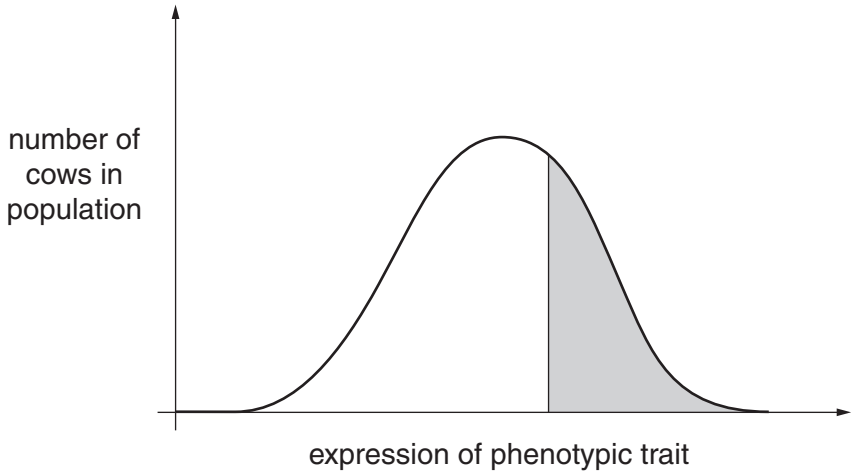
1 .....

2 .....

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

(ii) Fig. 1.1 shows the pattern of variation of a phenotypic trait in a herd of dairy cows. The shaded part of the graph indicates those cows that are chosen to breed.

Draw, **on Fig. 1.1**, a second curve to show the pattern of variation in the next generation.



[2]

Fig. 1.1

(iii) In recent years, artificial selection of dairy cows has been helped by modern reproductive technology.

Name **two** modern techniques or procedures that can be used in the selective breeding of dairy cows.

1 .....

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

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(b) Lactase is an enzyme that is necessary to digest lactose sugar in milk.

In some parts of the world, animals are not farmed for milk and no dairy products are eaten. Adult humans that are native to these parts of the world do not produce lactase.

In areas where animals are farmed for milk, native adult humans do produce lactase. In these populations, a new allele has arisen by gene mutation.

(i) State what is meant by gene mutation.

.....

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

(ii) Over time, the frequency of this new allele increased in the gene pool of the human populations whose diet included milk.

Name the process by which this increase occurred.

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

(c) **(i)** All human babies produce the enzyme lactase. The genetic change that allows adults to produce this enzyme is thought to involve a mutation in a regulatory gene. This mutation causes the structural gene to be expressed in adults.

Distinguish between the terms 'regulatory gene' and 'structural gene'.

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

(ii) Adult humans who cannot produce the enzyme lactase are described as lactose-intolerant and cannot drink milk without experiencing health problems. However, lactose-intolerant people can safely eat yogurt.

Yogurt is produced from milk that is fermented by bacteria. These bacteria perform anaerobic respiration, using carbohydrate as their respiratory substrate.

Suggest why yogurt is a suitable food for lactose-intolerant people.

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.....

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

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(d) The control of the expression of the *lac* operon genes, which allow uptake and digestion of lactose in the bacterium *Escherichia coli*, is well known.

Fig. 1.2 shows the arrangement of the elements of the *lac* operon.

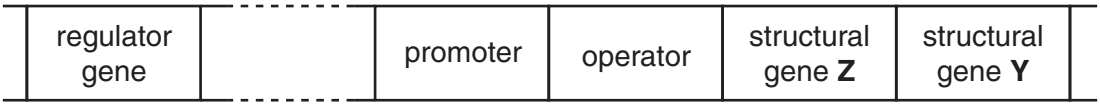


Fig. 1.2

Describe how genes **Z** and **Y** are switched on in bacteria that are moved to a nutrient medium that contains lactose.

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

[Total: 16]

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2 This question is about types of muscle and how the nervous system and hormones control their activity.

(a) There are three types of muscle within the human body. These differ in their cellular structure and in their function.

Complete Table 2.1 to show how each type of muscle **differs from the other two** types.

Table 2.1

	voluntary (skeletal) muscle	involuntary (smooth) muscle	cardiac muscle
cellular structure			
function			

[6]

(b) The human thorax is the area between the base of the neck and the base of the rib cage. All three types of muscle can be found within this area.

For each type of muscle, identify where **in the thorax** this type of muscle may be found.

voluntary .....

involuntary .....

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

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(c) Fig. 2.1 shows a vertical section through the human brain.

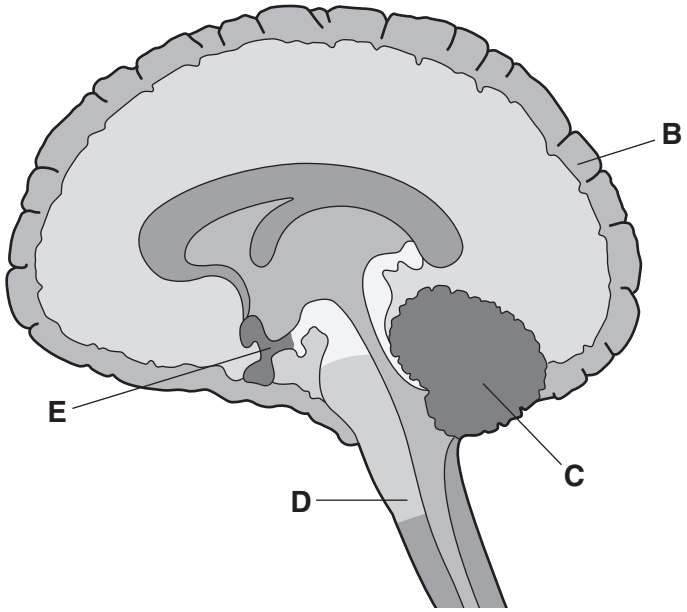


Fig. 2.1

Use Fig. 2.1 to state the letter (**B** to **E**) of the part of the brain that would be involved in the following:

adjusting the rate of contraction of cardiac muscle .....

clapping the hands together .....

automatically correcting balance when riding a bicycle ..... **[3]**

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(d) Movement disorders are conditions in which people lose the ability to control their body movements.

Scientists have discovered that inserting electrodes to stimulate parts of the brain can help to cure some movement disorders. This discovery has resulted from experimental work with monkeys, which has made the research controversial.

Suggest why monkeys rather than other laboratory animals, such as rats, were used for this work **and** comment on whether their use in this way is justified or not.

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

QUESTION 2(e) STARTS ON PAGE 8

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(e) The 'fight or flight' response to threatening environmental stimuli is coordinated by the nervous and endocrine systems.

Describe and explain how the activation of the 'fight or flight' response affects voluntary, involuntary and cardiac muscle.



In your answer, for each type of muscle, you should give a named structure in which it is found and explain how the nervous and endocrine systems affect its response.

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..... **[9]**

[Total: 24]

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3 Total plant growth within an ecosystem depends on the light intensity, temperature and the supply of water and inorganic minerals to the ecosystem.

Table 3.1 shows the net primary production by plants in four different ecosystems.

Table 3.1

ecosystem	net primary production ($kJ\,m^{-2}\,year^{-1}$)
temperate grassland	9240
temperate woodland	11340
tropical grassland	13440
tropical rainforest	36160

(a) Discuss possible reasons for the differences in net primary production in these ecosystems.

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

QUESTION 3(b) STARTS ON PAGE 10

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(b) To calculate the net primary production figures in Table 3.1 in $kJ\,m^{-2}\,year^{-1}$, it is necessary to measure the energy content of the primary producers.

Outline how the energy content, in kJ, of a primary producer such as grass can be measured in the laboratory.

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

(c) The efficiency with which consumers convert the food they eat into their own biomass is generally low.

Table 3.2 compares the energy egested, absorbed and respired in four types of animal.

Table 3.2

animal	percentage of energy consumed that is:			
	egested	absorbed	respired	converted to biomass
grasshopper, a herbivorous insect	63	37	24	13
perch, a carnivorous fish	17	83	61	
cow, a herbivorous mammal	60	40	39	
bobcat, a carnivorous mammal	17	83	77	6

(i) **Complete Table 3.2** to show the percentage of energy consumed that is converted into biomass in the perch and the cow.

You may use the space below for your working.

[2]

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(ii) Describe **and** explain, using the data from Table 3.2, how the trophic level of a **mammal** affects the percentage of its food energy that it is able to convert to biomass.

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

(iii) Using the data from Table 3.2 and your knowledge of energy flow through food chains, suggest which of these four animals could be farmed to provide the maximum amount of food energy in $kJ\,m^{-2}\,year^{-1}$ for humans.

Explain the reasons for your choice.

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

[Total: 14]

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4 The antibiotic penicillin is produced by batch culture of the fungus *Penicillium chrysogenum*.

(a) Fig. 4.1 shows the concentration of penicillin, lactose and ammonia as well as the fungal biomass over time when penicillin is being produced by batch culture.

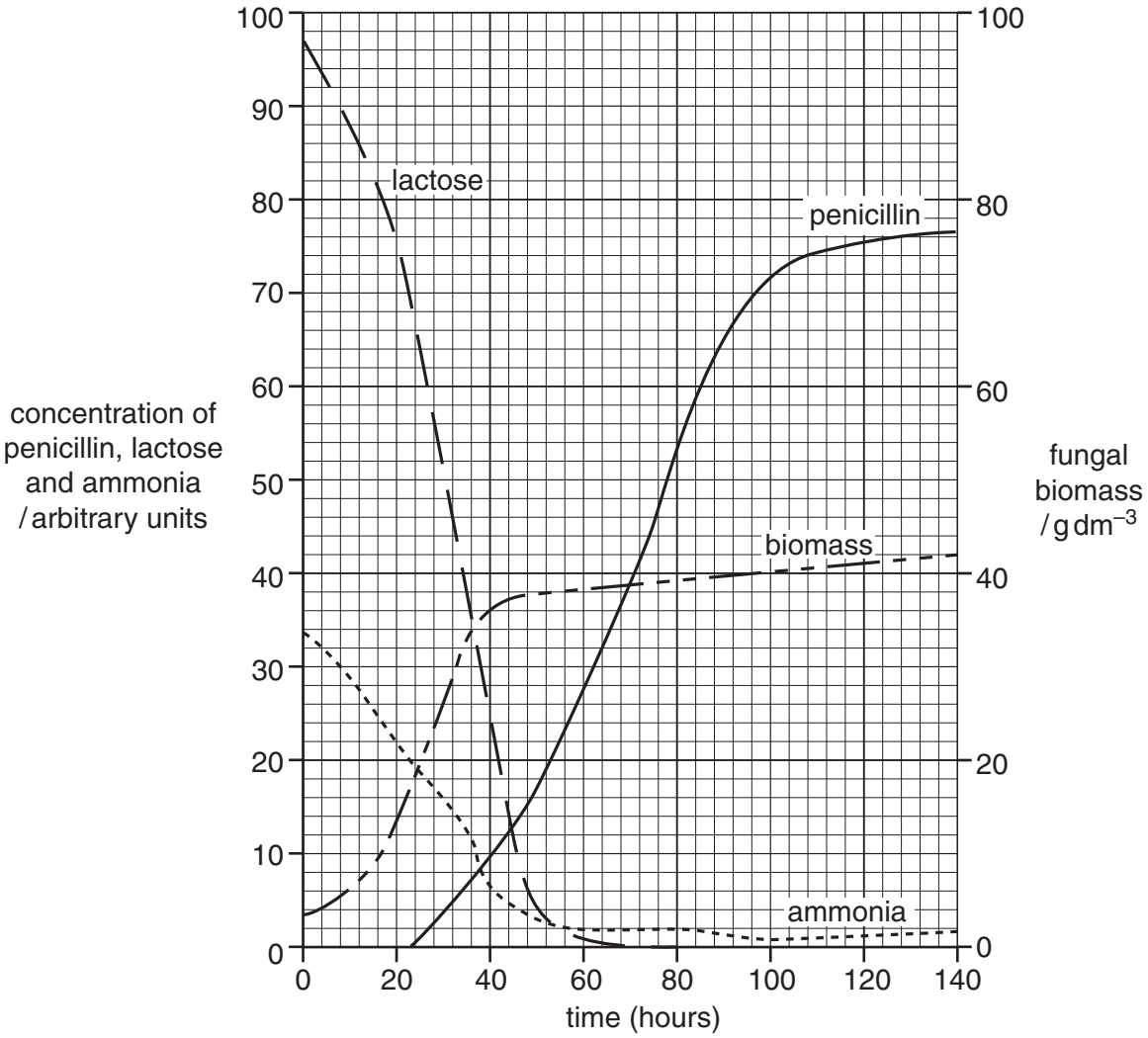


Fig. 4.1

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(i) With reference to Fig. 4.1, describe and explain the changes in concentration of lactose **and** ammonia.

description .....

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explanation .....

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

(ii) A student incorrectly suggested that penicillin might be produced by continuous culture fermentation instead of by batch culture.

Suggest how the curves for lactose, ammonia and biomass on Fig. 4.1 might differ in continuous culture.

.....

.....

.....

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

(iii) A second student said that continuous culture would not be suitable, as penicillin is a secondary metabolite.

What evidence is there in Fig. 4.1 that penicillin is a secondary metabolite?

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

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(b) (i) Explain the importance of maintaining aseptic conditions in manufacturing penicillin by fermentation.

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

(ii) State **three** physical or chemical factors within the fermenter, other than nutrient levels, that need to be monitored and controlled.

For each factor, explain **why** it must be controlled.

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

[Total: 14]

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5 This question is about genetic engineering and the techniques used for making multiple copies of genes (gene cloning).

(a) Genetic engineering uses the following:

A an enzyme that synthesises new DNA
B an enzyme that cuts DNA at specific sequences
C an enzyme that reseals cut ends of DNA
D small circular pieces of DNA found in bacteria; these pieces of DNA have antibiotic resistance genes
E an enzyme found in some viruses with an RNA genome; this enzyme converts RNA into DNA.

Name **A** to **E**.

A .....

B .....

C .....

D .....

E ..... **[5]**

(b) Genes are cloned for a number of reasons. For example,

- one group of research scientists at a hospital wanted to sequence a disease-causing mutation to learn more about a human disease; these scientists started their research using white blood cells;

- another group of scientists at a biotechnology company wanted to clone the insulin gene in order to manufacture its protein product to treat diabetes; these scientists started their research using cells from the pancreas.

Suggest **and** explain the biological reasons why the two groups each started with a different cell.

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

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(c) A gene can be cloned *in vitro* (in a test-tube) by the polymerase chain reaction (PCR). Alternatively, a gene can be cloned *in vivo* (in living cells) by introducing the gene into bacterial host cells.

Table 5.1 identifies some of the key steps in each process.

Table 5.1

in vitro gene cloning (PCR)	*in vivo* gene cloning
At 95 °C, DNA extracted from a cell separates into two strands.	A library of gene fragments is produced and introduced into host bacteria.
At 50 °C, specially-made primer sequences attach to the ends of the desired gene only.	Bacteria are screened for antibiotic resistance to identify those with recombinant DNA.
At 72 °C complementary copies of both DNA strands are made.	A gene probe is used to select the bacterial colony containing the desired gene.
The cycle of temperature changes is repeated and more copies of the gene are made.	This colony is grown on in nutrient broth and the DNA is then purified.

Compare the two processes of gene cloning by explaining the advantages of each.



In your answer you should ensure that clear comparisons between the two processes are made and explained.

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.... **[8]**

[Total: 17]

QUESTION 6 STARTS ON PAGE 18

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6 **(a)** State the term used to describe:

(i) a directional growth response of a plant

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

(ii) a signalling molecule that enables **plants** to respond to environmental change

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

(iii) plants that lose their leaves seasonally

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

(iv) the process of managing an ecosystem sustainably to protect biodiversity

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

(v) organisms that return inorganic minerals from the bodies of dead organisms to the abiotic environment

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

(vi) the conversion of nitrogen gas to ammonium compounds in the soil.

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

(b) Describe briefly **one** example of each of the following types of **animal** behaviour:

(i) habituation

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.....

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.....

.....

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

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(ii) operant conditioning

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

(iii) social behaviour in primates and its importance.

.....

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

[Total: 15]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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RECOGNISING ACHIEVEMENT

GCE

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Unit **F215:** Control, Genomes and Environment

Mark Scheme for January 2011

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Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	**1** *idea that* (produces) large , yield / volume / amount, of milk ; **2** *idea of* long lactation period ; **3** *idea of* high milk quality ; **4** large udders / correct udder shape (for milking machine) ; **5** resistance to , (named) disease / mastitis / pathogens **or** effective immune system ; **6** *idea of* calm temperament ; **7** AVP ;	**3 max**	**Mark the first suggestion on each line** ***1*** **DO NOT CREDIT** milk yield unqualified ***2*** ***3*** **DO NOT CREDIT** milk quality unqualified or ref. meat ***4*** ***5*** **DO NOT CREDIT** disease free ***6*** **CREDIT** docile / placid ***7*** eg • walk / stand , comfortably without need for hoof-trimming • *idea that* converts food to milk efficiently
1	(a)	(ii)	normal shaped curve ; shifted to the right of original ;	**2**	Position of curve must meet the following conditions: • **curve must end** to right of original end • **must not start** to left of original • **may start** at same point as original or to right of original

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Question			Expected Answer	Mark	Additional Guidance
1	(a)	(iii)	**1** artificial insemination / AI ; **2** in vitro fertilisation / IVF ; **3** *idea of* progeny testing ; **4** embryo transplantation / use of surrogate mother ; **5** cloning ; **6** genetic screening / use of gene probes ; **7** AVP ; **8** AVP ;	**2 max**	**Mark the first suggestion on each line** ***1*** **IGNORE** performance testing ***2*** ***3*** ***4*** **CREDIT** embryo splitting ***5*** ***6*** **ACCEPT** genetic engineering ***7*** eg ● sex selection technique / screening X and Y sperm ***8*** eg ● portmanteau animals
1	(b)	(i)	*idea of* change to , DNA / base(s) / nucleotide(s) ;	**1**	
1	(b)	(ii)	natural / directional , selection ;	**1**	**ACCEPT** evolution **DO NOT CREDIT** genetic drift
1	(c)	(i)	*regulatory* *idea that* makes , repressor protein / transcription factor **or** *idea that* product switches (structural / another) gene , on / off ; *structural* *idea that* makes , enzyme / polypeptide / protein ; *relationship between the 2* *idea that* regulatory gene , controls / affects , the expression of structural gene ;	**2 max**	**ACCEPT** 'makes regulatory protein' **ACCEPT** 'switching on / off' for idea of control **IGNORE** explanation involving repetition of word "regulates"

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Question			Expected Answer	Mark	Additional Guidance
1	(c)	(ii)	lactose has been , removed / digested / respired / broken down (by bacteria) ; to , lactic acid / lactate / other sugars ; yogurt still a good source of , calcium / vitamins ;	2 max	**DO NOT CREDIT** if context wrong (eg heat) eg ● glucose (and galactose)
1	(d)		**1** lactose binds to repressor protein ; **2** changes , shape / structure (of protein) ; **3** removes it from / stops it binding to , operator ; **4** RNA polymerase binds to promoter ; **5** *idea that* (so that Z and Y) are , transcribed / mRNA made ;	3 max	***1*** **DO NOT CREDIT** regulator substance ***2*** **IGNORE** ref. to active site ***3*** ***4*** **DO NOT CREDIT** DNA polymerase ***5*** **CREDIT** lactose permease and β-galactosidase for Z and Y **IGNORE** gene , switched on / expressed
			Total	16	

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Question			Expected Answer	Mark	Additional Guidance
2	(a)			6	**For each box, mark the first answer that will result in a mark being awarded.** If an additional answer is given that is incorrect or contradictory then **= 0 marks** **IGNORE** information in second or third boxes across row that is identical to 1st or 2nd box – each box should be different (as Q asks for differences between the types) eg striated(✓) unstriated(✓) striated = **2** multinucleate(✓) uninucleate(✓) uninucleate = **2** striated(✓) unstriated(✓) striated multinucleate uninucleate uninucleate(✓) = **3** **CREDIT** drawings if feature such as striated / multinucleate / uninucleate, are clearly shown * **ACCEPT** description of striated / non striated (eg stripey) ** **ACCEPT** control , blood pressure / diameter of blood vessels / diameter of airways ** **CREDIT** vasoconstriction / vasodilation , for controlling diameter of blood vessels

	voluntary (skeletal)	involuntary (smooth)	cardiac
cellular structure	*striated / bands of actin & myosin **or** cylindrical cells **or** multinucleate ;	*unstriated / *non striated **or** spindle-shaped cells **or** uninucleate ;	*striated **or** branched cells **or** uninucleate **or** interlocking / junctions / intercalated discs ;
function	to move , bones / skeleton / joints / (named) limbs ;	*idea of* **controlling diameter of , arteries / arterioles / bronchi / bronchioles **or** peristalsis **or** uterine contraction **or** control pupil size ;	to pump blood / AW ;

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Question			Expected Answer	Mark	Additional Guidance
2	(b)		*voluntary* intercostal / diaphragm ; *involuntary* bronchi / bronchioles / arteries / arterioles / aorta / oesophagus ; *cardiac* heart ;	3	**CREDIT** trapezius / deltoid / pectorals / latissimus dorsi / rotator cuff muscles **ACCEPT** 'between the ribs' for intercostal **DO NOT CREDIT** named artery not found in thorax **IGNORE** gut unqualified **ACCEPT** walls of , atria / ventricle(s)
2	(c)		(cardiac) **D** ; (clapping) **B** ; (bicycle) **C** ;	3	
2	(d)		*monkeys rather than rats* **1** *idea that* (humans & monkeys) closely related / share more genes / share a common ancestor ; **2** (humans & monkeys) both <u>primates</u> ; **3** *idea that* brain / body , structure / physiology / behaviour , similar (to humans) ; **4** monkey brain bigger (than rat) ; ***max 2*** *comment* **5** argument in favour ; **6** argument against ; ***max 2***	3 max	**MAXIMUM 2 marks from either section** ***1*** **DO NOT CREDIT** 'monkeys are closest ancestors to humans' ***2*** ***3*** **ACCEPT** having a similar response to treatment ***4*** ***5*** eg ● to alleviate human suffering / can save lives ***6*** eg ● causes , pain / distress / stress , to monkeys **DO NOT CREDIT** 'cruel to monkeys' unqualified 'right to life of monkeys' / monkeys killed

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Question			Expected Answer	Mark	Additional Guidance
2	(e)				**ACCEPT** phonetic spelling throughout
			appropriate parts of nervous / endocrine systems		
			1 sympathetic (motor neurones) stimulated ;		***1***
			2 noradrenaline / norepinephrine ;		***2***
			3 neurotransmitter released at , neuromuscular junction / organs ;		***3*** May be awarded in the context of acetylcholine
			4 adrenaline (secreted / released into blood) ;		***4***
			5 from adrenal , glands / medulla ;		***5***
			6 *idea of* adrenaline / noradrenaline , binding to receptors (on target tissue) ;		***6***
			7 AVP ;		***7*** eg • correct ref to corticosteroids • correct ref to medulla oblongata
			effect on structures containing 3 types of muscle		**C** = cardiac
			C8 *idea of* heart beats faster ;		***C8***
			C9 *idea of* heart beats more forcefully ;		***C9***
					S = smooth
			S10 alter blood flow / increase blood pressure ;		***S10*** eg • contriction / dilation , of arterioles
			S11 less blood flow to , gut / skin ;		***S11***
			S12 reducing gut secretions / making skin pale ;		***S12***
			S13 smooth muscle in gut relaxes / peristalsis slows down ;		***S13*** **ACCEPT** involuntary for smooth
			S14 smooth muscle in airways relaxes / airways wider ;		***S14*** **ACCEPT** involuntary for smooth
			S15 iris radial muscle contracts / pupil dilates ;		***S15***
					V = voluntary
			V16 *idea of* breathing / intercostals contracting / diaphragm contracting , faster ;		***V16***
			V17 more blood flow to (skeletal) muscles ;		***V17***
			V18 *idea of* (named skeletal) muscles being primed for action ;		***V18*** **ACCEPT** 'leg muscles' as named eg **CREDIT** glycogenolysis in muscle for priming
			19 AVP ;	**8 max**	***19*** eg • erector pili muscles raise hairs
			QWC – linking structure to response ;	**1**	**Award if** **2** different mps from mps **1 – 7** correctly linked to **2** different mps from mps **C7 – V17**
			Total	**24**	

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<table>
<tr><th colspan="3">Question</th><th colspan="2">Expected Answer</th><th>Mark</th><th>Additional Guidance</th></tr>
<tr><td>3</td><td>(a)</td><td></td><td></td><td>climate - tropical versus temperate
tropical has …

1 higher temperature / hotter ;
2 more (sun)light / days longer ;
3 photosynthesis faster ;

4 idea that
more storage of , organic molecules / biomass / energy
or
more formation of , organic molecules / biomass ;

5 AVP ;

vegetation - woodland or rainforest versus grassland(s)
woodland or forest has …

6 idea of greater complexity / greater biodiversity / more niches ;
7 competition for space less limiting ;

8 AVP ;</td><td>4 max</td><td>CREDIT reverse arguments for temperate

<table><tr><td></td><td>tropical</td><td>temperate</td></tr><tr><td>temperature</td><td>higher</td><td>lower</td></tr><tr><td>light intensity</td><td>more</td><td>less</td></tr><tr><td>photosynthesis</td><td>more</td><td>less</td></tr><tr><td>biomass made</td><td>more</td><td>less</td></tr></table>
eg ● less seasonal change
● faster , mineral cycling / decomposition

CREDIT reverse arguments for grassland

<table><tr><td></td><td>wood</td><td>grassland</td></tr><tr><td>complexity</td><td>more</td><td>less</td></tr><tr><td>competition</td><td>less</td><td>more</td></tr></table>
eg ● greater , humidity / shelter</td></tr>
<tr><td>3</td><td>(b)</td><td></td><td colspan="2">(bomb) calorimeter ;

detail of technique ;

detail of , measurement / analysis ;</td><td>2 max</td><td>

eg ● known / dry , mass of (organic material)
● (material) burnt in oxygen

eg ● temperature rise of water measured
● known volume of water
● calculation described / converted to kJ</td></tr>
</table>

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Question			Expected Answer		Mark	Additional Guidance	
3	(c)	(i)	(perch) 22 ; (cow) 1 ;		2		
3	(c)	(ii)	1	higher in bobcat / lower in cow ;		1	**DO NOT CREDIT** figs alone **IGNORE** refs to grasshopper and perch **ALLOW** ecf if cow calculated as > 6 in **(i)**
				for bobcat			
			2	more (energy) absorbed ; **ora**		2	
			3	less (energy / waste) egested ; **ora**		3	
			4	correct comparative figs. quoted from table ;		4	bobcat 83(%) <u>and</u> cow 40(%) (absorbed) **or** bobcat 17(%) <u>and</u> cow 60(%) (egested)
			5	meat more digestible ; **ora**		5	
			6	mainly protein and fat ;		6	
			7	contains no <u>cellulose</u> ; **ora**	3 max	7	
3	(c)	(iii)				If perch is suggested, candidate can only access mp 2 **= max 1** If bobcat or cow suggested, then **= 0**	
			1	<u>grasshopper</u> ;		1	
			2	*idea of* high conversion to biomass figure ;		2	**ACCEPT** ref to more energy accumulated in body **ACCEPT** mp2 in context of perch for max 1
			3	*idea of* herbivore / primary consumer / low(er) trophic level than perch ;		3	
			4	*idea of* more food available ;		4	
			5	*idea of* one stage of energy loss in food chain not two / more energy passes through food chain (to humans) ;	3 max	5	
				Total	**14**		

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Question			Expected Answer		Mark	Additional Guidance
4	(a)	(i)				**max 2 for description and max 2 for explanation** If bacteria mentioned, penalise once and then apply ecf. If incorrect units used, penalise the mark point and then apply ecf for subsequent mark points.
				description		
			1	lactose decreases and qualified ;		***1*** eg ● single **figure quote** **either** at start (96 / 97 (a.u.)) **or** levelling-off point (45 - 60 h) **or** end (65 -70 h)
			2	ammonia decreases and qualified ;		***2*** eg ● single **figure quote** **either** at start (34 (a.u.)) **or** levelling-off point (40 - 55 h)
			3	ammonia , plateaus / constant , at c. 2 (a.u.) (between 55 -140 h) ; ***max 2***		***3***
				explanation		
			4	*idea that* lactose / ammonia , used , for growth / to make biomass ;		***4***
			5	lactose / ammonia , used to make penicillin ;		***5***
			6	lactose broken down to glucose (and galactose) ;		***6***
			7	lactose / glucose , used for , respiration / energy ;		***7*** **IGNORE** ammonia
			8	ammonia used to make named N-containing molecule ; ***max 2***	**4 max**	***8*** eg ● amino acids / protein / nucleotides / nucleic acids / chitin / glycoprotein

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Question			Expected Answer	Mark	Additional Guidance
4	(a)	(ii)	lactose **and** ammonia levels **,** stay high / oscillate **;** biomass **,** continues to rise / does not level off **;**	**2**	If bacteria mentioned, penalise once and then apply ecf. **IGNORE** incorrect ref to stationary phase **DO NOT CREDIT** 'remains constant' without the idea of more being added **ACCEPT** 'biomass **,** rises and falls / levels off**'** only if reference made to harvesting / removal
4	(a)	(iii)	*idea that* most penicillin produced after main growth phase **;** after 24 h / when nutrients declining **;** not needed for growth **;** (however evidence not entirely clear as) production begins during biomass log phase **;**	**2 max**	If bacteria mentioned, penalise once and then apply ecf. **IGNORE** incorrect ref to stationary phase
4	(b)	(i)	**1** to avoid unwanted microbe **,** entry / presence **;** **2** so no competition for nutrients **;** **3** so conditions remain unchanged **;** **4** so no decrease in yield **;** **5** so no contamination of **,** batch / product / penicillin **or** batch is unusable **;** **6** to prevent escape of **,** microbes / fungus / *Penicillium* / spores **;**	**3 max**	If bacteria mentioned, penalise once and then apply ecf. ***1*** **IGNORE** pathogens ***2*** ***3*** ***4*** ***5*** **DO NOT CREDIT** contamination unqualified ***6***

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Question			Expected Answer	Mark	Additional Guidance
4	(b)	(ii)	temperature - as it affects enzymes ; pH - as it affects enzymes ; oxygen content – ref. respiration ; AVP ;	3 max	If bacteria mentioned, penalise once and then apply ecf. **DO NOT CREDIT** air eg ● salt concentration – affects osmosis / water potential / enzymes ● removal of waste gases (CO_2) – reduce pressure / prevents explosion of fermenter ● speed of stirrer – ensure even , mixing / temperature
			Total	**14**	

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Question			Expected Answer	Mark	Additional Guidance
5	(a)		**A** DNA polymerase / Taq polymerase ; **B** restriction endonuclease ; **C** (DNA) ligase ; **D** plasmid(s) ; **E** reverse transcriptase ;	5	**Mark the first answer on each prompt line.** If an additional answer is given that is incorrect or contradicts the correct answer, then **= 0 marks** ***B*** **ACCEPT** restriction enzyme or named example **DO NOT ACCEPT** restriction endonucleus
5	(b)		*hospital* **1** WBCs , easy to obtain / obtained from blood sample ; **2** WBCs good source of DNA ; **3** mutant gene's location unknown / need to look in whole genome ; *biotechnology company* **4** *idea that* insulin made in pancreas ; **5** many mRNA copies there / mRNA easier to find ; **6** AVP ;	4 max	***1*** **ACCEPT** *idea that* these cells less , painful / expensive / dangerous , to obtain ***2*** ***3*** ***4*** ***5*** ***6*** eg • introns already removed in mRNA

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Question			Expected Answer		Mark	Additional Guidance
5	(c)					**For A marks** points must be comparative - need to **either** match the 2 processes and state the advantage (eg PCR is quick and in vivo is slow) **or** use a comparative adjective (------er, less, more, least, most, better, best etc) as shown in the mark scheme. **For the related E mark,** accept any explanation that is true of **one** of the processes *and relates to the advantage described*. (Note that in some cases a statement could be considered as an advantage or as an explanation.)
				advantages of PCR		
			A1 **E1**	PCR quick**er** ; explanation ;		***A1*** ***E1*** eg ● few hours versus weeks ● 30 cycles ● no bacterial growth or screening stages
			A2 **E2**	PCR uses **less** equipment ; explanation ;		***A2*** ***E2*** eg ● tube and heat block for PCR ● multiple test tubes or agar plates for in vivo
			A3 **E3**	PCR uses **less** space ; explanation ;		***A3*** ***E3*** eg ● DNA and enzyme more compact than whole cells ● no growth medium required ● in vivo requires many plates to be , stored / incubated / refrigerated
			A4 **E4**	PCR **less** labour-intensive / easi**er** / (some parts of process) **less** costly ; explanation ;		***A4*** ***E4*** eg ● PCR set to run and left ● in PCR gene is identified & cloned in one stage ● in vivo requires work to pick out and transfer colonies ● in vivo requires more purification of DNA at end
			A5 **E5**	PCR combines selection of gene and amplification **but** in vivo requires separate steps ; explanation ;		***A5*** ***E5*** eg ● primer selects only correct gene to be copied ● in vivo needs probe to identify correct gene
		contd				

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Question			Expected Answer		Mark	Additional Guidance
5	(c)	*contd*	**A6** **E6**	PCR safe**r** ; explanation ;		***A6*** ***E6*** eg ● PCR uses DNA and enzymes ● PCR does not use whole cells which could cause contamination
			A7 **E7**	PCR can use low**er** quality DNA ; explanation ;		***A7*** ***E7*** eg ● can use **,** old / prehistoric / forensic **,** DNA
				advantages of in vivo		
			A8 **E8**	in vivo **less** prone to mutation ; explanation ;		***A8*** ***E8*** eg ● Taq polymerase occasionally inserts wrong base ● early mutation reproduced many times in PCR ● exact correct sequence needed for making therapeutic proteins
			A9 **E9**	in vivo **less** expensive ; explanation ;		***A9*** ***E9*** eg ● materials for growing bacteria cheap ● PCR chemicals / primers / Taq polymerase / high temperatures **,** expensive
			A10 **E10**	in vivo **less** technically complex ; explanation ;		***A10*** eg ● conditions not so critical ***E10*** ● optimising PCR takes time
			A11 **E11**	in vivo useful **,** when gene **less** well known / as longer piece of DNA can be cloned ; explanation ;	**7 max**	***A11*** ***E11*** eg ● searching for new gene ● obtains complete gene ● PCR has limited size (for cloning)
			QWC – clearly stated advantage linked to correct explanation ;		**1**	2 pairs of A & E marks awarded. (eg A1 & E1 **and** A5 & E5 A9 & E9 **and** A4 & E4 etc)
				Total	**17**	

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Question			Expected Answer	Mark	Additional Guidance
6	(a)				**Mark the first answer on each prompt line for all parts of (a).** If an additional answer is given that is incorrect or contradicts the correct answer, then **= 0** **ACCEPT** phonetic spelling
6	(a)	(i)	tropism(s) ;	1	**IGNORE** named tropism eg phototropism
6	(a)	(ii)	(plant) hormone / growth substance / growth regulator / pgr ;	1	
6	(a)	(iii)	deciduous ;	1	
6	(a)	(iv)	conservation ;	1	**DO NOT CREDIT** preservation
6	(a)	(v)	decomposer(s) ;	1	**ACCEPT** saprotroph / saprophyte / saprobiont **IGNORE** fungi / bacteria **DO NOT CREDIT** detritivore
6	(a)	(vi)	nitrogen fixation ;	1	**ACCEPT** nitrogen fixing **DO NOT CREDIT** nitrogen fixing bacteria
6	(b)	(i)	stimulus identified ; organism named **and** normal response described ; response **,** stops / lessens **,** after repeated stimulation / over time ;	3	eg ● touch eg ● sea anemone withdrawing tentacles 'learning to ignore' is not quite enough
6	(b)	(ii)	organism named **and** voluntary behaviour described ; reinforcer / reward / punishment **,** identified ; behaviour **,** increases (for reward) / decreases (for punishment) **,** in frequency ;	3	eg ● dog begging eg ● food reward / treat

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Question			Expected Answer	Mark	Additional Guidance
6	(b)	(iii)			Marks can be awarded in general context of social interaction instead of a specific piece of behaviour described.
			primate species identified ;		**CREDIT** English names eg chimpanzee, gorilla, orang-utan, (named) monkey, lemur or ape **IGNORE** humans
			behaviour described ;		eg ● include dominance hierarchy interactions (play, aggressive, affiliative) ● allogrooming ● communication behaviours (vocal, facial, postural) ● passing on of , cultural / tool-using, knowledge ● *idea of* prolonged / frequent , mother-infant interactions
			purpose / importance , stated ;	3	**CREDIT** answers relating to benefit to group or to individual eg ● with respect to access to food, resources or mates eg ● reducing , disease / parasites
			Total	**15**	

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RECOGNISING ACHIEVEMENT

ADVANCED GCE

BIOLOGY

Control, Genomes and Environment

F215

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Other Materials Required:
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- Ruler (cm/mm)

Wednesday 16 June 2010
Morning

Duration: 1 hour 45 minutes

OCE/16442

F215

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page 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.
- This document consists of **20** pages. Any blank pages are indicated.

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Answer **all** the questions.

1 Fig. 1.1 is a flow diagram showing the main stages involved in making cheese. The starting material is milk, which contains the protein, casein.

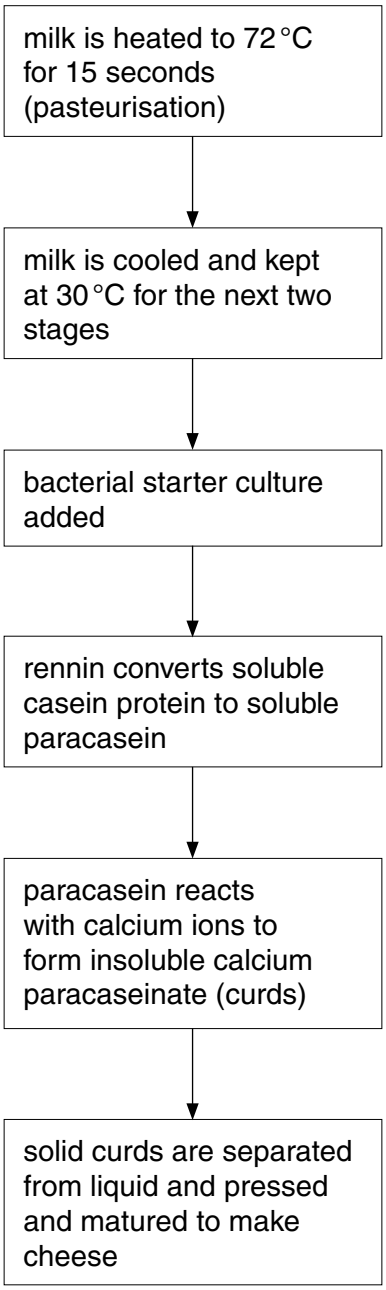


Fig. 1.1

(a) (i) Explain why making cheese can be described as a biotechnological process.

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

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(ii) Suggest **two** benefits of the pasteurisation stage.

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

(b) (i) Rennin is a protein that can be obtained from the stomach lining of calves. It is used in the cheese-making process in the ratio one part rennin to 10 000 parts milk.

Suggest what type of protein rennin is **and** explain how a very small quantity of rennin is able to convert a large quantity of milk.

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

(ii) Rennin could, in theory, be immobilised for use in cheese-making.

List **two** potential advantages of this.

1 .....

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

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(c) Rennin can now be made by genetically modified microorganisms.

Outline the process by which bacteria can be genetically modified to produce rennin.

In your answer, you should make clear how the steps in the process are sequenced.

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.... **[8]**

[Total: 17]

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2 Four different eye pigments in the fruit fly, *Drosophila melanogaster,* are made from the amino acid tryptophan. A simplified metabolic pathway of pigment production is shown in Fig. 2.1.

Three different gene loci control the pathway. Each locus has two alleles. These alleles are **V** or **v**, **C** or **c** and **B** or **b**, as shown in Fig. 2.1.

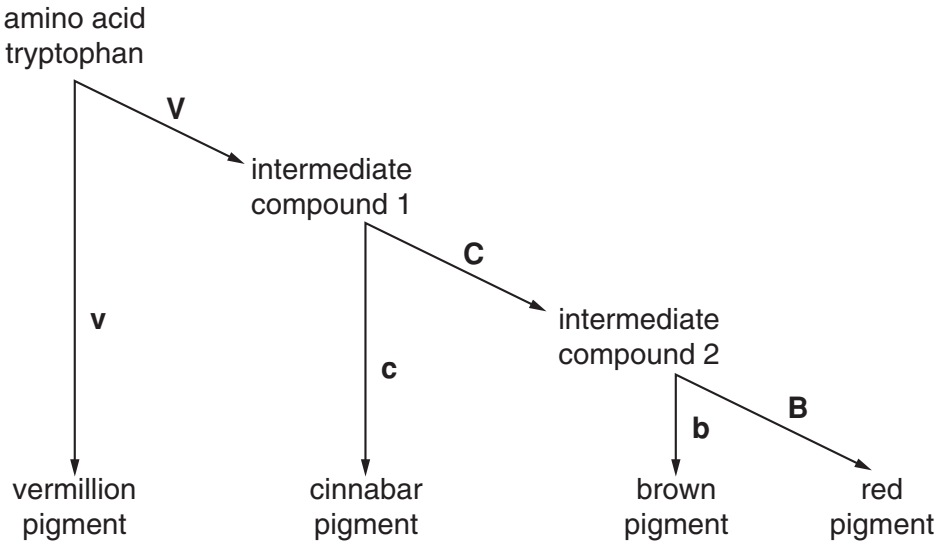


Fig. 2.1

(a) (i) Using the information in Fig. 2.1, deduce the phenotypes of flies with the following genotypes:

genotype	*phenotype*
VvCcBb	.....
vvCCBB	.....
VvccBB	..... **[3]**

(ii) State the term that is applied to this type of gene interaction.

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

(iii) Explain how the products **coded for** by the genes interact to give the different pigments.

.....

.....

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.....

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

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(b) A mutation in another gene at another locus in *Drosophila* gives rise to white-eyed flies. The red eye allele of this gene (**R**) is known to be dominant to the white eye allele (**r**).

A student crossed a red-eyed fly with a white-eyed fly, expecting to get an F1 generation of red-eyed flies. In fact, the results were as shown in Table 2.1.

Table 2.1

phenotype of fly	number of offspring
red-eyed female	27
red-eyed male	0
white-eyed female	0
white-eyed male	23

(i) The student first suggested that the reason for there being red-eyed and white-eyed flies in the offspring was that the red-eyed parent was heterozygous.

Explain why this **cannot** be the correct explanation for the results shown in Table 2.1.

.....

.....

.....

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

(ii) In *Drosophila*, the males are the heterogametic sex, possessing two different sex chromosomes, X and Y.

Draw a genetic diagram to show how the results shown in Table 2.1 could have been produced.

Parental genotypes …… ……

Gametes …… ……

F_1 genotypes …… ……

[3]

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(iii) The chi-squared (χ^2) test can be used to analyse the results in Table 2.1.

The expected ratio of red-eyed females to white-eyed males is 1:1.

Use Table 2.2 to calculate a value for chi-squared (χ^2).

$$\chi^2 = \Sigma \frac{(O - E)^2}{E} \qquad df = n - 1$$

Key to symbols:

Σ = 'sum of …'
df = degrees of freedom
n = number of classes
O = observed value
E = expected value

Table 2.2

phenotype of fly	O	E	O – E	$(O - E)^2$	$\frac{(O - E)^2}{E}$
red-eyed female					
white-eyed male					

χ^2 = ...

Use your calculated value of χ^2 and the table of probabilities shown in Table 2.3 to test the significance of the difference between the observed and expected results.

State your conclusion in the space below.

Table 2.3

degrees of freedom	probability, p			
	0.90	0.50	0.10	0.05
1	0.02	0.45	2.71	3.84
2	0.21	1.39	4.61	5.99

Conclusion .....

.....

.....

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

[Total: 16]

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3 **(a)** The fruit fly, *Drosophila melanogaster*, the zebra fish, *Danio rerio*, and the mouse, *Mus musculus*, have all been used by scientists to find out more about how genes control development in all animals, including humans. They are described as 'model organisms'.

(i) Suggest why information gained from studying such model organisms can be applied to humans.

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.....

.....

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

(ii) Suggest **two** characteristics that researchers should look for when choosing an organism for research into how genes control development.

1 .....

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

(b) Fig. 3.1 and Fig. 3.2, **on the insert**, show the heads of two *Drosophila* fruit flies.

Fig. 3.1 shows a normal wild type fly.
Fig. 3.2 shows a mutant fly.

(i) Name the type of microscope used to take the two pictures.

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

(ii) State one significant difference between the two heads.

.....

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

(iii) Name the type of gene which, if mutated, gives rise to dramatic changes in body plan.

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

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(c) Describe how the information coded on genes is used to synthesise polypeptides **and** how these polypeptides control the physical development of an organism.

In your answer, you should consider both the synthesis of polypeptides and their roles.

[8]

[Total: 16]

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4 Fig. 4.1 shows a junction between two neurones where the neurotransmitter is dopamine. Fig. 4.2 shows a neuromuscular junction.

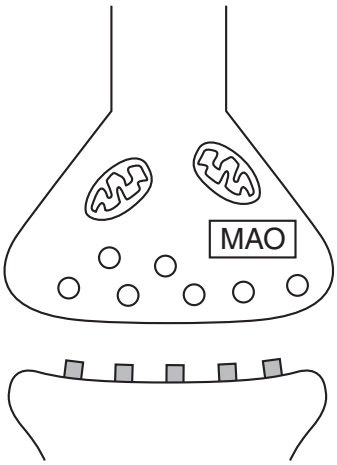


Fig. 4.1

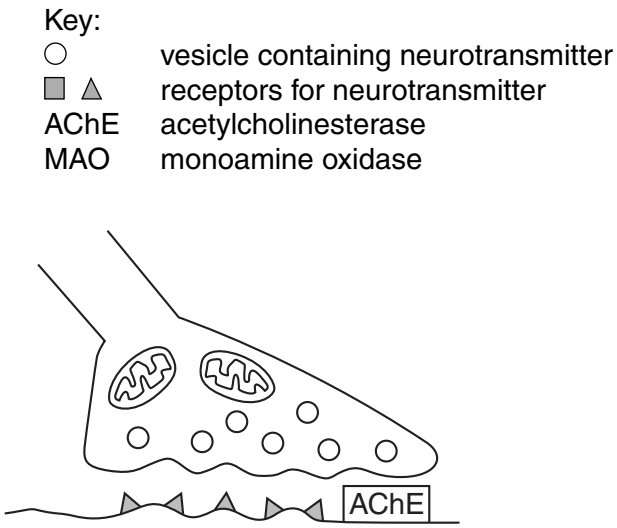


Fig. 4.2

(a) Complete Table 4.1 below to compare the structure and function of the dopamine synapse and the neuromuscular junction.

Table 4.1

	similarity	difference
structure		
function		

[4]

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(b) The sequence of events at a dopamine synapse is given below:

- dopamine molecules bind to the protein receptors on the postsynaptic membrane and trigger a response
- dopamine leaves the receptors and moves back into the presynaptic neurone
- some dopamine is repackaged into vesicles
- some dopamine is broken down by the enzyme monoamine oxidase (MAO).

Table 4.2 summarises the action of some drugs that affect dopamine synapses.

Table 4.2

drug	action at synapse
phenothiazine	binds to and blocks dopamine receptors
phenelzine	acts as an inhibitor of MAO
amphetamine	binds to and activates the dopamine receptor and causes release of stored dopamine from vesicles

(i) Use the information in Table 4.2 to suggest which drug molecule could have a shape that **differs** from that of the dopamine molecule. Give a reason for your answer.

.....

.....

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

(ii) Schizophrenia is a condition in which there is a higher than usual level of dopamine in certain areas of the brain.

Suggest why phenothiazine is used to treat schizophrenia.

.....

.....

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

(c) DRD4 is a dopamine receptor in humans. The DRD4 receptor gene has a large number of alleles, of which a single individual can only have two.

(i) Explain why one individual can only have two of the different alleles of the DRD4 gene.

.....

.....

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

(ii) Name a technique that would reveal differences in the lengths of the different forms of the DRD4 receptor gene.

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

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(d) Three alleles of DRD4 have the following alterations:

- a single base-pair substitution
- a 21 base-pair deletion
- a 13 base-pair deletion.

Suggest which of the three mutations will have the most serious consequences for the structure of the protein receptor. Give a reason for your choice.

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

(e) One allele of DRD4 has been found more frequently amongst individuals whose personality is described as 'novelty-seeking' and whose behaviour tends to be exploratory and impulsive.

Suggest how this particular allele of the DRD4 receptor could have become common in the human population.

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

[Total: 18]

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QUESTION 5 STARTS ON PAGE 14

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5 Sarawak is an area of tropical rainforest in south-east Asia. Logging has been allowed in 60% of the forest.

A study was carried out into the effects of logging on the diversity of mammal species living in the forest. An area of rainforest was sampled before logging, immediately after logging and then again two years and four years after logging.

Before logging began, there were 29 mammal species and four years after logging there were 26 mammal species.

Table 5.1 shows the population densities of six groups of mammals before and after logging. Where numbers were too small to measure the density, the species was recorded as "present".

Table 5.1

mammal	mean number of animals per km^2			
	before logging	immediately after logging	two years after logging	four years after logging
marbled cat	present	0	0	0
oriental small-clawed otter	present	0	0	0
giant squirrel	5	1	4	1
small squirrel	16	24	104	19
tree shrew	10	5	10	38
barking deer	3	1	10	present

(a) Marbled cats and otters are carnivores, while squirrels, shrews and deer are herbivores.

Use the information provided to choose the best word(s) or terms to complete the following passage.

The rainforest …… is a dynamic set of interactions between populations of organisms and the abiotic environment. Energy flows from …… , such as trees, to …… consumers, such as squirrels, and on to consumers such as cats and otters at higher …… . The activities of decomposers contribute to the energy lost from the …… component of the rainforest but decomposers allow …… to be recycled. **[6]**

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(b) (i) Table 5.1 shows that the number of small squirrels increases initially, but then decreases.

Explain, using your knowledge of factors affecting population growth, why the small squirrel population in this rainforest does **not** increase in size indefinitely.

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

(ii) Describe, using the information provided, how species richness **and** species evenness change in the rainforest by comparing the situation before logging and four years after logging.

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

(c) (i) Suggest why marbled cats and oriental small-clawed otters became extinct in this area but other mammals did not.

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

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(ii) Outline **three** reasons for conserving biological resources, such as the rainforest in Sarawak.

1 .....

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2 .....

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3 .....

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

(d) Timber is produced sustainably in the United Kingdom.

Describe **and** explain the benefits of **two** management practices used in sustainable timber production in a temperate country.

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

[Total: 20]

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QUESTION 6 STARTS ON PAGE 18

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6 **(a)** Plant responses to environmental changes are co-ordinated by plant growth substances (plant hormones).

Explain why plants need to be able to respond to their environment.

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

(b) The following investigation was carried out into the effects of plant growth substances on germination:

- a large number of lettuce seeds was divided into eight equal batches
- each batch of seeds was placed on moist filter paper in a Petri dish and given a different treatment.

The different treatments are shown in Table 6.1. Each tick represents one of the eight batches of seeds.

Table 6.1

	treatment	concentration of gibberellin (mol dm^{-3})			
		0.00	0.05	0.50	5.00
A	water	✓	✓	✓	✓
B	abscisic acid	✓	✓	✓	✓

The batches of seeds were left to germinate at 25 °C in identical conditions and the percentage germination was calculated.

Fig. 6.1 shows the results of this investigation.

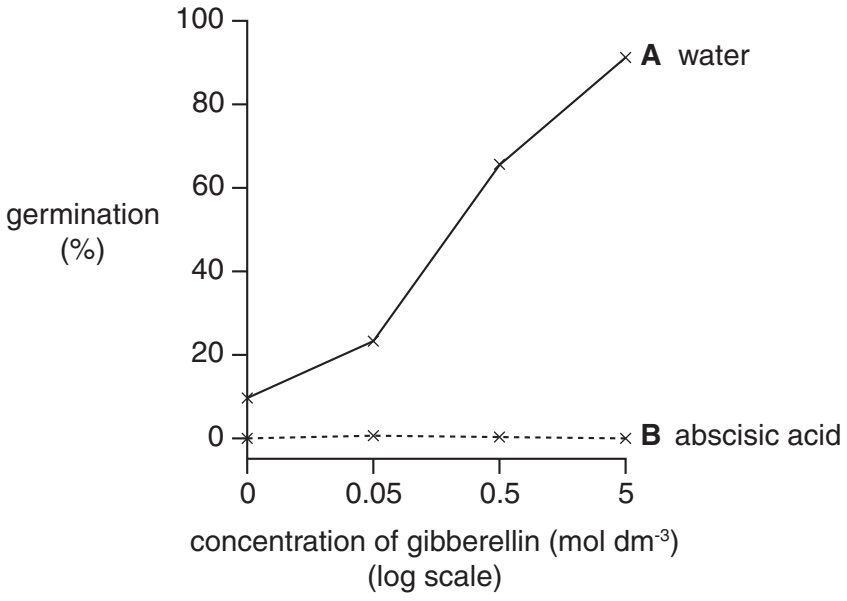


Fig. 6.1

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(i) Describe, with reference to Fig. 6.1, the effects of the plant growth substances on the germination of lettuce seeds.

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

(ii) Explain why all the lettuce seeds were kept at 25 °C.

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

(iii) State **three** variables, **other than temperature**, that needed to be controlled in the investigation.

1 .....

2 .....

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

(c) State **two** commercial uses of plant growth substances.

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

[Total: 13]

END OF QUESTION PAPER

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ADDITIONAL PAGE

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OCR
RECOGNISING ACHIEVEMENT

GCE

Biology

Advanced GCE **F215**

Control, Genomes and Environment

Mark Scheme for June 2010

Oxford Cambridge and RSA Examinations

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Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

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Question			Expected Answer	Mark	Additional Guidance
1	(a)	(i)	microbes **/** (living) organisms **/** cells **/** enzymes **;** (make) product **/** for human benefit / (carry out) conversion / reaction / industrial process **;**	**2**	**CREDIT** microorganisms / bacteria / prokaryotes / fungi **CREDIT** living things **CREDIT** cell components / parts of cells **CREDIT** example such as (named) food or medicine BUT **IGNORE** cheese (as stated in question) **IGNORE** process unqualified
1	(a)	(ii)	microbes **/ AW ,** killed / removed / not present **;** enzymes <u>denatured</u> **;** (so no) competitors **/** unwanted reactions **/** (human) health risk **;**	**2 max**	**Mark the first two suggestions** **IGNORE** contamination / sterile **IGNORE** idea of preserving milk **AW** for microbes as in **(a)(i)** plus **ACCEPT** organisms **DO NOT CREDIT** microbes denatured **CREDIT** (no) competition **CREDIT** (no) food spoilage / change of flavour / loss of quality **CREDIT** (no) pathogens / harmful microbes / TB "Kills harmful microbes" or "Kills pathogens" scores 2 marks (mps 1 & 3)

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Question			Expected Answer	Mark	Additional Guidance
1	(b)	(i)			**Award mp 1 plus 2 max from the other mark points**
		1	enzyme **;**		***1*** **ACCEPT** globular / tertiary / catalyst / catalytic (protein)
			plus any 2 of the following	**1**	
		2	(enzyme) not, changed / used up **; ora**		***2*** **ora** = can be used again / re-used **IGNORE** enzyme recycled
		3	*idea of* ESC (forms) / substrate and enzyme (bind) **;**		***3*** ESC = enzyme-substrate complex **ACCEPT** substrate entering active site
		4	products (and enzyme) released at end **;**		
				max 2	
1	(b)	(ii)			**Mark the FIRST suggestion on each numbered line** **IGNORE** 'cheaper' without qualification
		1	(enzyme can be removed to be) used again **;**		
		2	(enzyme can) to leave pure(r) product **; ora**		***2*** **ACCEPT** cheaper / easier, downstream processing
		3	(enzyme) more stable / more efficient / works better **;**		***3*** **CREDIT** less susceptible to, pH / temperature, change / extremes "enzymes work at high temperatures" = 0 "enzymes work at higher temperatures" = 1 (because comparative statement made)
				2	

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Question			Expected Answer	Mark	Additional Guidance
1	(c)		***This is a QWC question***		
			Section I - Obtaining the gene		
		1	use restriction, enzyme / endonuclease **;**		***1*** **CREDIT** named example e.g. *Eco* R1, *Bam* H1, *Hin* dIII
		2	to, cut out / get / isolate, (rennin) gene / DNA coding for rennin ***or*** to, fragment / digest, DNA **;**		***2*** **DO NOT CREDIT** 'cut gene' **IGNORE** 'break up DNA'
		3	gene probe **;**		
			OR		
		4	obtain rennin mRNA **;**		***NOTE***
		5	(use) reverse transcriptase **;**		***1-9*** **CREDIT** whichever of the three alternative "obtaining the gene" protocols yields most marks, **either award marking points 1-3 or 4-6 or 7-9**
		6	to make cDNA **;**		
			OR		
		7	sequence, rennin (protein) **;**		
		8	work out base code **;**		
		9	make this DNA sequence **;**		
		10	sticky ends **;**		***10*** can be awarded, once only, in Sections I or II
			Section II - Vector		
		11	cut (open), plasmid / phage **;**		***11*** **DO NOT CREDIT** 'cut out plasmid' **DO NOT CREDIT** 'ring of DNA' unless it is clear that plasmid is being referred to
		12	using same restriction enzyme **;**		***12*** **CREDIT** same named enzyme (re. mp1)
		13	annealing / base pairing of sticky ends **;**		***13*** **CREDIT** idea of sticky end bases hydrogen bonding
		14	join sugar-phosphate backbones **;**		***14*** **CREDIT** formation of phosphodiester bonds
		15	(using DNA) ligase **;**		
		16	recombinant, vector / plasmid / phage / DNA **;**		
			Section III - Introduction into host cell		
		17	mix with bacteria **;**		
		18	detail of conditions **;**		***18*** e.g. Ca^{2+} ions added / heatshock (freeze then inc to $40^{o}C$)
		19	transformation (plasmid) / transduction (phage) **;**		***19*** **CREDIT** transform / transformed / transduce / transduced **IGNORE** transgenic
				max 7	
			QWC – sequencing of steps – at least 1 mark point scored from each of the three sections, in the correct order ;	**1**	I. obtaining gene (mp **1 – 9**) followed by II. vector (mp **13 – 16**) followed by III. introduction to host cell (mp **17 – 19**)
			TOTAL	**17**	

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Question			Expected Answers	Marks	Additional Guidance
2	(a)	(i)	red ; vermillion ; cinnabar ;	3	
2	(a)	(ii)	(recessive) epistasis / epistatic ;	1	**ACCEPT** complementary epistasis **DO NOT CREDIT** dominant epistasis
2	(a)	(iii)			
		1	gene products are enzymes ;		***2*** needs to be a clear generalised statement (and not implied - e.g. by awarding mp 3) **IGNORE** 'metabolic' pathway (as given in question)
		2	multi-enzyme / multi-step, pathway ;		
		3	3, steps / enzymes, change tryptophan to red pigment ;		***3*** **ACCEPT** V, C and B are responsible for the change of tryptophan to red
		4	product of one reaction / intermediate compound, is, substrate / starting point, for next ;		
		5	dominant allele gives, functional / wild-type / AW, enzyme ;		
		6	recessive allele gives, non-functional / different / AW, enzyme ;	max 3	
2	(b)	(i)	*if (red-eyed parent) was heterozygous*		**IGNORE** ref to sex linkage
		1	there would be no difference between, sexes / males and females ;		
		2	red-eyed males **and** white-eyed females would occur ;		***2*** **ACCEPT** "because there are no red-eyed males **and** white-eyed females (in results)" "*all* 4 phenotypes would, occur / be represented" **DO NOT** infer phenotype(s) from genotype(s)
		3	1:1:1:1 ratio **or** 1:1 ratio in both sexes ;	max 2	***3*** If 4 phenotypes stated / listed *together with the ratio*, then award mp 2 as well

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<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>2</td><td>(b)</td><td>(ii)</td><td>parental genotypes XrXr XRY- ;
gametes Xr XR and Y- ;
F1 genotypes XRXr XrY- ;</td><td>3</td><td>ACCEPT alternative letters only if a KEY is given. Must have capital letter for dominant allele and small (same) letter for recessive allele.

CREDIT GAMETES either on the correct line
or in correct place on Punnett square, whichever is correct.
They do not need to be in circles.

ACCEPT ecf once only if Y wrongly shown as carrying ‘r’ allele
ACCEPT ecf once only if X and Y missing

DO NOT CREDIT F1 genotypes written in blank space if F1 phenotypes put on bottom lines instead</td></tr>
<tr><td>2</td><td>(b)</td><td>(iii)</td><td>
<table>
<tr><th>phenotype of fly</th><th>O</th><th>E</th><th>O - E</th><th>$(O - E)^2$</th><th>$\frac{(O - E)^2}{E}$</th></tr>
<tr><td>red-eyed female</td><td>27</td><td>25</td><td>2</td><td>4</td><td>0.16</td></tr>
<tr><td>white-eyed male</td><td>23</td><td>25</td><td>-2</td><td>4</td><td>0.16</td></tr>
</table>
;
;
χ^2 = 0.32 ;

no significant difference (at 95% confidence level) ;</td><td>4</td><td>One mark per row

ACCEPT fractions in last column (4/25)

ACCEPT not significant
IGNORE ref to happening by chance

ACCEPT ecf for last two points
IGNORE arguments referring to null hypothesis</td></tr>
<tr><td></td><td></td><td></td><td>Total</td><td>16</td><td></td></tr>
</table>

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Question			Expected Answers	Marks	Additional Guidance
3	(a)	(i)			
		1	similar / same, cells / metabolism ;		*1* **ACCEPT** they are all eukaryotic cells
		2	similar / same / share, genes **or** have genes in common ;		
		3	similar / same, (embryonic) development ;		
		4	shared, ancestry / ancestor **or** all related by evolution ;		*4* **CREDIT** due to phylogeny **ACCEPT** all same kingdom **IGNORE** 'they are all animals'
				max 2	
3	(a)	(ii)			**Mark the FIRST answer on each numbered line**
		1	small ;		
		2	short life cycle ;		*2* **ACCEPT** fast development / mature quickly / fast reproductive rate / short generation time
		3	easy to, keep / breed / AW ;		*3* **ACCEPT** produce many offspring
		4	cheap (to buy / keep) ;		
		5	readily available / common / not rare ;		
		6	large cells ;		
		7	previously well-studied / many known mutants ;		*7* **ACCEPT** genome has been, mapped / sequenced
				max 2	
3	(b)	(i)	scanning ; electron (microscope) ;	2	**CREDIT** SEM = 2 marks **ACCEPT** transmission electron / TEM = 1 mark **IGNORE** micrograph
3	(b)	(ii)	description of legs in place of antennae in, mutant / 3.2 / AW ;	1	**ACCEPT** projections on head / antennae / feelers, longer (in Fig. 3.2) **DO NOT CREDIT** antennae / projections vs. none **DO NOT CREDIT** mandibles / fangs **DO NOT CREDIT** incorrect statement e.g. legs on mouth
3	(b)	(iii)	homeotic / homeobox / hox ;	1	

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Question			Expected Answers	Marks	Additional Guidance
3	(c)	1	*synthesis*		**MAX 6** marks for synthesis
		2	DNA, copied into / →, mRNA **or** described **;**		**MAX 6** marks for roles
		3	transcription / transcribed **;**		
			one strand copied **;**		***1*** **DO NOT CREDIT** descriptions that contain errors
		4			
		5	complementary base-pairing **;**		***3*** **ACCEPT** coding / sense / non-sense / template, strand (implying one only)
		6	triplet code / code read in threes / codon is 3 bases **;**		***4*** **CREDIT** description of base pairing as correct to context
		7	base sequence determines amino acid sequence **;**		
		8	translation **;**		
		9	ribosomes **;**		
			role of tRNA described **;** **(max 6)**		***9*** e.g. "tRNA brings amino acid" or "tRNA anticodon binds to mRNA codon"
		10	*roles of polypeptides*		
		11	(named) structural protein **;**		
			enzymes / catalyse reactions / control metabolism **;**		***10*** e.g. actin / myosin / collagen / keratin
		12			
		13	hormones / growth factors **;**		***12*** **CREDIT** growth hormone / GH / somatotrophin / FSH
		14	receptor proteins **;**		
			adenyl cyclase / cAMP **;**		***14*** most likely to be expressed in context of mp 12
		15			
			idea of switching genes, on / off **;**		***15*** **CREDIT** transcription factors / regulatory proteins / repressor proteins
		16			
			homeotic / homeobox, genes		
		17	**or** homeodomain proteins **;**		
			idea of master switch gene / one gene turns on/off whole set of other genes / cascades of gene switching **;**		
		18			
			apoptosis **;** **(max 6)**		
				7 max	
			QWC – balanced account ;	**1**	At least 2 marks from points 1 - 9 **and** at least 2 marks from points 10 – 18
			Total	**16**	

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<table>
<tr><th colspan="3">Question</th><th>Expected Answers</th><th>Marks</th><th>Additional Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td></td><td>
<table>
<tr><th></th><th>similarity</th><th>difference</th></tr>
<tr><td>structure</td><td>mitochondria
or
vesicles
or
postsynaptic receptors ;</td><td>NMJ membrane(s), wavy / AW * ora
or
receptors different (shape)
or
enzymes in different places ;</td></tr>
<tr><td>function</td><td>(neuro)transmitter, released / crosses gap
or
changes potential difference / AW **
or
enzymes break down (neuro)transmitter ;</td><td>different neurotransmitters / ACh vs. dopamine
or
muscle contraction vs. nerve impulse
or
different enzymes ;</td></tr>
</table>
</td><td>4</td><td>One mark per box

difference
NMJ is neuromuscular junction
* AW ACCEPT wiggly / bumpy / not smooth / rough / larger SA / any suitable description but IGNORE microvilli

difference
ACh is acetylcholine

similarity
** AW CREDIT depolarises / -70 mV → +40 mV but IGNORE pass on action potential</td></tr>
<tr><td>4</td><td>(b)</td><td>(i)
1

2
3

4</td><td>phenelzine ;

no ecf from incorrect drug
idea that does not bind to (dopamine) receptor ; ora
idea that binds to, MAO / enzyme ;

allosteric site / non-competitive inhibitor ;</td><td>1

max 1</td><td>Award mp1 and, if correct, any 1 from the remaining points

2 CREDIT other two do bind to dopamine receptor
3 IGNORE inhibits, MAO / enzyme (as given in the question)
4 ACCEPT “not a competitive inhibitor”</td></tr>
<tr><td>4</td><td>(b)</td><td>(ii)</td><td>(drug) occupies / blocks / binds to, (dopamine) receptors ;
without causing, action potential / response ;
reduces effect of dopamine / is a dopamine antagonist ;</td><td>2</td><td>CREDIT “without causing depolarisation” / AW
DO NOT CREDIT “inhibits dopamine” or “reduces dopamine levels</td></tr>
</table>

8

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Question			Expected Answers	Marks	Additional Guidance
4	(c)	(i)	humans are, diploid / 2n ; chromosomes, are in pairs / homologous ; one, (copy / gene / allele), from each parent / on each chromosome of pair ;	2 max	**DO NOT CREDIT** ref to bivalents
4	(c)	(ii)	(gel) <u>electrophoresis</u> ;	1	
4	(d)	1	13 b-p deletion (has most serious consequences) ;		
		2	frameshift / alter reading frame ;		
		3	genetic code is triplet / read in groups of 3 bases ;		
		4	alters all amino acids (coded for) after the mutation ;		
		5	21 b-p deletion causes 7 amino acids to be lost ;		
		6	substitution changes, one / no, amino acids ;	3 max	***6*** **CREDIT** could be a silent mutation / 1 b-p substitution may not have an effect
4	(e)	1	<u>natural selection</u> ;		
		2	<u>selective advantage</u> ;		
		3	(allele / behaviour) increases, survival / breeding / AW ;		***3*** **CREDIT** increases reproductive success / AW
		4	(because) helped, find food / find new resources / make new tools / get mates ;		***4*** **ACCEPT** more promiscuous / AW
		5	<u>allele</u> passed on (to next generation) ;		
		6	(allele / behaviour) increased in frequency over, generations / time ;	4 max	***6*** **MUST HAVE** time element
			Total	18	

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Question			Expected Answers	Marks	Additional Guidance
5	(a)		ecosystem ; producers / autotrophs ; primary ; trophic level(s) ; biotic / living ; minerals / elements ;	6	**DO NOT CREDIT** plants **DO NOT CREDIT** tropic **CREDIT** named, element / ion, e.g. nitrogen, nitrate **ACCEPT** symbol e.g. N / NO_3^- **ACCEPT** nutrient **DO NOT CREDIT** energy / waste products
5	(b)	(i)			
		1	limiting / density-dependent, factors ;		
		2	carrying capacity ;		
		3	intraspecific competition ;		***3*** **ACCEPT** description e.g. ● "competition with other members of the same species" ● "competition with other (small) squirrels"
		4	for, food / nesting sites ;		***4*** **ACCEPT** they run out of food
		5	interspecific competition ;		***5*** **ACCEPT** description e.g. "competition with other species"
		6	with, deer / tree shrew / giant squirrel ;		
			larger squirrel populations		
		7	attract more predators ;		***7*** **DO NOT CREDIT** predation alone, must be linked to larger squirrel population
		8	parasites / diseases, spread more easily ;		***8*** **DO NOT CREDIT** disease alone, must be linked to larger squirrel population
				max 4	

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Question			Expected Answers	Marks	Additional Guidance
5	(b)	(ii)	species richness & evenness decrease **; ora** (richness) 29 → 26 (species) **;** (evenness) large numbers of, 2 / some, species, but, low numbers / none, of other species **;**	**max 2**	**ACCEPT** they both, decrease / decline / fall **or** they were higher at start **ACCEPT** 6 → 4 **or** 2 fewer (from table) **or** 3 fewer (from text) **CREDIT** suitable named e.g.s from table
5	(c)	(i)	rare initially / AW **;** prey, numbers have reduced / have become extinct / have left the area **;** idea of slower reproductive rate / AW **;**	**max 1**	**ACCEPT** that there weren't very many at start **DO NOT CREDIT** 'lack of food' unless has indicated that food is an animal **ACCEPT** don't breed as fast / don't have as many offspring
5	(c)	(ii)		**max 3**	**Mark the FIRST suggestion on each numbered line**
		1	aesthetic / amenity / recreational, value **;**		***1*** **ACCEPT** description, e.g. beautiful / so people will visit / so people will use it for leisure
		2	(eco)tourism **;**		***2*** **ACCEPT** description, e.g. raise money from visitors
		3	to, preserve biodiversity / preserve genetic diversity / stop extinction **;**		***3*** **ACCEPT** description, e.g. keep more species
		4	ref. interactions between species / need to preserve whole habitat **;**		***4*** **ACCEPT** description, e.g. if habitat destroyed there will be a knock-on effect on many species
		5	(rainforest species / preserve gene pool as) could be useful, in future / as potential, for, medicine / genetic engineering / AW **;**		***5*** **ACCEPT** for drugs, pharmaceuticals, GM or GM e.g. (like crop improvement)
		6	to support indigenous peoples / AW **;**		***6*** **ACCEPT** let native people continue to live in forest income for indigenous people
		7	to stop effect of deforestation on, atmosphere / climate / soil **;**		***7*** **ACCEPT** to stop, CO_2 % rising / global warming / erosion **or** forest acts as C, sink / store
		8	AVP **;**		***8*** e.g. ● habitat for pollinators ● habitat for predators of pests **DO NOT CREDIT** 'right to life'

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Question			Expected Answers	Marks	Additional Guidance
5	(d)		*management practices*		**LOOK FOR** key ideas expressed in different ways
		M1	coppicing / pollarding / description ;		***M1*** **CREDIT** coppicing with standards / rotational coppicing
		M2	selective felling / description ;		***M2*** **ACCEPT** only some trees cut down
		M3	rotational felling / description ;		***M3*** **ACCEPT** cycle of felling different areas
		M4	strip felling ;		
		M5	replant after felling ; **(max 2)**		
			explanation of benefits re. sustainability		
		B1	preserves / prevents disruption to, habitat / ecosystems / nesting sites ;		
		B2	maintains / increases, species diversity / biodiversity ;		
		B3	prevents, soil erosion / leaching ;		
		B4	less disturbance by machinery ;		
		B5	AVP ; **(max 2)**		***B5*** **CREDIT** specific benefits linked to a practice e.g. ● faster recovery due to seeding from untouched areas nearby (M3) ● pollarding so deer can't eat shoots (M1)
				max 4	
			Total	**20**	

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Question			Expected Answers	Marks	Additional Guidance
6	(a)	1	to cope with changing conditions / AW ;		***1*** Looking for a general statement **DO NOT CREDIT** "adapt to change"
		2	avoid <u>abiotic</u> stress ;		
		3	to maximise photosynthesis **or** to obtain more, light / water / minerals **; ora**		***3*** **CREDIT** named elements / ions **IGNORE** nutrients
		4	avoid, herbivory / grazing ;		***4*** methods of preventing grazing could include producing more toxins / more spines / encouraging stinging ants **IGNORE** predation
		5	to ensure, germination in suitable conditions / pollination / seed set / seed dispersal ;	**max 2**	***5*** **DO NOT CREDIT** 'maximise reproduction' without further qualification
6	(b)	(i)			
		1	in water / in **A** / with no abscisic acid, germination increases as conc. GA increases ;		
		2	when abscisic acid present / in **B**, no germination ;		***2*** **DO NOT CREDIT** 'inhibits germination' (as this is a conclusion not a description)
		3	maximum germination 90% with 5 mol dm^{-3} GA, in water / without abscisic acid ;		***3*** **ACCEPT** 91% (± 2%) for 90%
		4	2 comparative figures (x and y refs. plus units) ;		***4*** EITHER compare **A** and **B** at the same GA conc OR two points on same line **with units for both**
		5	GA concentration increases, logarithmically / by a factor of 10, on x axis ;		
		6	10 times more GA gives, 3 (conc 0.05 to 0.5) / 0.5 (conc 0.5 to 5), times more germination ;	**4 max**	

GA conc (mol dm^3)	A (%)	B (%)
0	10 ± 2	0
0.05	22 ± 2	0
0.5	66 ± 2	0
5	91 ± 2	0

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Question			Expected Answers	Marks	Additional Guidance
6	(b)	(ii)			
		1	so temperature doesn't affect results / so only desired variable(s) changed / to show just the effect of plant hormones ;		*1* **ACCEPT** fair test **IGNORE** to control temperature / temperature is a limiting factor / temperature is a controlled variable
		2	since temperature affects enzyme activity ;		*2* **CREDIT** "optimum temperature for enzyme activity" or "this is the temperature when enzymes work best"
		3	suitable / optimum, temperature for (lettuce) germination ;	2 max	*3* **ACCEPT** 'these' seeds
6	(b)	(iii)			**Mark the FIRST suggestion on each numbered line** **DO NOT CREDIT** conc, GA / giberrellin (as this is the independent variable) **IGNORE** number of seeds (as given in the question)
		1	volumes of liquid(s) ;		*1* **DO NOT CREDIT** amounts / levels **CREDIT** volume of, water / GA / ABA
		2	ABA concentration ;		
		3	oxygen availability ;		*3* **IGNORE** carbon dioxide
		4	age of seeds ;		
		5	previous storage of seeds / viability idea ;		
		6	genotype / variety, of seeds ;		*6* **CREDIT "**from same batch of seeds" or "seeds from same plant"
		7	size / type of, petri dish / filter paper ;		
		8	length of time experiment left for (before recording results) ;		
		9	space between seeds ;		
		10	AVP ;		*10* e.g. ● light qualified (duration / intensity / wavelength) ● use of distilled water ● all lids, off / on
				3 max	

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Question			Expected Answers	Marks	Additional Guidance
6	(c)				**Mark the FIRST TWO suggestions** **IGNORE** the names of plant growth regulators
		1	seedless, fruits / grapes **;**		
		2	weedkillers **;**		
		3	rooting powder / to grow cuttings / used in tissue culture **;**		
		4	control fruit ripening **;**		***4*** could be used to speed up or slow down
		5	controls fruit drop **;**		
		6	restrict hedge growth **;**		
		7	preserve, cut flowers / green vegetables **;**		
		8	specific example of improved fruit quality **;**		***8*** e.g. ● longer stalks on grapes ● longer apples
		9	producing malt / in brewing **;**		
		10	AVP **;**		***10 & 11*** e.g. ● promoting sexual maturity in conifers ● promoting latex flow in rubber plants ● promoting sexual maturity in female cucumber plants ● longer nodes in sugar cane ● restricting growth in, chrysanthemums / other e.g.
		11	AVP **;**	**2 max**	
			Total	**13**	

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