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.

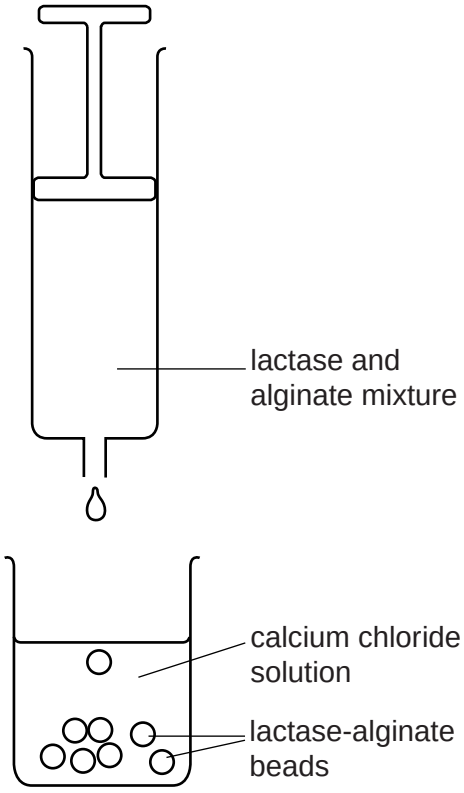

Fig. 1.1

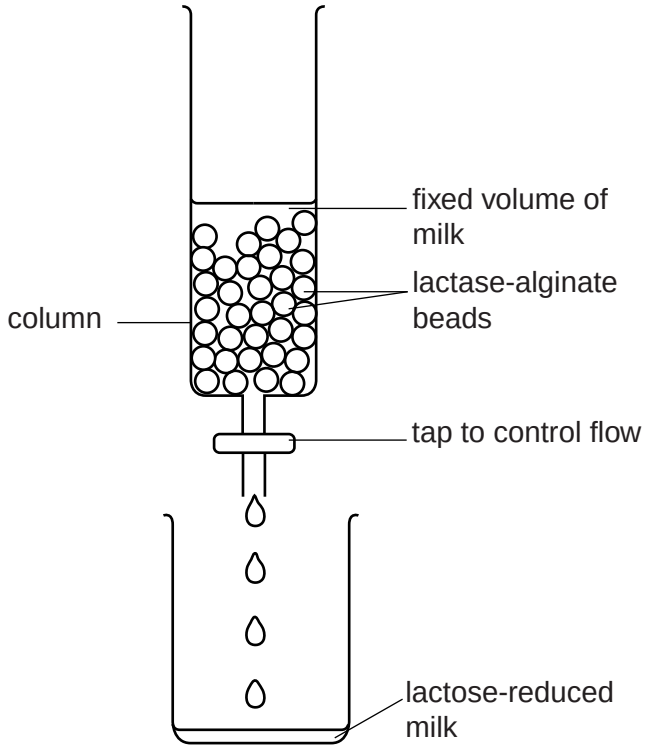

Fig. 1.2

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

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..... **[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.

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(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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[Total: 8]

Turn over

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

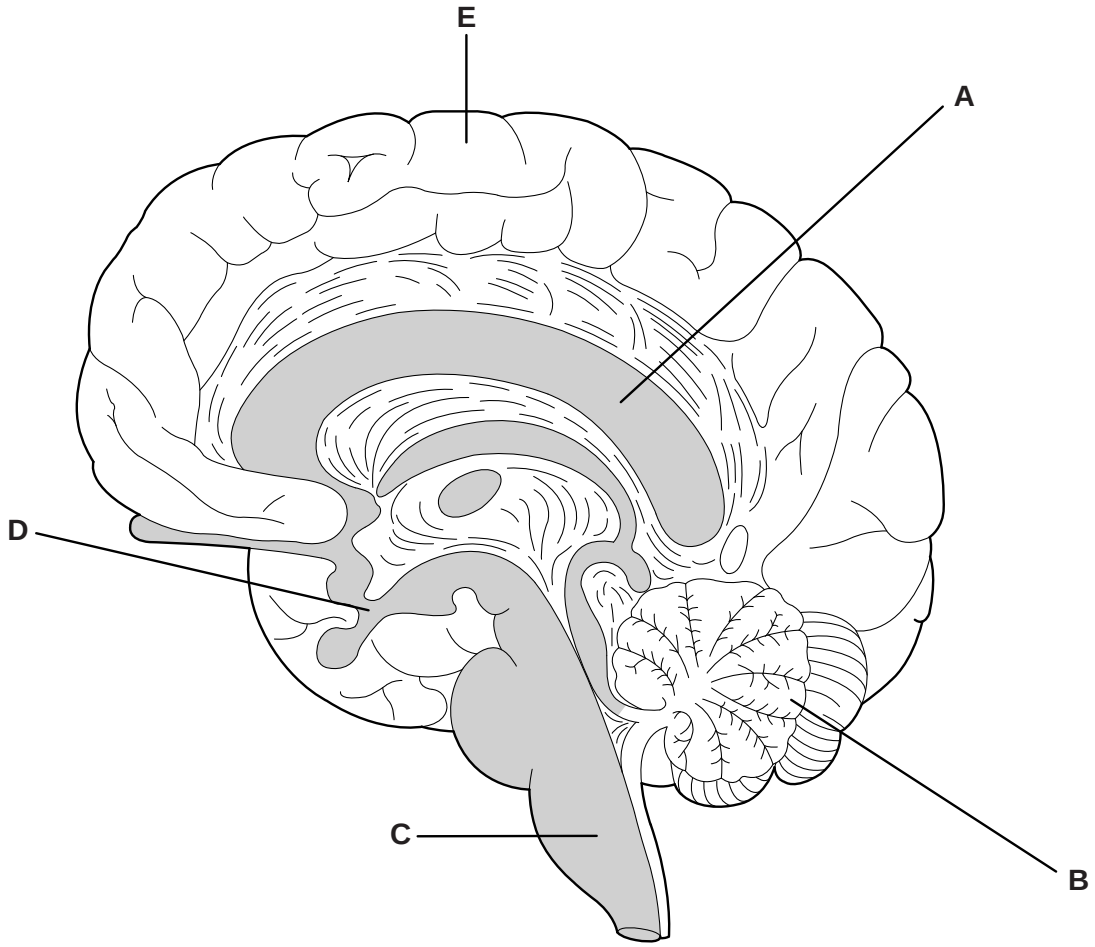

Fig. 2.1

(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]**

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

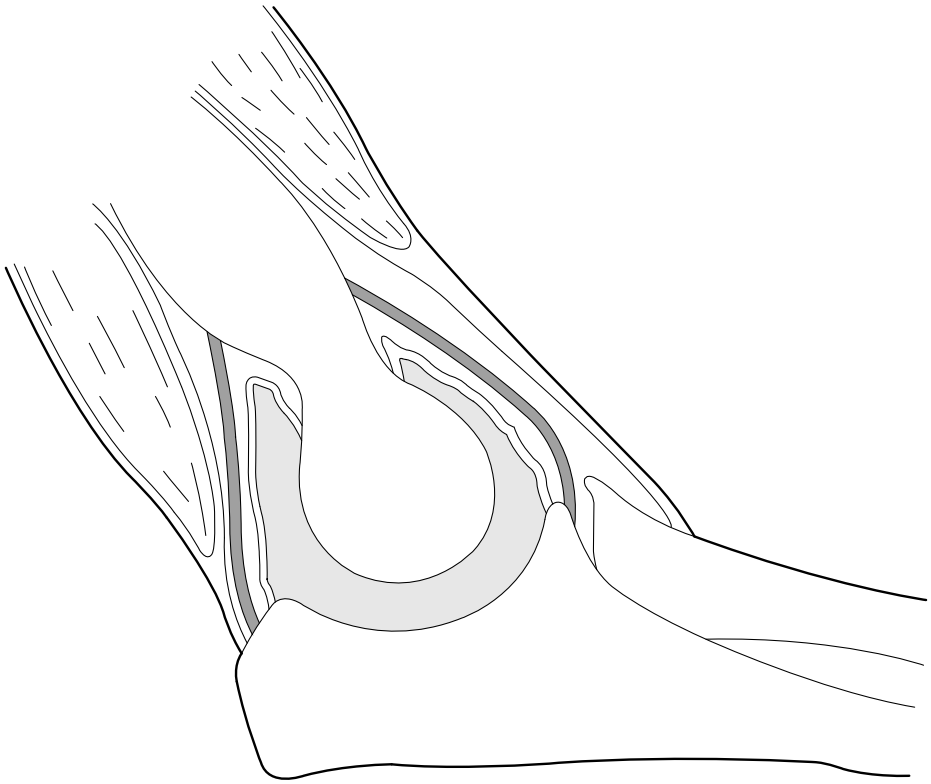

Fig. 2.2

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

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(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.

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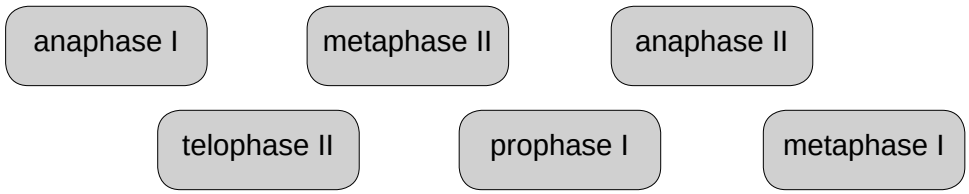
[Total: 15]

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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[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.

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

[Total: 11]

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]

(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]

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.

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

(ii) Suggest **two** purposes of a plant collection in a modern botanic garden.

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..... **[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)

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

(ii) electrophoresis

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

(iii) digestion of DNA by restriction enzymes.

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

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

Question 5(d) begins on page 14

(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.

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..... **[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?

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

[Total: 18]

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.

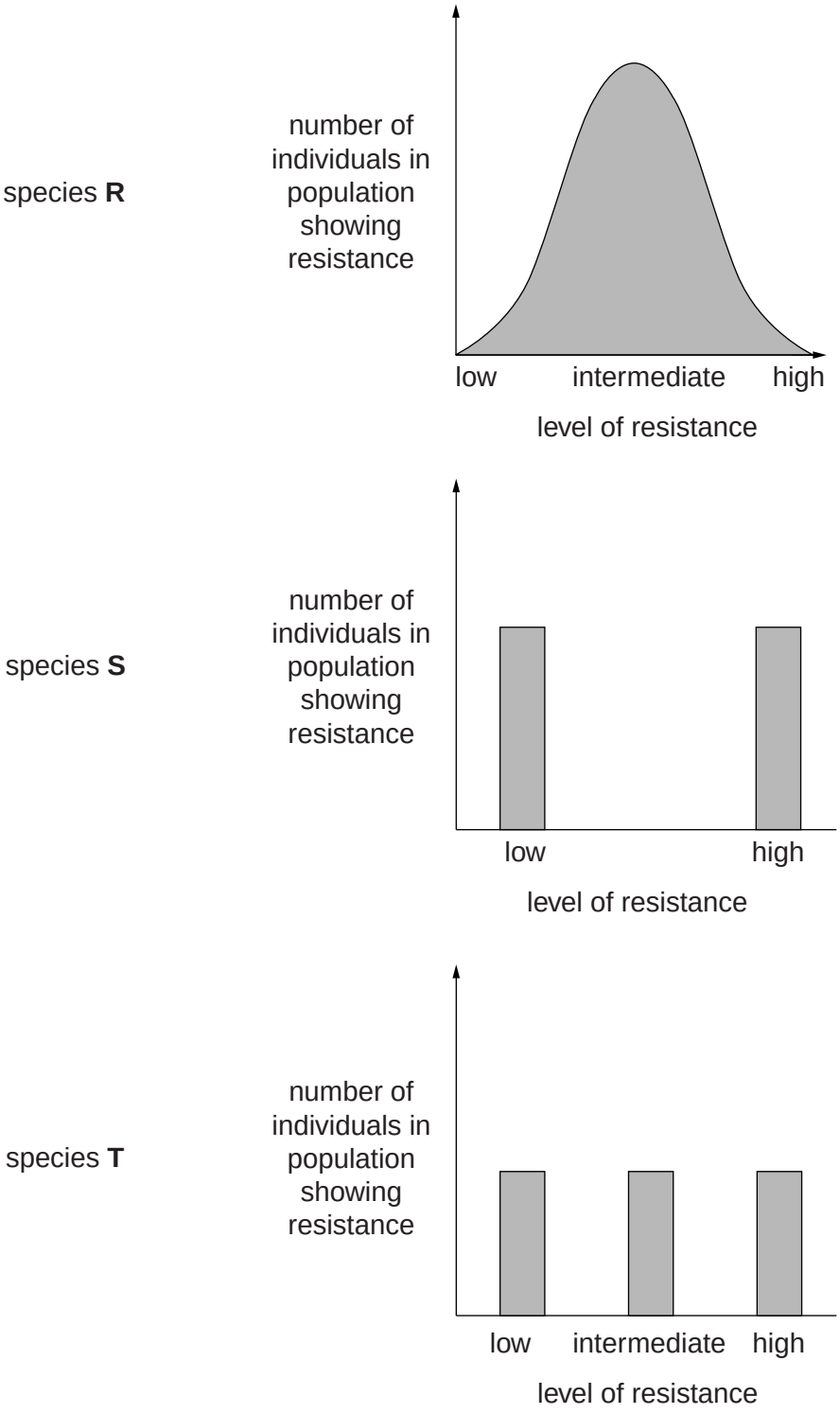

Fig. 6.1

(i) Complete the table below with the letter(s), **R**, **S** and **T**, to indicate which species show a continuous pattern of variation and which species show a discontinuous pattern.

	Discontinuous	**Continuous**
Species identified by letter		

[2]

(ii) A student noted a number of statements on his revision card that referred to the patterns of resistance shown in species **R**, **S** and **T** in Fig. 6.1.

Revision card – patterns of resistance

1. It's controlled by a single gene
2. There is an additive effect
3. May involve multiple alleles
4. Heterozygote shows a distinct phenotype
5. It's controlled by many genes (polygenic)
6. Involves a dominant and a recessive allele
7. Shows co-dominance or incomplete dominance
8. Involves just two alleles

Complete Table 6.1 below, by selecting the correct numbered statement(s) that explain the genetic basis of each pattern of resistance for each species.

You may select a number more than once.

Species	**Statement number(s)**
R	
S	
T	

Table 6.1

[6]

(b) Dog fleas are small parasitic insects that live in the fur of dogs and feed on their blood. Dogs are routinely treated with sprays or powders to kill fleas.

A vet believes that dog fleas may have become resistant to a popular flea-killer product.

He asks an A-level work experience student to plan an experiment to test this hypothesis.

The student needs to sample fleas from dogs visiting the surgery and also fleas from long grass in fields visited by dog-walkers. The fleas then need to be tested for resistance to the flea-killer.

Describe the methods the student could use to:

- collect both samples of fleas
- find out the proportion of fleas that are resistant
- process the data.

In your answer you should describe the methods for collection, testing and data processing in a logical series of steps.

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[Total: 15]

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.

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

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

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

(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.

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

(d) Steroid hormones are one example of molecules that can switch genes on and off in mammalian cells.

Other molecules involved in genetic control have been studied in both eukaryotes and prokaryotes.

Describe **one** other example of genes being switched on or being switched off by a molecule that binds directly to DNA.

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

[Total: 18]

END OF QUESTION PAPER