Question: 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

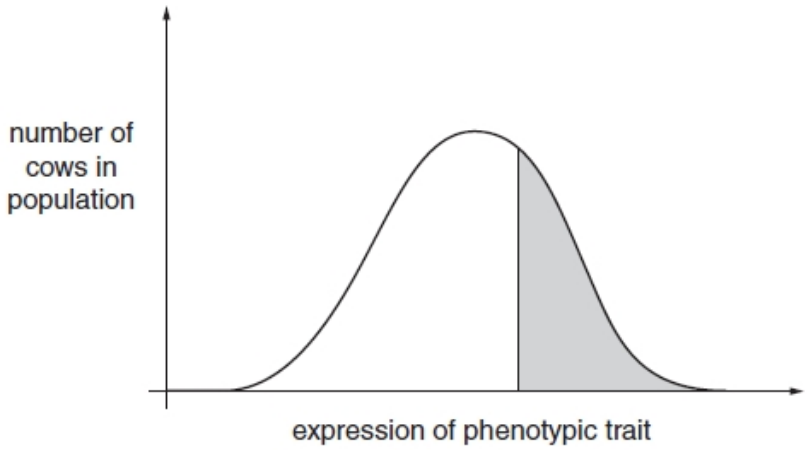


Fig. 1.1

[2]

(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]

(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

.

_____

_____

_____

_____

_____

[2]

(ii) Adult humans who cannot produce the enzyme lactase are described as lactoseintolerant 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.

_____

_____

_____

_____

_____

[2]

(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.

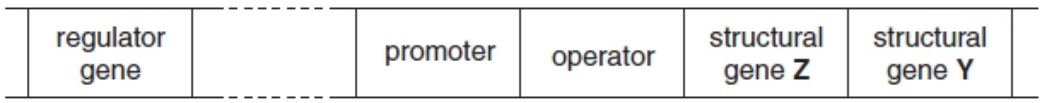


Fig. 1.2

Describe how genes Z and Y are switched on in bacteria that are moved to a nutrient medium that contains lactose.

_____

_____

_____

_____

_____

[3]

[Total: 16]

Question: 2

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]

(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.

_____

_____

_____

_____

_____

[5]

(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]

Question: 3

(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*.

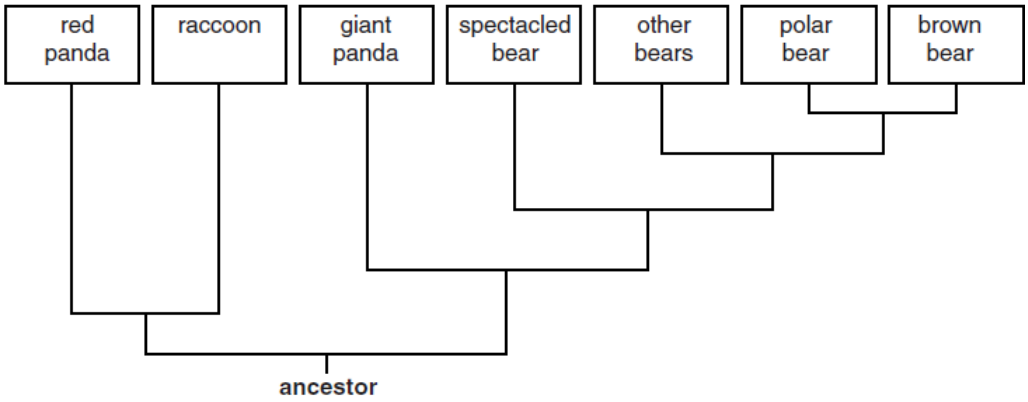


Fig. 7.1

(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.

(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.

[3]

(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.

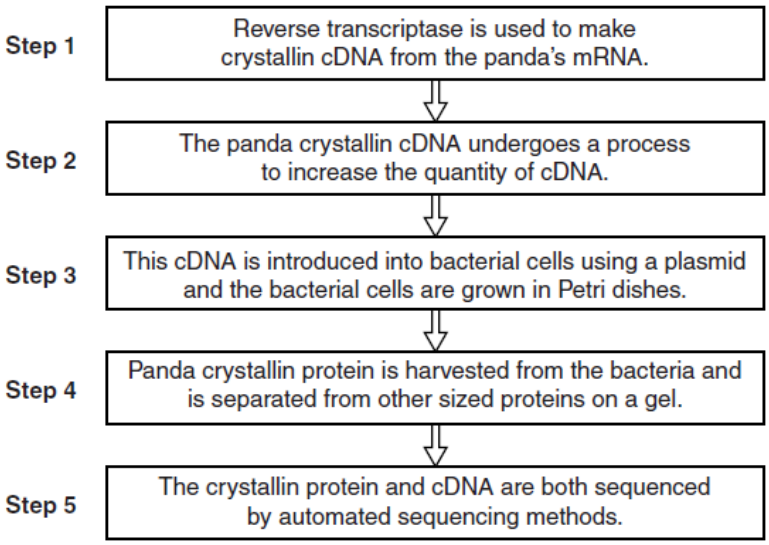


Fig. 7.2

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]

(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]

Question: 4

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	16000
1985	7000	19000
1990	9500	42000
1995	12500	58000
2000	17500	68000
2005	27500	125000

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]

(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]

(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.

_____

_____

_____

_____

_____

[2]
[Total: 13]

Question: 5

Microorganisms are often used in biotechnological processes.

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

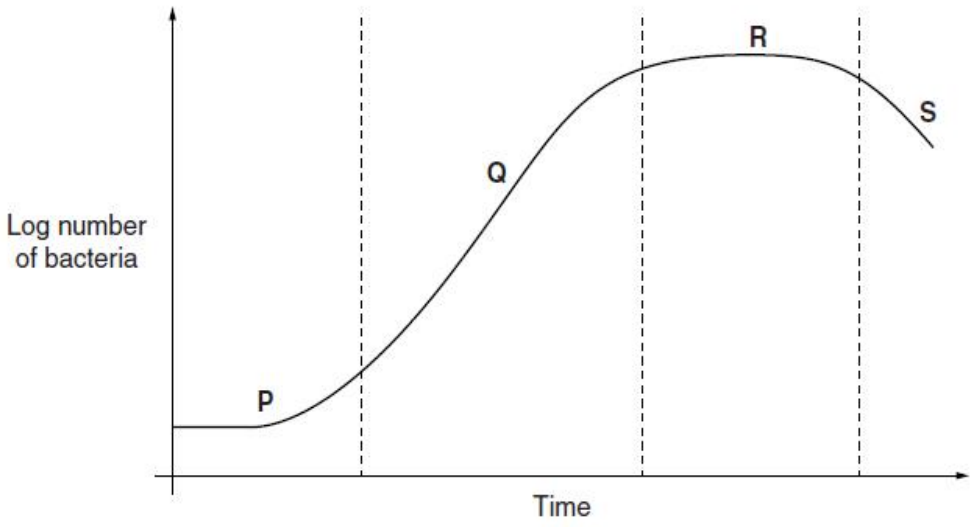


Fig. 6.1

(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]

(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.

[3]
[Total: 15]

Question: 6

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.

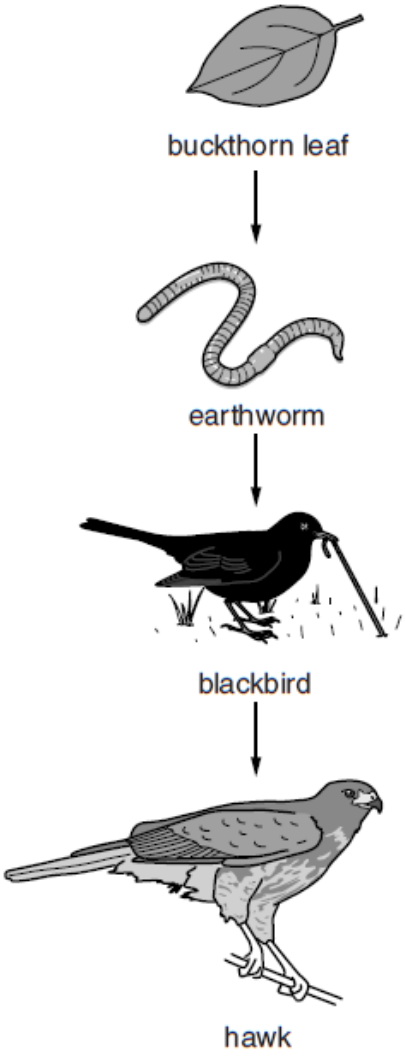


Fig. 8.1

(a) Define the following terms:

producer .....

consumer .....

trophic level .....

[3]

(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.

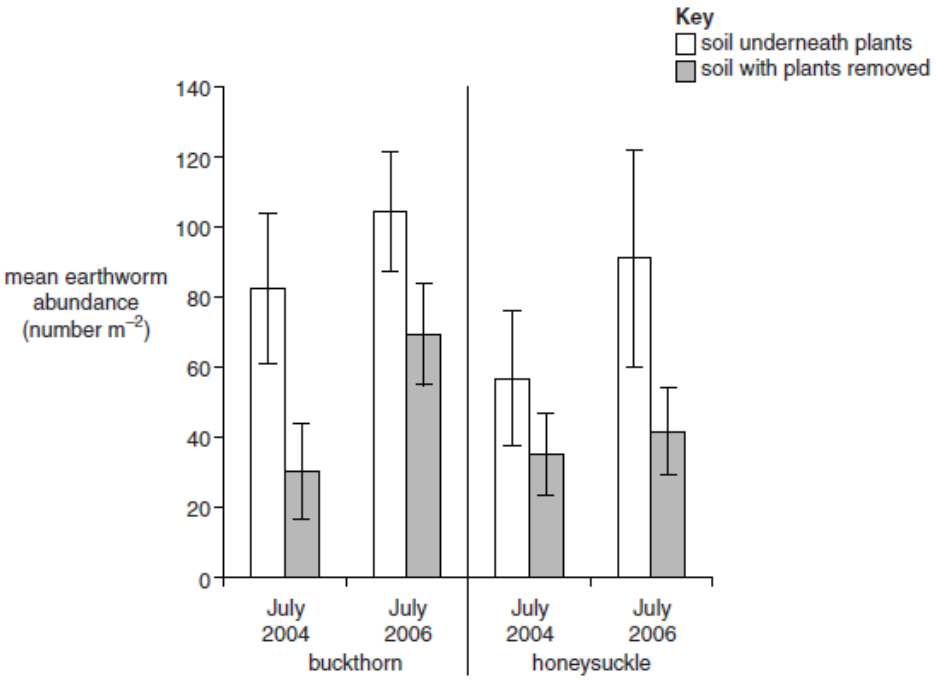


Fig. 8.2

(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]

Question: 7

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.

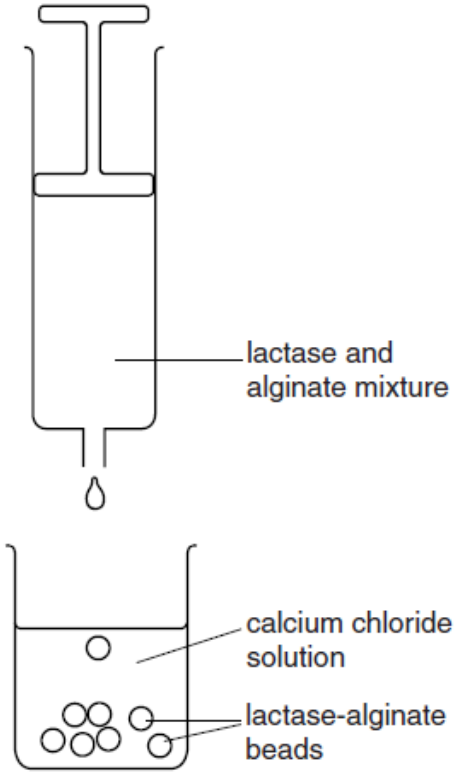


Fig. 1.1

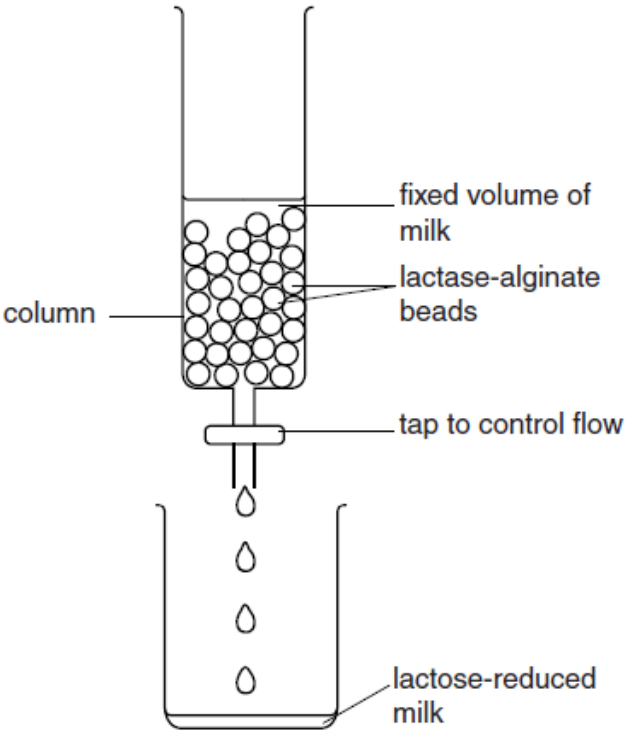


Fig. 1.2

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

_____

_____

_____

_____

_____

[2]

(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.

_____

_____

_____

_____

_____

[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.

_____

_____

_____

_____

_____

[4]
[Total: 8]

Question: 8

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

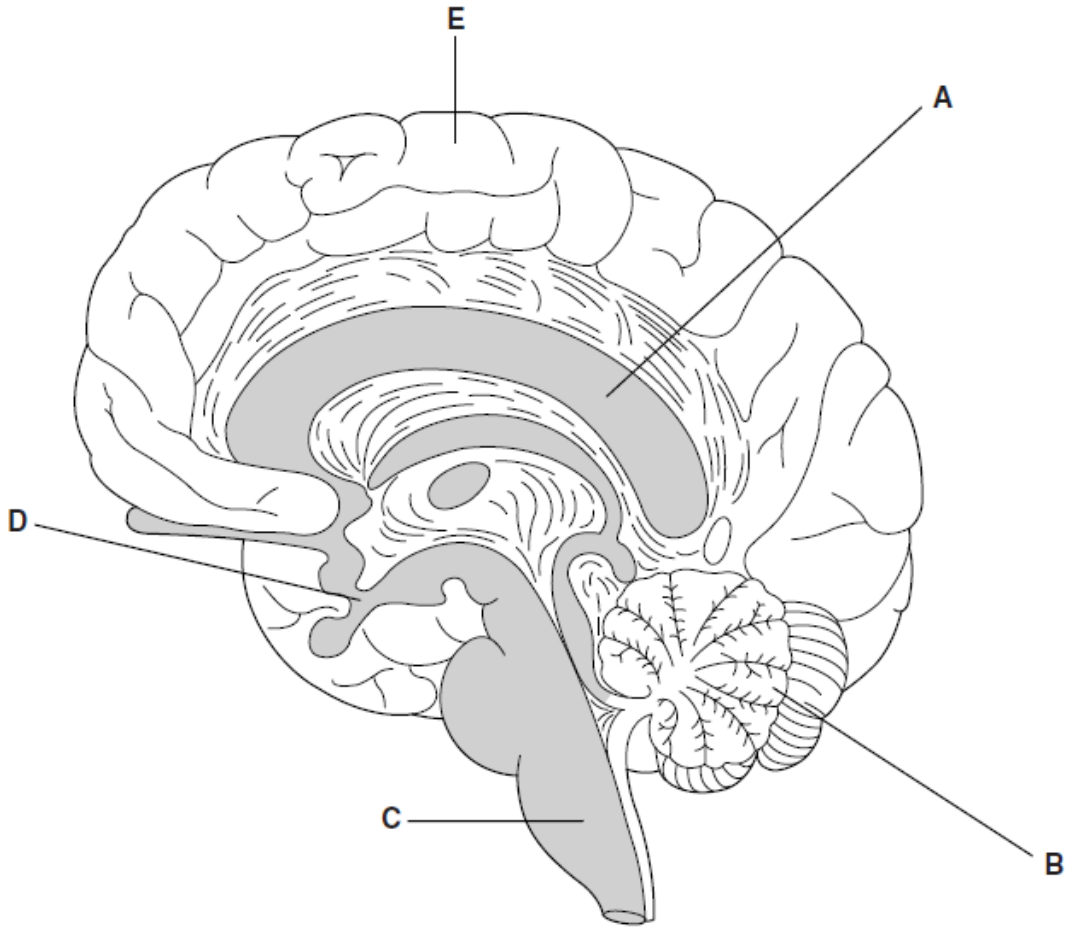


Fig. 2.1

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

(i) co-ordination of the autonomic control of heart rate

[1]

(ii) co-ordination of osmoregulation by the kidney

[1]

(iii) co-ordination of the muscles involved in walking in an adult

[1]

(iv) co-ordination of the muscles required to bend the elbow joint deliberately

[1]

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

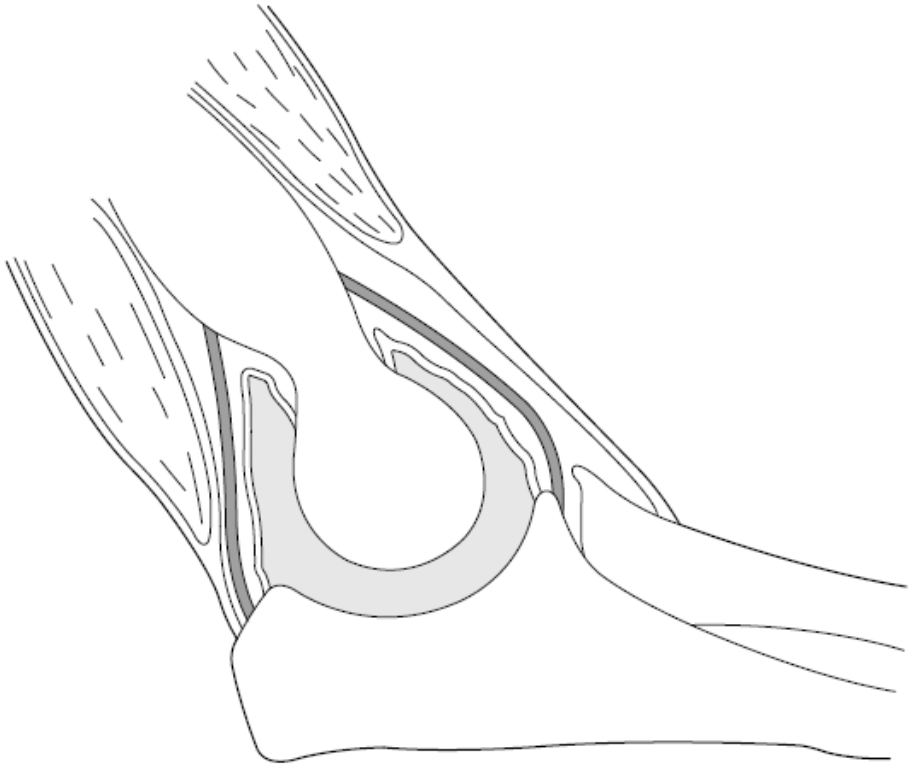


Fig. 2.2

(b) Describe how three named components of the elbow joint interact to bring about hinge movement (bending of the arm).

_____

_____

_____

_____

_____

[3]

(c) Outline the organisation and roles of the autonomic nervous system in mammals.

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

_____

_____

_____

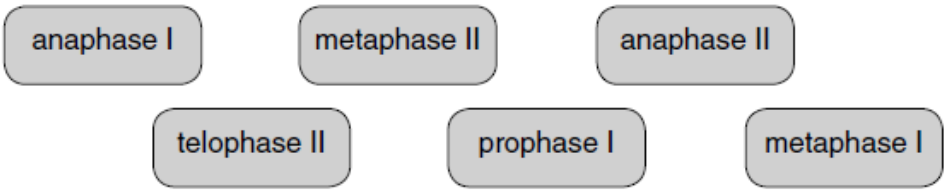
_____

_____

[8]
[Total: 15]

Question: 9

(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.

_____

_____

_____

_____

_____

[2]

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

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

_____

_____

_____

_____

_____

[1]

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

_____

_____

_____

_____

_____

[3]
[Total: 11]

Question: 10

(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]

(ii) electrophoresis

[2]

(iii) digestion of DNA by restriction enzymes.

[2]

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

[2]

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

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

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

Table 5.1

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

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

Show your working.

Answer =

[2]

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

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

[2]

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

[1]

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

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

_____

_____

_____

_____

_____

[2]
[Total: 18]

Question: 11

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 identify 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 complete 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		✕	

Table 5.1

[5]

(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.

_____

_____

_____

_____

_____

[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]

Question: 12

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, asonly 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]

(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 .....

_____

_____

_____

_____

_____

[5]

female .....

_____

_____

_____

_____

_____

(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]

Question: 13

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.

[5]

(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]

(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 take.

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

_____

_____

_____

_____

_____

[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.

_____

_____

_____

_____

_____

[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.

_____

_____

_____

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_____

[2]

[Total: 21]

Question: 14

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]

Question: 15

(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
	✓	×	✓	×
	✓	✓	×	×
	×	✓	×	×
	✓	✓	×	✓
	✓	×	×	×

Table 7.1

[5]
[Total: 9]