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.

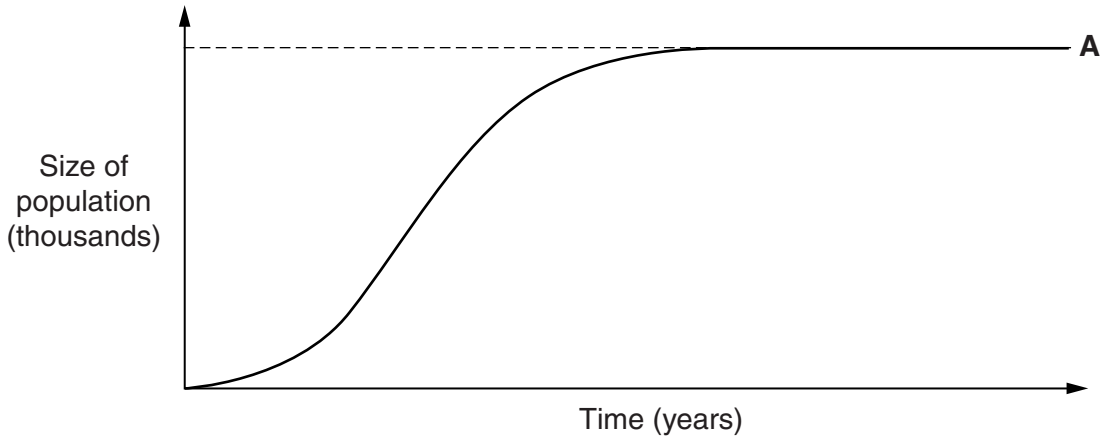


Fig. 1.1

(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.

.....

.....

..... **[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.

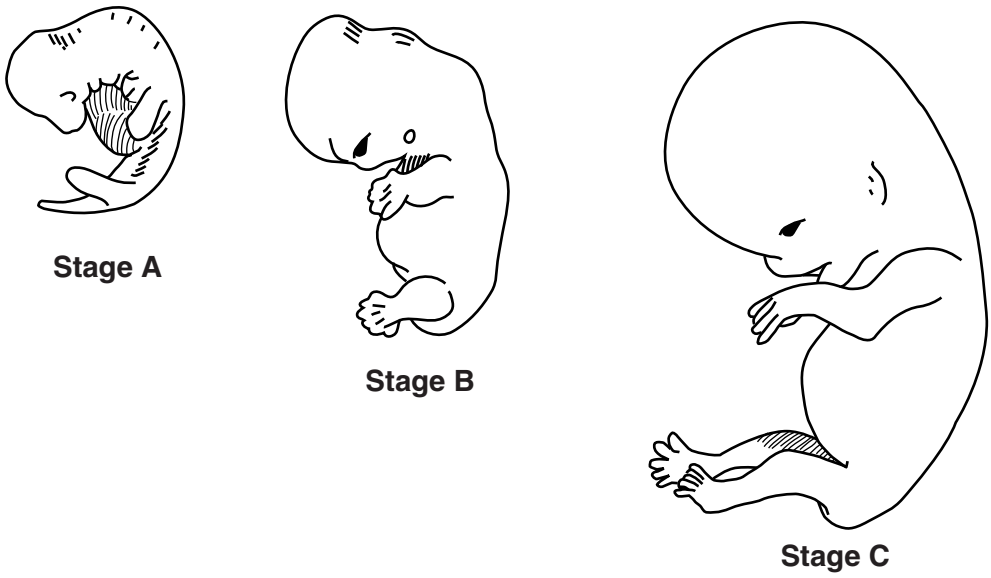


Fig. 2.1

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

.....

.....

..... **[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.

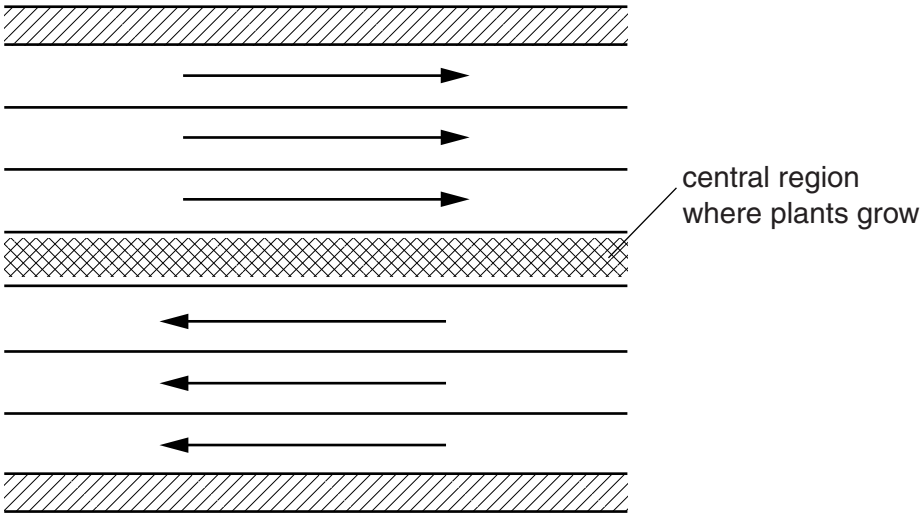


Fig. 3.1

(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.

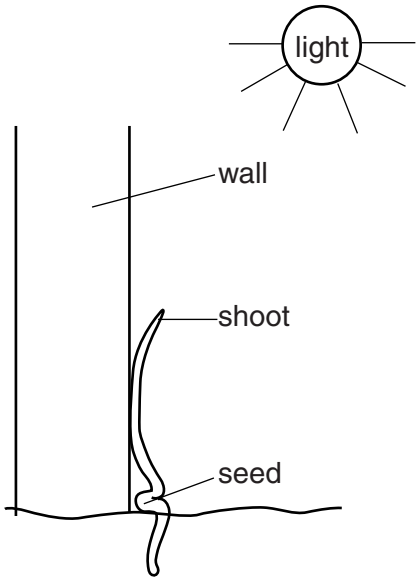


Fig. 3.2

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?

.....

..... **[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.

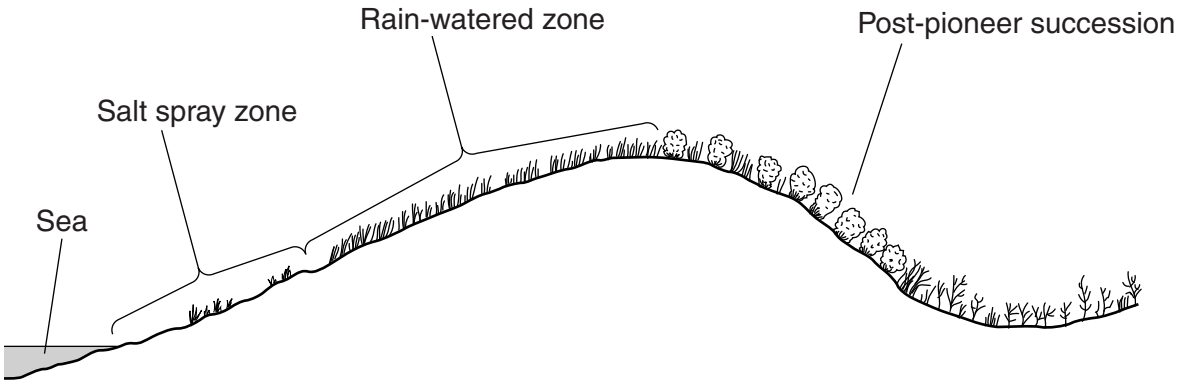


Fig. 4.1

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 <u>muscle</u> 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.

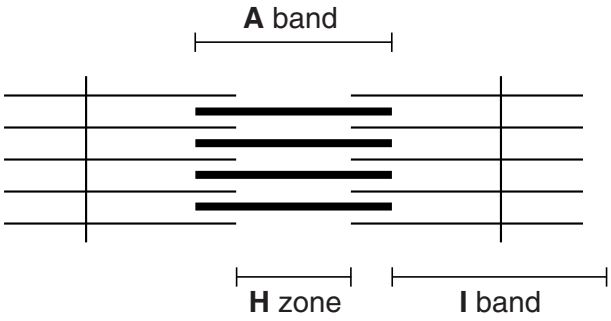


Fig. 5.1

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.

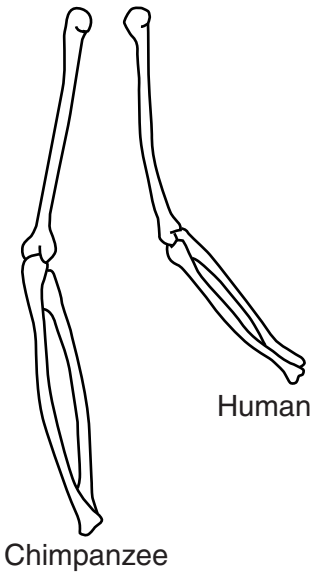


Fig. 5.2

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.

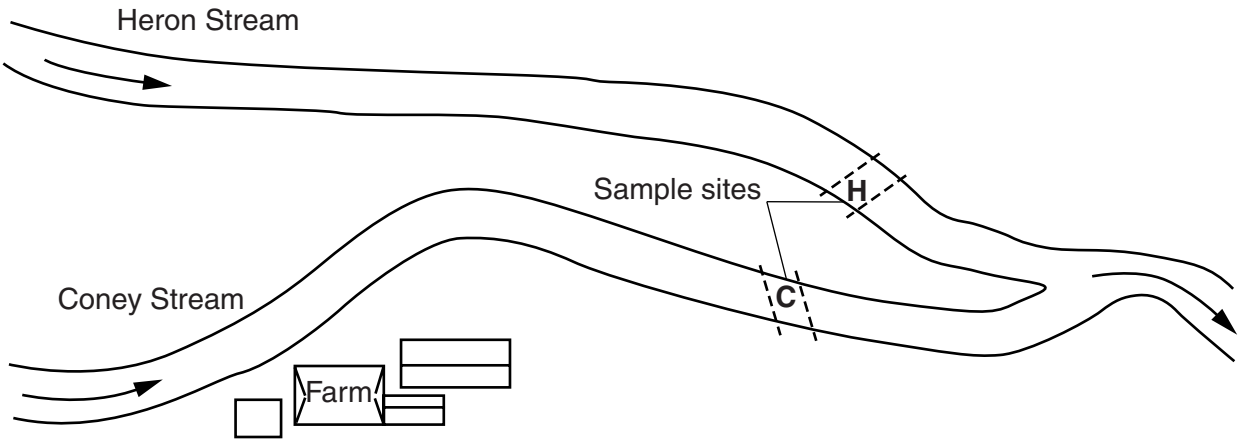


Fig. 6.1

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.

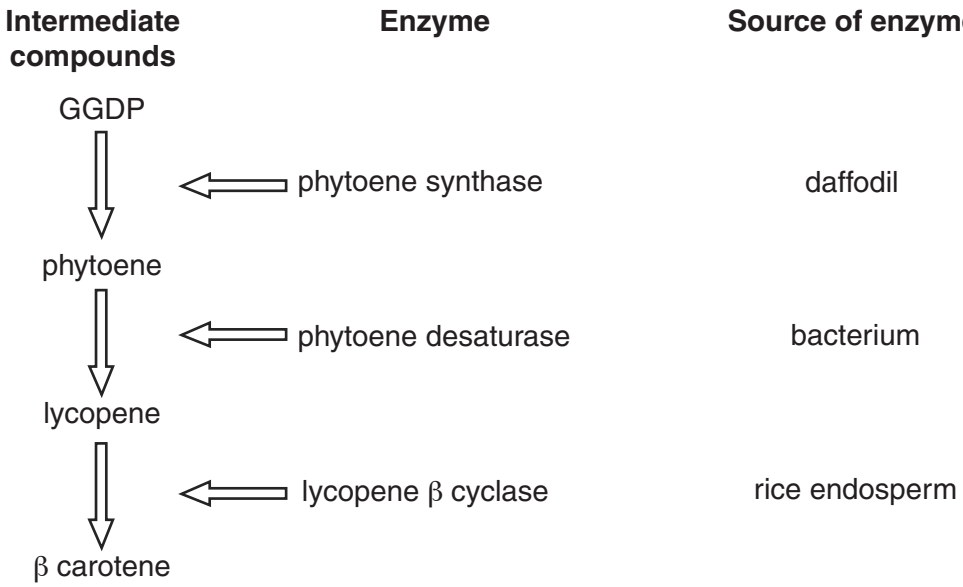


Fig. 7.1

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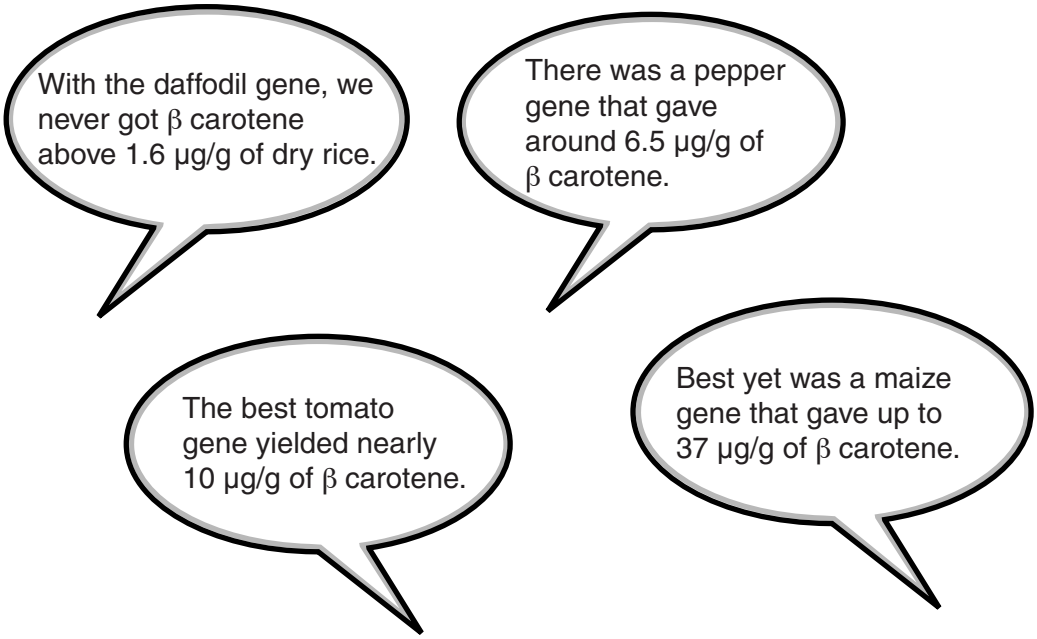
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..... **[2]**

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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

.....

.....

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**.

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..... **[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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