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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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.

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.....

.....

..... **[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

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gene locus

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..... **[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.

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..... **[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.

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..... **[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.

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

[Total: 21]

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

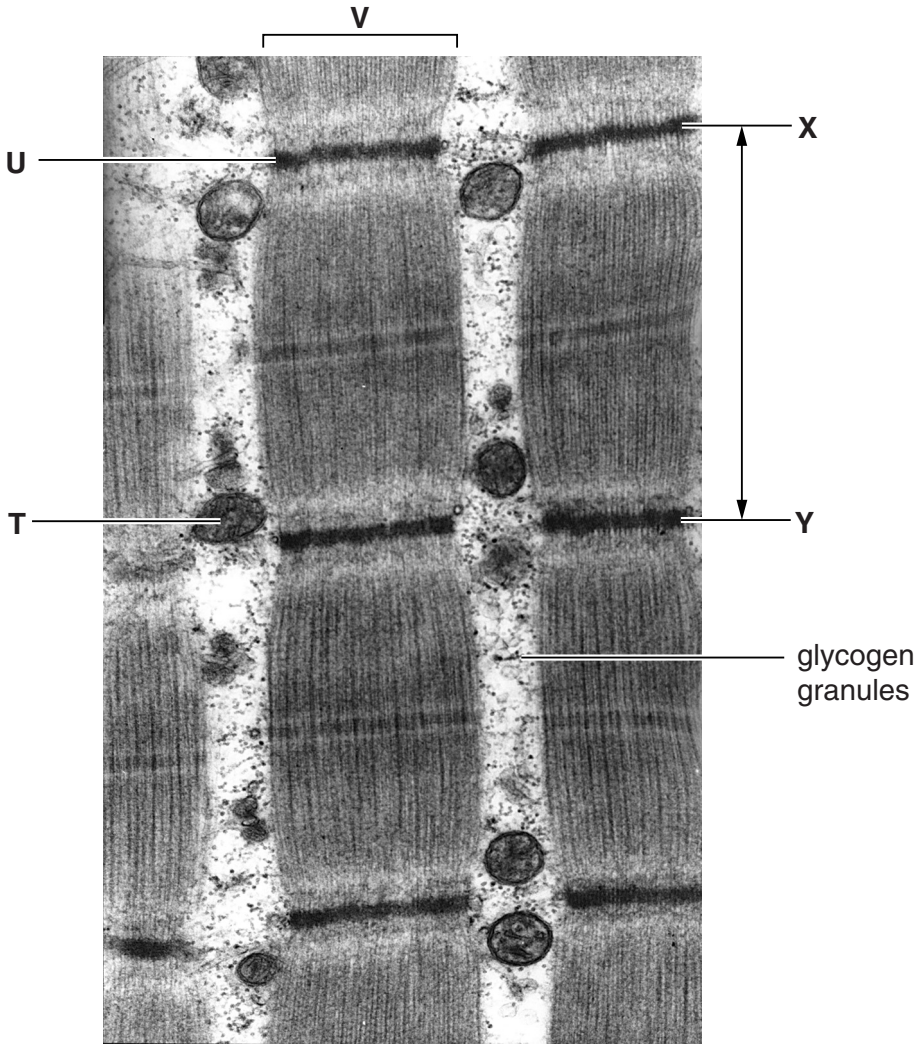


Fig. 2.1

(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.

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..... **[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.

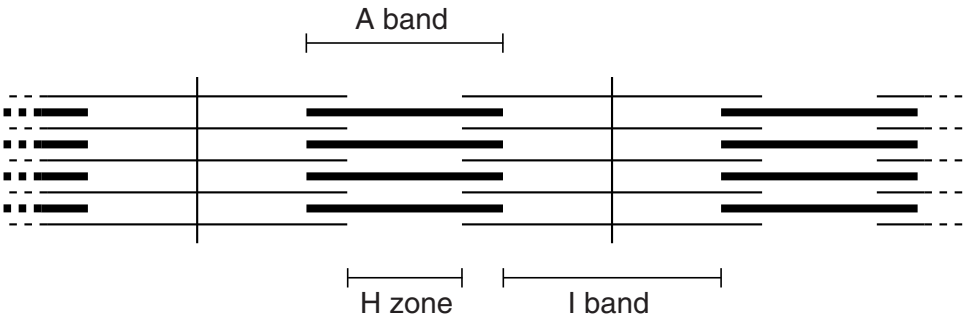


Fig. 2.2

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*.

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..... **[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 .....

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disadvantages.....

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..... **[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.

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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.

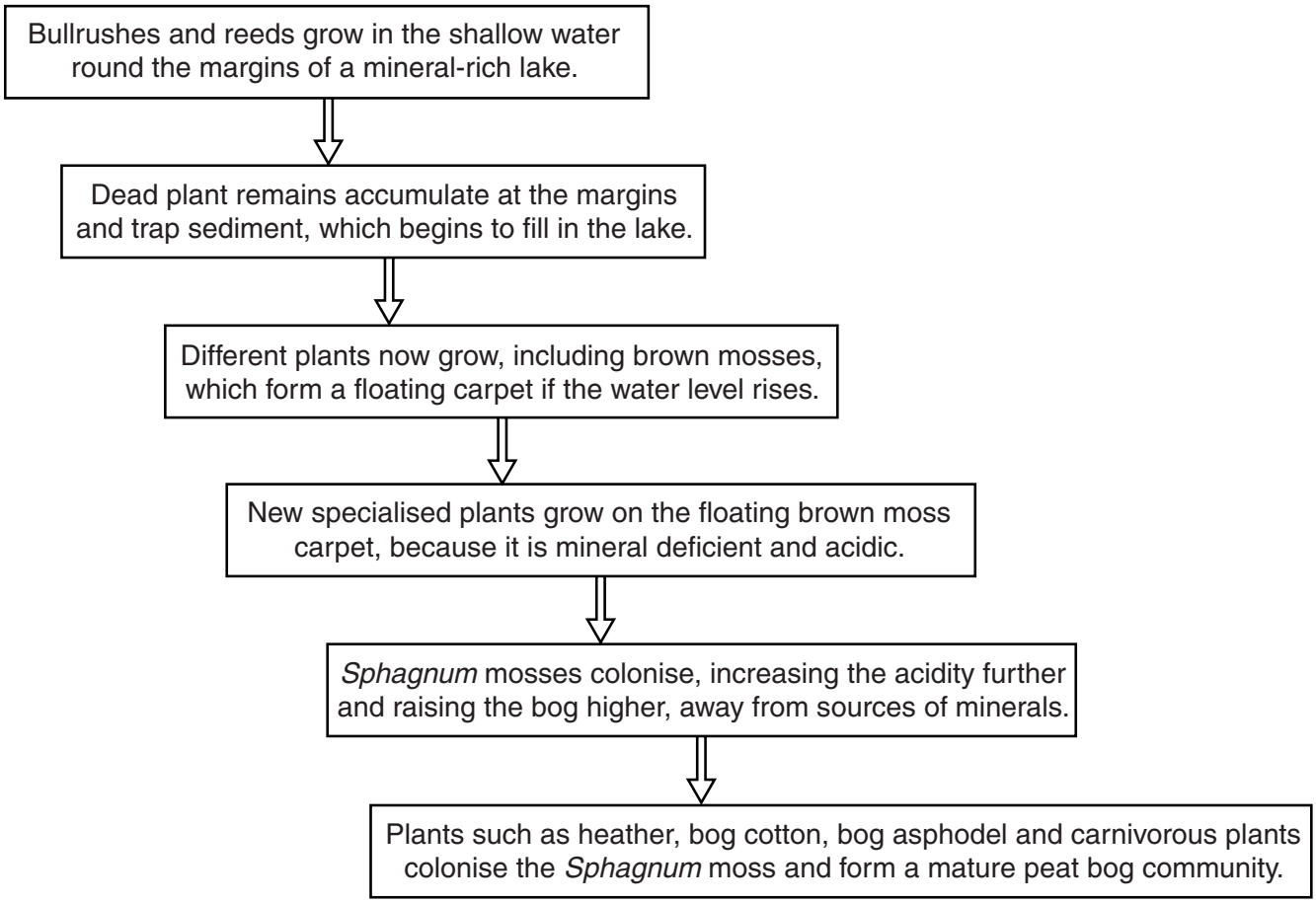


Fig. 5.1

(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 .....

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..... **[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.

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

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

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..... **[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.

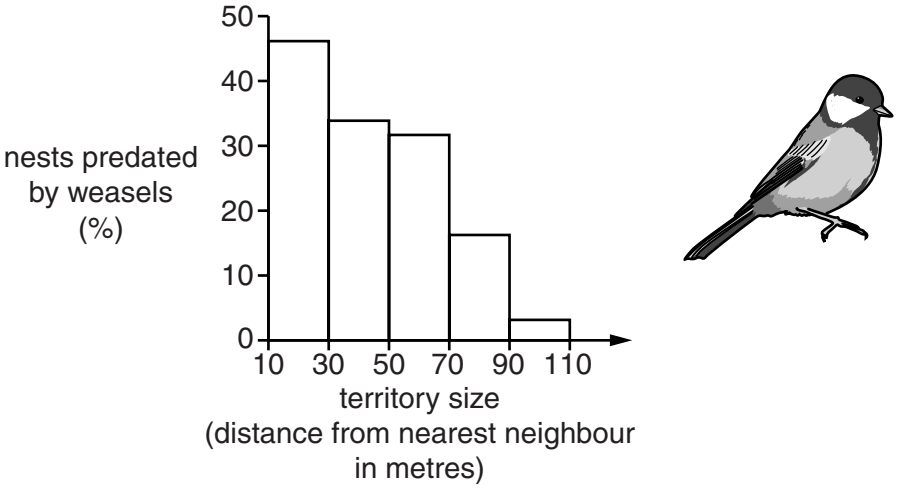


Fig. 6.1

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

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

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

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..... **[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.

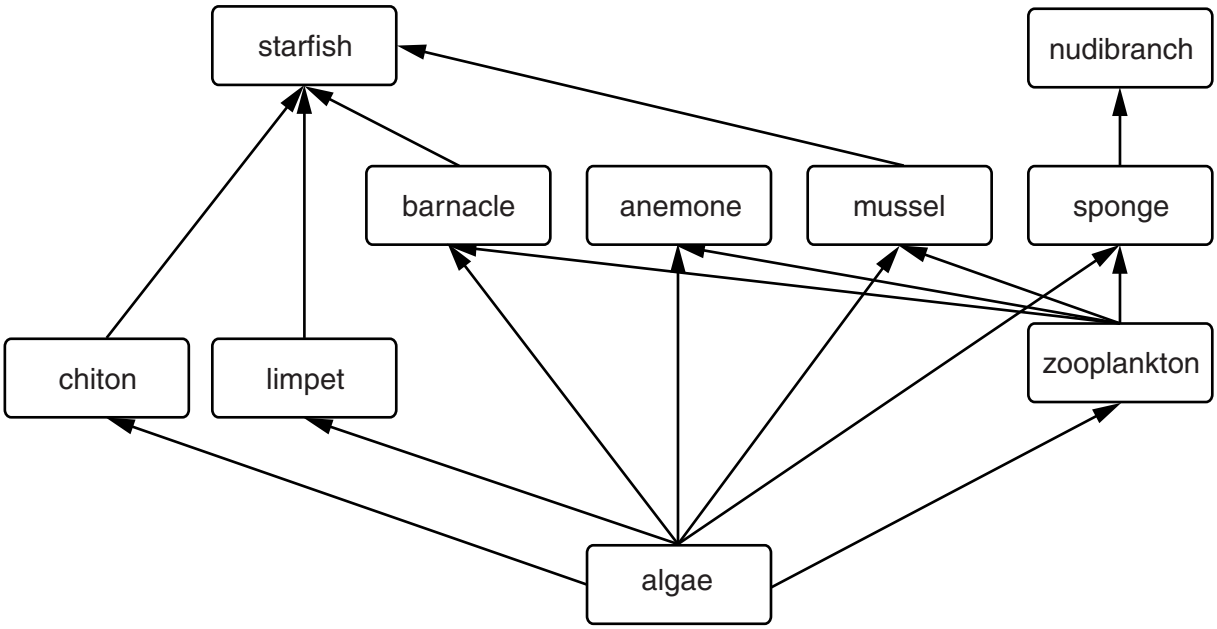


Fig. 6.2

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.

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..... **[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.

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..... **[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.

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..... **[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*.

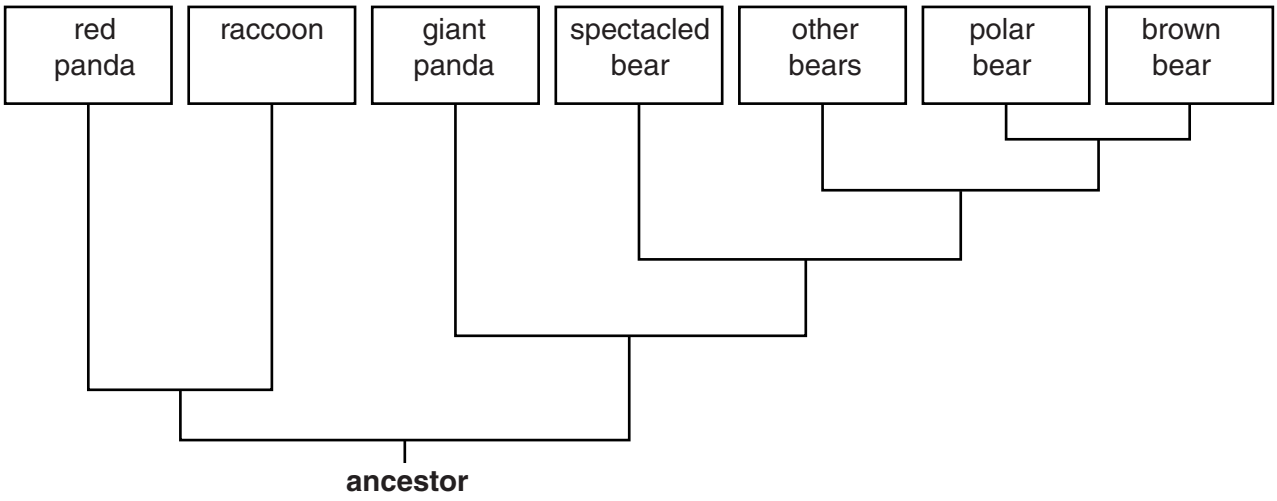


Fig. 7.1

(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.

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..... **[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.

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..... **[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.

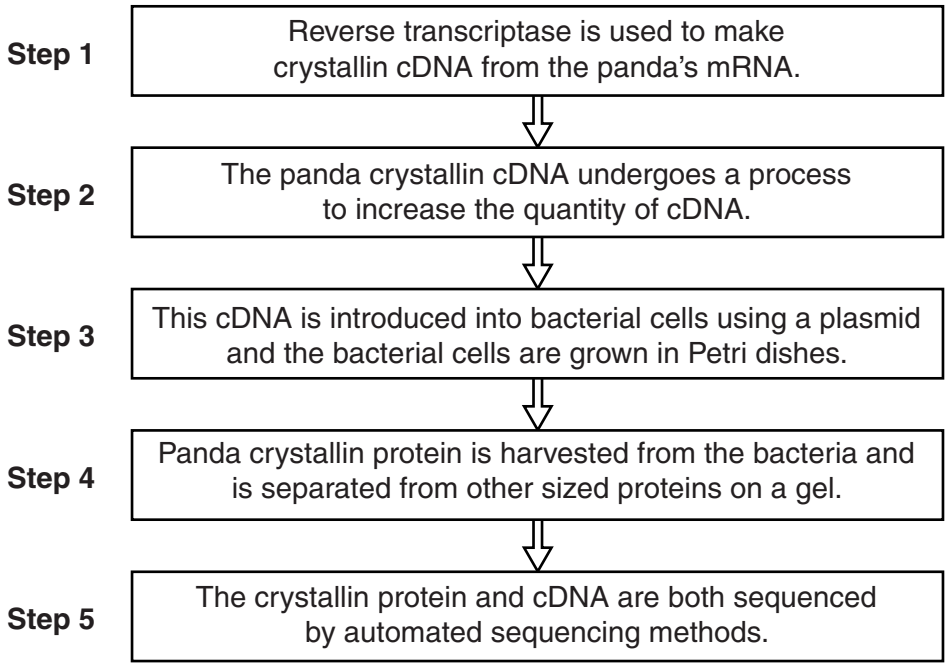


Fig. 7.2

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.

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..... **[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.

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..... **[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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