Q1. Insect pests can be controlled without using chemical insecticides.

For example, the bacterium *Bacillus thuringiensis* produces a toxin extremely poisonous to certain species of insects. The gene which produces this toxin has been introduced into tomato plants.
It gives them built-in resistance to a range of insect pests, but is not poisonous to humans.

(a) Explain, step-by-step, how the tomato plant is made resistant to some insect pests.

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(4)

(b) Give **two** arguments for and **two separate** arguments against controlling insect pests in this way.

For:

1 .....

2 .....

Against:

1 .....

2 .....

(4)
(Total 8 marks)

##

Spiders produce a protein thread which is extremely strong compared to man-made fibres of the same diameter.

Spider's web

Scientists can now use bacteria to produce the **same** protein.
How can they do this?

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(Total 3 marks)

Q3. Many insecticides contain "active" ingredients called pyrethrins. These are extracted from pyrethrum daisies. These plants are grown in Kenya, a developing country in Africa. They provide income for farmers and valuable exports.

An American biotechnology company has now transferred the gene for making a specific pyrethrin to brewers' yeast. This can be grown easily, so this pyrethrin can be produced cheaply. However, insect populations can build up resistance to specific pyrethrins.

(a) What are the advantages and disadvantages of using brewers' yeast to produce pyrethrins?

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(6)

(b) Describe, as fully as you can, how a gene for making pyrethrins is transferred from daisy to yeast.

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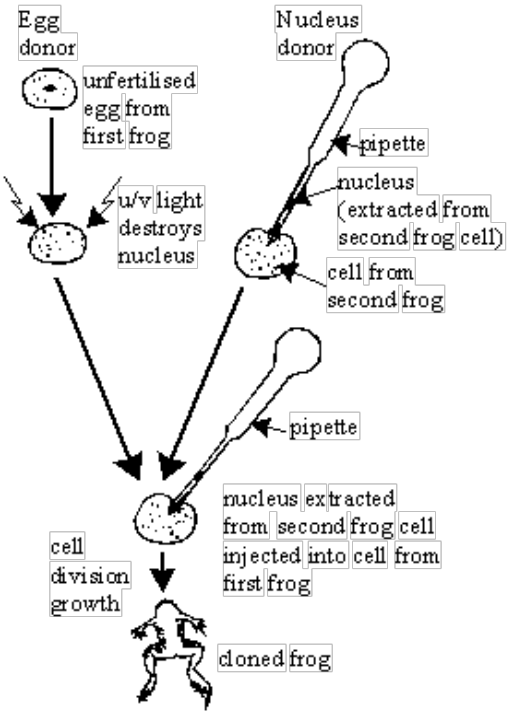
(3)
(Total 9 marks)

Q4. The diagram shows how a frog can be cloned.



(a) In the example shown, will the cells of the cloned frog be the same as those of frog 1 or frog 2?

Explain your answer as fully as possible.

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(4)

(b) Discuss the advantages and disadvantages of cloning compared to sexual reproduction.

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(5)
(Total 9 marks)

Q5. Insulin is now made by a biotechnological process. A description of the process is given below. Complete the gaps in the sentences.

(a) The first step in the biotechnological process is that a special enzyme is used to cut the insulin ..... out from a human ..... .

In a separate operation, a ring of bacterial ..... is cut open using a special enzyme.

These two pieces of genetic material are combined together to form a new plasmid ring which is inserted into a bacterium.

(3)

(b) Explain why large quantities of insulin are produced when this bacterium is put into a culture medium.

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(2)

(c) Before insulin was made in this way, it could only be obtained from sheep and pigs. Suggest **two** reasons, other than preventing the exploitation of animals, why it is better to obtain insulin by genetic engineering than from animals.

1 .....

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2 .....

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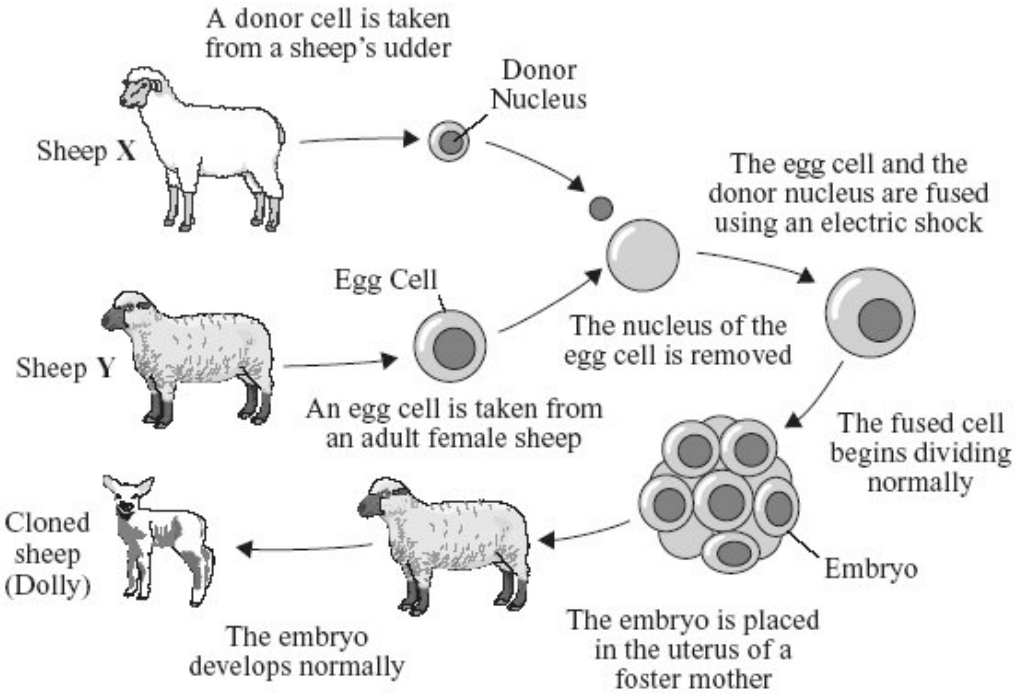
(2)
(Total 7 marks)

Q6. The diagram shows how Dolly the sheep was cloned.



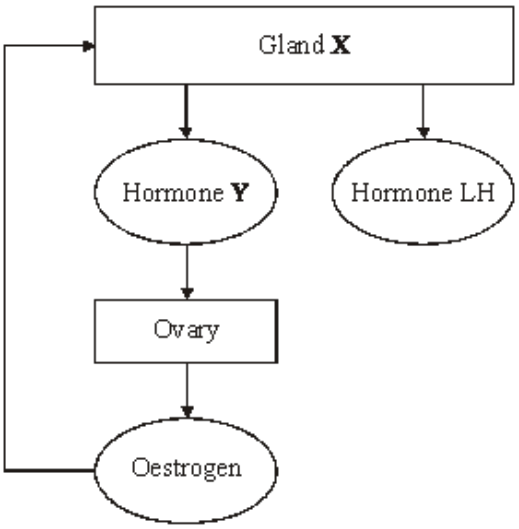
(a) Name the type of cell division that occurs:

(i) as the egg cell is produced; .....

(ii) as the fused cell begins to divide normally. .....

(2)

(c) The diagram below shows the relationships between the glands and hormones that control the menstrual cycle of a woman.



(i) Name:

gland **X**; .....

hormone **Y**. .....

(2)

(ii) Give **two** effects of the hormone oestrogen on gland **X**.

1 .....

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2 .....

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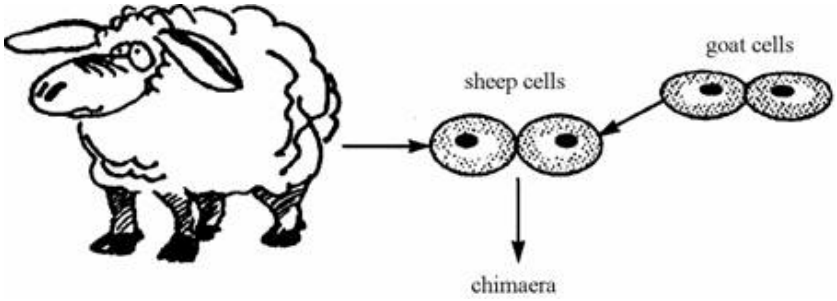
(2)

(Total 6 marks)

Q7. Read the passage.

One reason for cloning animals is to prevent rare breeds from becoming extinct. Early embryos can be divided into four to produce identical quads. Dividing a young embryo into more than four parts is a problem because each part may not have enough cells to create both an embryo and a placenta.

The problem can be overcome by adding cells from another embryo, to make a mixture of cells called a chimaera. The two sets of cells may be from two different breeds of animals, or even two different species, such as sheep and goats.



The aim is not to create freaks but chimaeras in which the added cells form the placenta only. The sheep embryos are given cells to make goat placentas and are carried to full term in the uteri of goats. They are born as pure sheep.

(a) Explain why the sheep embryos with added goat placental cells develop into sheep, not goats.

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(2)

(b) Use information from the passage and your own knowledge and understanding to evaluate the use of cloning techniques in agriculture.

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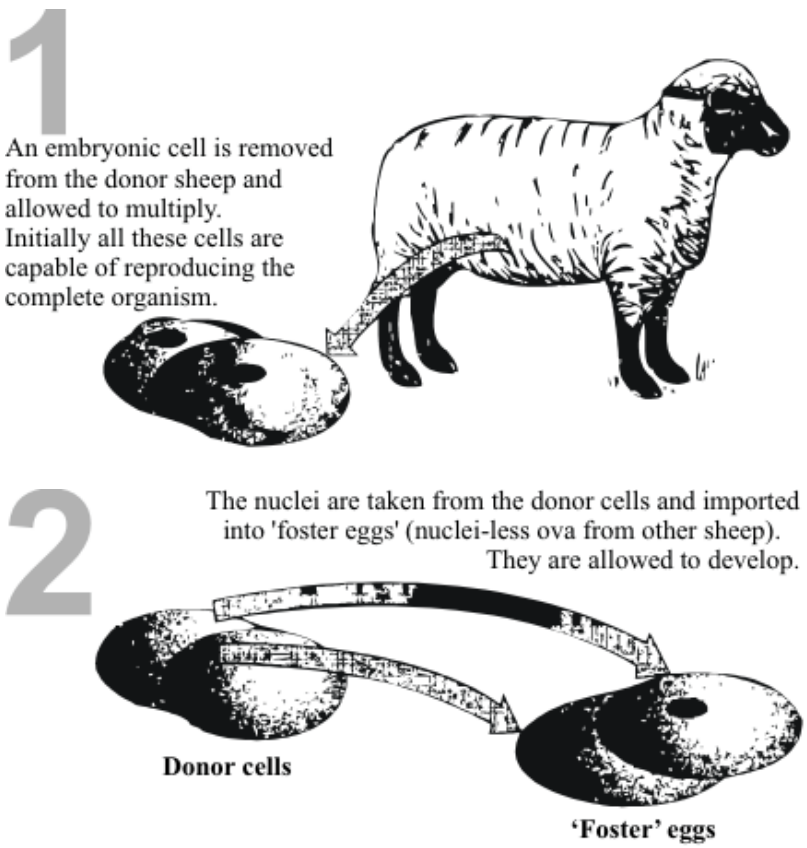
(6)
(Total 8 marks)

Q8. The diagram shows one method of cloning sheep.



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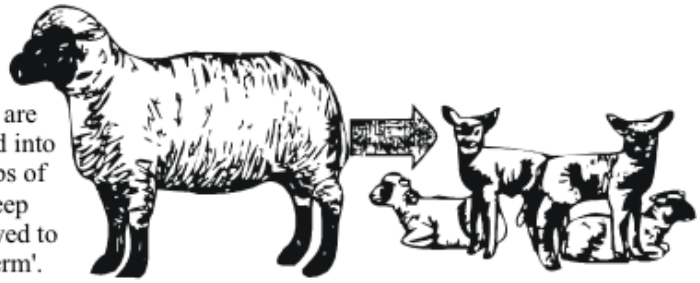

The eggs are implanted into the wombs of foster sheep and allowed to 'go full term'.

(a) Explain why the lambs produced by this technique are identical to each other.

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(2)

(b) Explain why the lambs are **not** genetically identical to the sheep which produced the 'foster' eggs.

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(2)

(c) Explain the drawback of widespread use of just a few clones of sheep.

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(3)
(Total 7 marks)

Q9. Cotton crops may become infested with weeds. Scientists are developing genetically-engineered strains of cotton which resist the action of herbicides. This means that when the crop is sprayed with herbicide, only the weeds are killed. However, there are potential dangers with this procedure. Cotton plants can interbreed with some other species of plants.

Evaluate the possible advantages and disadvantages of developing genetically-engineered herbicide-resistant crops.

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(Total 5 marks)

Q10. The article below appeared in the Daily Mail on February 24 1993.

March of the mutant tomatoes as Frankenfood hits the menu

Just when you thought it was safe to go back to the dinner table, 'Frankenfoods' are heading for the menu.

Rainbow trout with human genes and tomatoes grown with traits of flounder fish are the latest products of food scientists.

It is good news for producers – the trout grow bigger and more quickly, while the tomatoes have a lower freezing point, preventing them becoming damaged.

But consumer groups fear a whole breed of these 'genetically modified organisms' (GMOs) may be introduced without proper trials.

David King, director of the pressure group Genetic Forum, said: 'The march of scientists who want to genetically alter food has very serious implications both for animal welfare and the environment.'

'You run the risk of introducing triffid-like creatures – plants which have the capacity to overtake landscapes and force out other plant life.'

Genetic forum is to join groups including the RSPCA and World Wide Fund for Nature to debate a number of GMOs awaiting licenses in the United States.

They have called for proper labelling so shoppers can decide for themselves whether they want to buy modified foods.

Two genetic compounds – certain brands of cheddar cheese and bakers' yeast are already approved for use in British food manufacture, said Mr. King.

British multi-national ICI also has a company, Zeneca seeds, working on genetically altering food and is planning to sell tomatoes in which the ripening gene has been 'blocked' to increase shelf life.

An ICI spokesperson said 'Extensive trials are carried out on all these modified foods and we are required by the Ministry of Agriculture to provide full information on all our trials.'

Growers were able to pick the new tomato when it was ripe and red instead of green and it was wrong to label such an advance 'Frankenfood', she said.

'It has very negative connotations which are not at all correct. The entire drive behind this work is to produce positive benefits to the consumer.'

ICI had helped to produce crops able to resist pests and diseases, bringing food to people who otherwise would go hungry, she added.

(a) The foods described in the article have been produced by genetic engineering. Explain, as fully as you can, how this technique is used to produce 'genetically modified organisms'.

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(4)

(b) Having produced the desired type of tomato by genetic engineering, how might scientists quickly produce large numbers of the new plants to supply to horticulturists?

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(2)

(c) Using information from the article and your own knowledge, assess the advantages and disadvantages of producing new types of food by genetic engineering.

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(6)
(Total 12 marks)

Q11. The following passage is adapted from an article by Martin Kelly in The Independent newspaper.

Thanks to the test tube banana

Specially bred resistant varieties may

save African crops from disease

A banana is a fruit, but it has no seeds. And if there are no seeds how do the plants reproduce? At one level the answer is easy; centuries of selective breeding have resulted in varieties with plenty of tasty flesh but few bitter inedible seeds, and propagation is carried out by means of root corms.

Most bananas we eat are thus actually 'clones' of a few successful plants, as is also the case with the potato. Banana clones are genetically identical to their parents, so growers can be completely sure their fruits will be big and tasty.

Genetic variability of these cloned plants is extremely low. Resistance to new diseases, therefore, is almost nil; witness the spread of potato blight through Ireland in the 1840s.

The issue goes well beyond our high streets and supermarkets. The banana has a larger relative called a plantain, which is starchy rather than sweet and is a staple food of more than 60 million Africans. Bananas and plantains are being ravaged by a new fungal disease called Black Sigatoka. The commercial planters that produce the bananas we buy in supermarkets have little problem here; they can afford to buy chemicals to spray their crops. African subsistence farmers, forced to rely on 'organic' methods can only sit by and watch their plants die.

Several governments have turned to the International Institute for Tropical Agriculture (IATA) for help. IATA is in Africa, but is not of Africa. It is internationally funded with levels of staffing and equipment that enable advanced bio-technological techniques to be used. However, even with genetic engineering, to breed resistant varieties is a long-term project and Black Sigatoka is not going to wait. IATA scientists have had to divide their energies between two approaches: an interim solution and the development of resistant varieties.

The interim solution was easily found in a group of 'cooking bananas' which were resistant to Black Sigatoka disease and which could, to some extent, be substituted for plantain in the diet. These, however, were only found in localised areas and the first problem facing IATA was to obtain enough plants from the few available plants of resistant varieties to supply the needs of the affected farmers.

(a) Explain how selective breeding may have been used to produce bananas with tasty flesh.

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(2)

(b) Explain, as fully as you can, why "Genetic variability of these cloned plants is extremely low" compared with natural populations.

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(4)

(c) Explain, as fully as you can, how IATA scientists might be able to "obtain enough plants from the few available plants of resistant varieties to supply the needs of affected farmers".

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(3)

(d) Explain, as fully as you can, how IATA scientists may use genetic engineering to produce varieties of banana resistant to Black Sigatoka disease.

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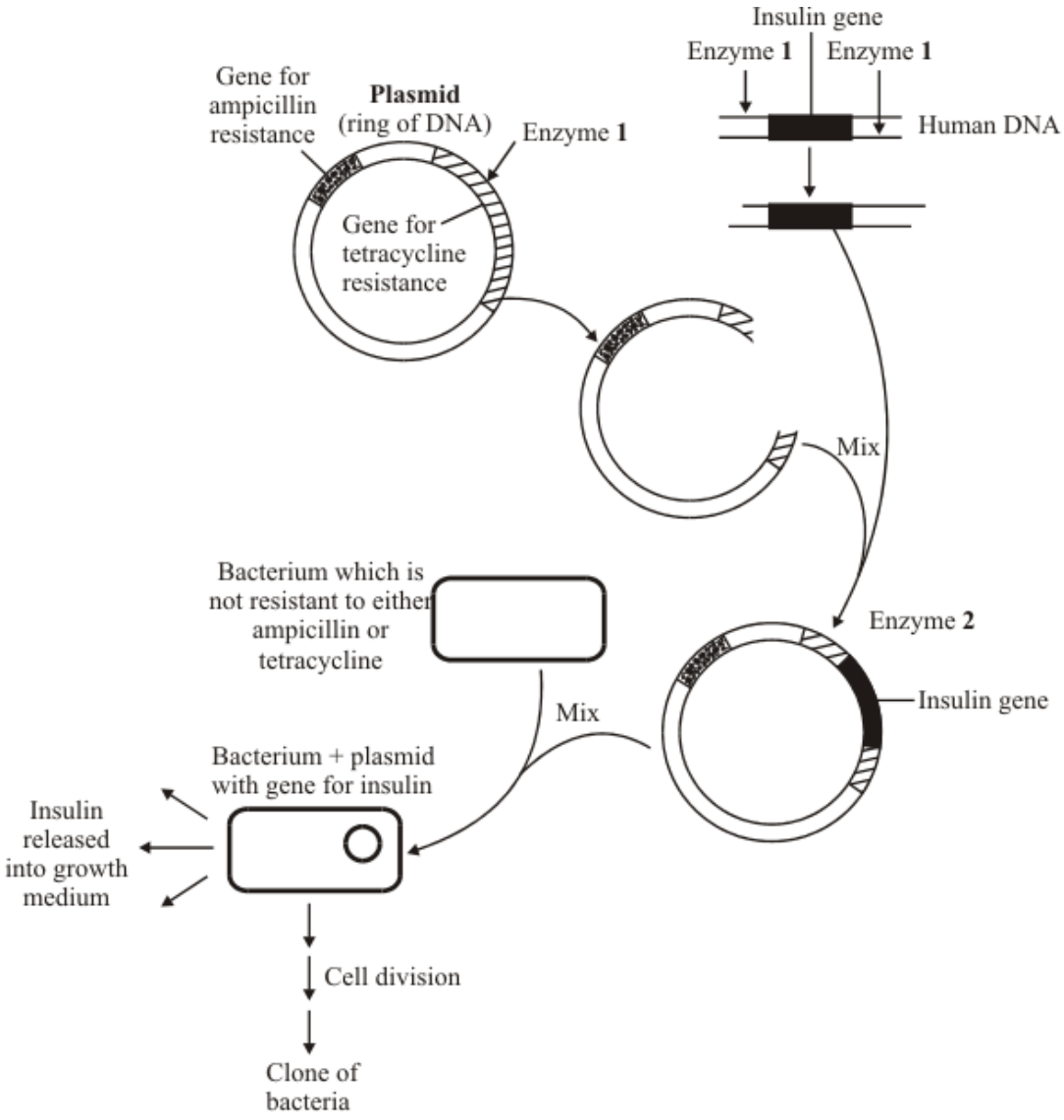
(4)
(Total 13 marks)

Q12. The diagram shows how genetic engineering can be used to produce human insulin from bacteria. Ampicillin and tetracycline are two types of antibiotic. Study the diagram carefully and answer the questions.



In experiments like these, some bacteria take up the plasmid (ring of DNA) containing the insulin gene. Other bacteria fail to take up a plasmid, or they take up an unmodified plasmid (a ring of DNA which has not been cut open and which does not contain the insulin gene).

(a) Complete the table by putting a tick (✓) in the correct boxes to show which bacteria would be able to multiply in the presence of ampicillin and which bacteria would be able to multiply in the presence of tetracycline.

	Bacterium can multiply in the presence of	
	Ampicillin	**Tetracycline**
Bacterium + plasmid with the insulin gene		
Bacterium without a plasmid		
Bacterium with an unmodified plasmid		

(3)

(b) The bacterium with the plasmid containing the insulin gene multiplies by cell division to form a clone of bacteria.

Will **all** the bacteria in this clone be able to produce insulin? Explain your answer.

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(3)
(Total 6 marks)

Q13. Tetra is the first monkey to be cloned.

The method is described below.

- A sperm and an egg were combined and the resulting embryo was allowed to split into two cells, then four, then eight cells.
- At the eight-cell stage, the embryo itself was split by scientists to produce four two-cell embryos.
- The four embryos were then implanted into surrogate mothers. Three of the embryos did not survive. The fourth, Tetra, was born 157 days later. Her name means 'one of four'.

(a) Explain why this method could produce several identical monkeys.

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(2)

(b) Suggest **two** reasons why these monkeys would be valuable in trials of new treatments for human diseases.

1. .....

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2. .....

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(2)

(Total 4 marks)

Q14. Read the passage about IVF (in-vitro fertilisation) and embryo-splitting.

> "IVF is not as successful as we would like it," says scientist Michael Tucker. "On average, only one in five or one in six of all the embryos that we generate in the IVF lab will develop as far as full-term delivery as a baby."
>
> "There is a way to perhaps double those odds. A new, identical embryo is split off from the original embryo made in the IVF lab."
>
> "What we are really doing is creating an identical twin," says scientist Dr Hilton Kort.
>
> "And that's what happens in nature every day. Cloning is creating a replica of a person or an animal."

(a) Explain why the two embryos will develop into identical twins.

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(2)

(b) Explain why the embryos are **not** clones of their parents.

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(2)

(c) The scientists want to develop this technique, but are afraid to do so because public opinion might be against the technique.

Suggest an explanation for this.

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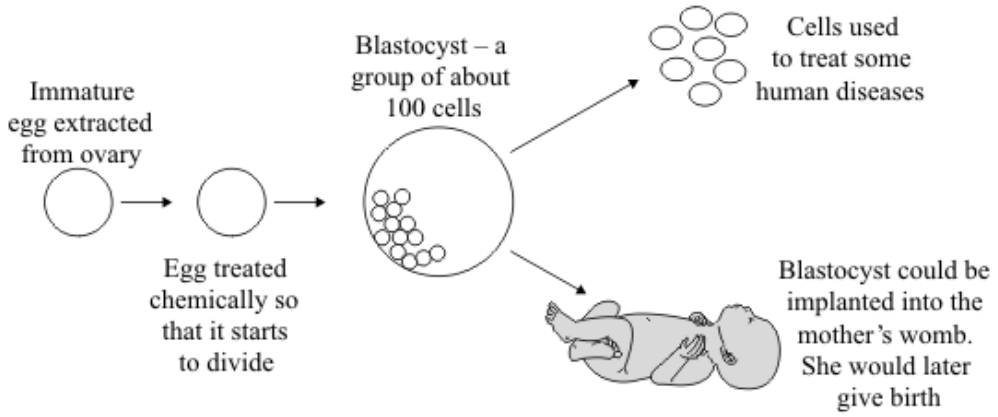
(1)

(Total 5 marks)

Q15. The diagram shows how an immature egg could be used either to produce cells to treat some human diseases or to produce a baby.



Scientists may be allowed to use this technique to produce cells to treat some human diseases, but not to produce babies.

Using information from the diagram, suggest an explanation for this.

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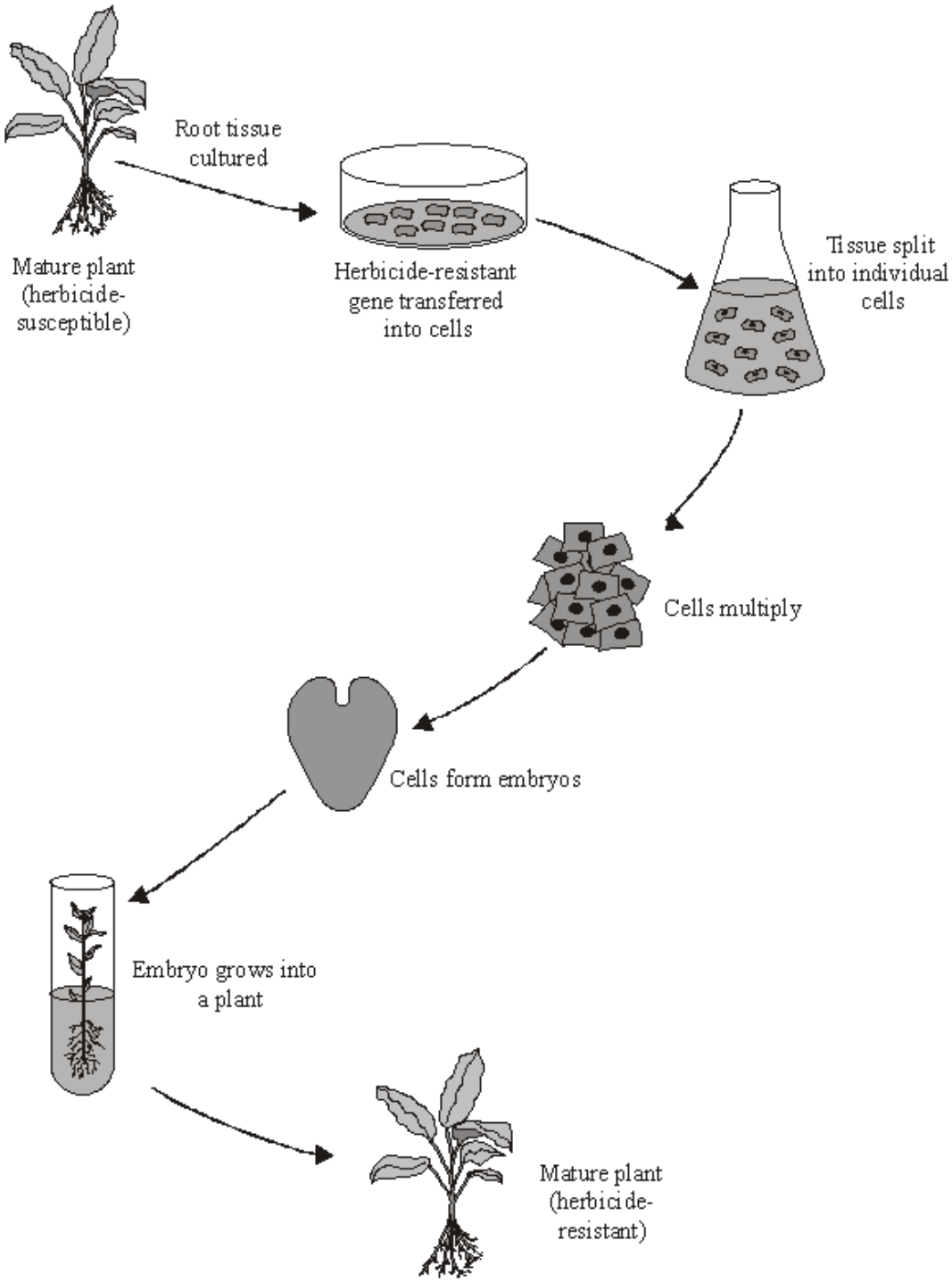
(Total 4 marks)

Q16. The diagram shows one method of producing herbicide-resistant crop plants.



(a) (i) The herbicide-resistance gene is obtained from a herbicide-resistant plant.

Which structure in a cell carries the genes?

.....

(1)

(ii) How is the herbicide-resistance gene cut out of this structure?

.....

.....

(1)

(b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

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(2)

(c) Suggest **one** advantage to a farmer of growing herbicide-resistant crops.

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(1)

(d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

Suggest **one** reason why.

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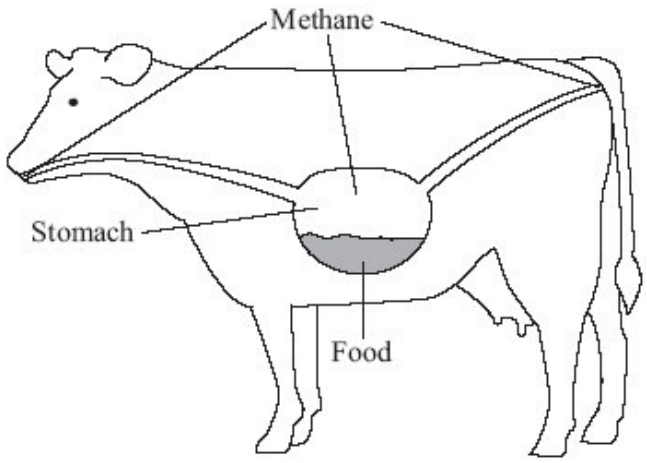
(1)

(Total 6 marks)

Q17. Scientists are investigating how to reduce methane emissions from cattle.

Most of this methane is emitted by the cows belching.



Scientists have found that less methane is belched if the cows eat high-sugar rye grass.

This rye grass has been produced by genetic engineering.

(i) Suggest how the high-sugar rye grass might have been produced by genetic engineering.

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(3)

(ii) Some people might object to the growing of genetically-engineered, high-sugar rye grass for feeding cattle.

Give **two** reasons why.

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2 .....

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(2)

(Total 5 marks)

Q18. The use of cloned animals in food production is controversial.

It is now possible to clone ‘champion’ cows.

Champion cows produce large quantities of milk.

(a) Describe how adult cell cloning could be used to produce a clone of a ‘champion’ cow.

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(4)

(b) Read the passage about cloning cattle.

> The Government has been accused of 'inexcusable behaviour' because a calf of a cloned American 'champion' cow has been born on a British farm. Campaigners say it will undermine trust in British food because the cloned cow's milk could enter the human food chain.
>
> But supporters of cloning say that milk from clones and their offspring is as safe as the milk we drink every day.
>
> Those in favour of cloning say that an animal clone is a genetic copy. It is not the same as a genetically engineered animal. Opponents of cloning say that consumers will be uneasy about drinking milk from cloned animals.

Use the information in the passage and your own knowledge and understanding to evaluate whether the government should allow the production of milk from cloned 'champion' cows.

Remember to give a conclusion to your evaluation.

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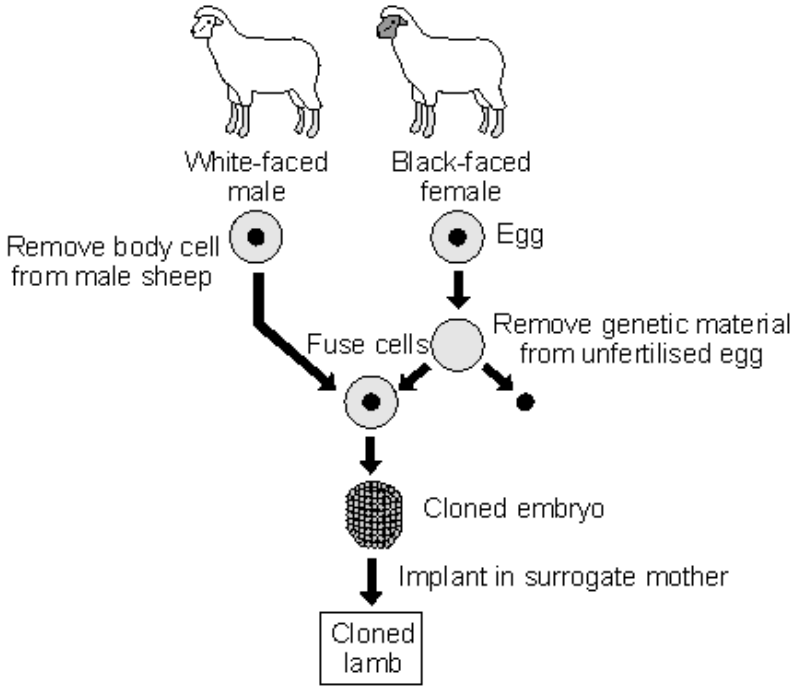
(5)
(Total 9 marks)

Q19. The diagram shows one method of cloning sheep.



(a) The fusion of the body cell from the male sheep and the egg from the female sheep is an example of asexual reproduction.

Explain why.

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(2)

(b) (i) Give the gender and face colour of the cloned lamb.

Gender .....

Face colour .....

(1)

(ii) Give the reasons for your choice.

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(2)
(Total 5 marks)

Q20. Scientists have recently cloned a mouse that had died and been frozen for 16 years.

(a) Explain what is meant by a clone.

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(2)

(b) The scientists used an egg cell from a living mouse and the genetic material from a brain cell of the frozen mouse.

Describe how the process of adult cell cloning could be used to clone the frozen mouse.

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(3)

(c) People could ask scientists to use this technique to clone long-dead relatives, whose bodies have been deep-frozen.

Most people would be opposed to cloning a human from a deep-frozen, long-dead relative.

Give **one** reason why.

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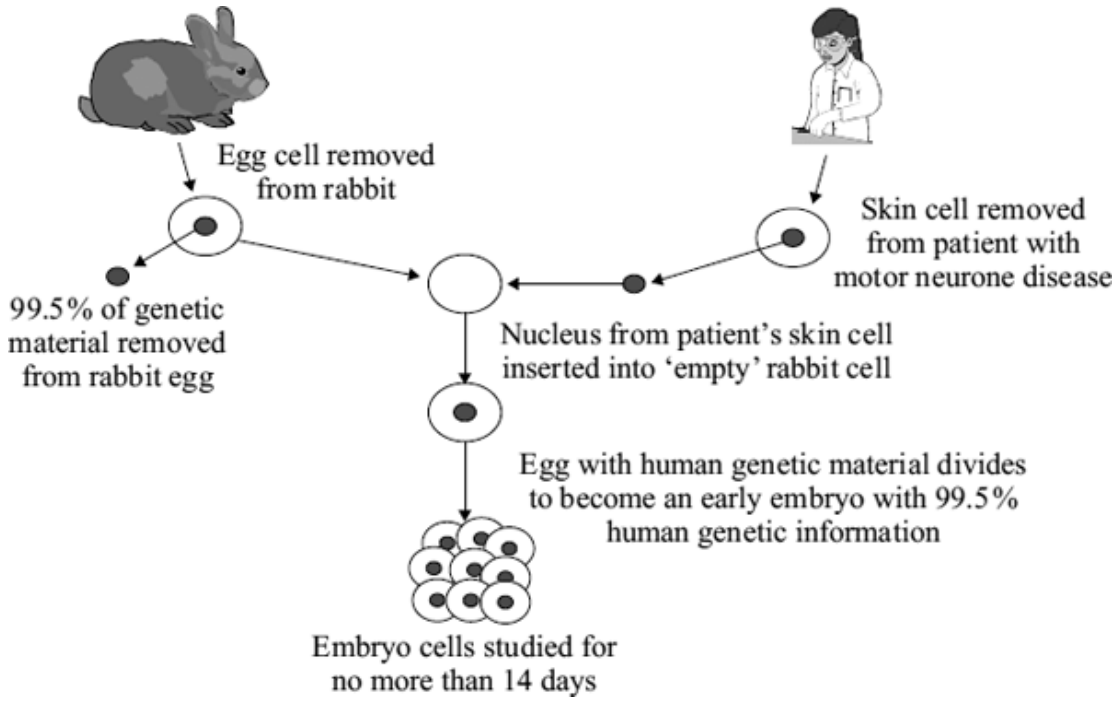
(1)
(Total 6 marks)

Q21. Scientists in Korea have discovered a method of producing rabbit–human embryos.Rabbit–human embryos could provide cells for research into human diseases such as motor neurone disease. Rabbits produce large numbers of eggs. Rabbit–human embryos could overcome a shortage of human embryo cells for research.

The diagram shows how rabbit–human embryos are produced.



(a) Which structures in the nucleus contain 99.5% of a cell's genetic information?

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(1)

(b) Use the above information and your own knowledge and understanding to evaluate how the production of rabbit–human embryos may help research into human diseases.

Remember to give a conclusion as part of your evaluation.

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(4)
(Total 5 marks)

Q22. Organisms can be produced by asexual reproduction and by sexual reproduction.

(a) Give **two** differences between asexual reproduction and sexual reproduction.

1 .....

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2 .....

.....

(2)

(b) Adult cell cloning is a type of asexual reproduction.

Explain why.

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(2)
(Total 4 marks)

Q23. Scientists have brought an extinct species of mountain goat, the Pyrenean ibex, 'back to life'. These scientists used skin cells from preserved Pyrenean ibex in cloning experiments.

The Scientists:

- removed the nuclei from domestic goat egg cells
- transferred cell nuclei from the skin cells of the Pyrenean ibex into domestic goat egg cells
- used the domestic goats as surrogate mothers for the embryos that developed.

The scientists made 439 cloned embryos, but only 57 were suitable for transfer into the surrogate goat mothers. Only seven of the goats got pregnant and only one live offspring was born.

Some biologists are very worried about using cloning to preserve endangered animals, because cloned animals often have developmental problems. Some endangered animals are difficult to breed in captivity. For these animals cloning is another way to continue the genetic line.

The biggest threats to endangered animals today are habitat loss, illegal hunting, pollution and climate change. Many scientists say that cloning is not as important as trying to preserve the wild places on Earth. The wild places are being lost very quickly and the animals and plants living in the wild places are dying out.

(a) The Pyrenean ibex was 'brought back to life'.

How is this process different from using adult cell cloning to clone a pet animal?

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(1)

(b) Evaluate the use of adult cell cloning to conserve endangered species.

Use the information given and your own knowledge and understanding.

Remember to give a conclusion to your evaluation.

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(4)

(Total 5 marks)

Q24. A child saved apple seeds from an apple she ate. She planted the seeds in the garden. A few years later the apple trees she had grown produced apples.

(a) The apples from the new trees did **not** taste like the original apple.

Explain why.

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(2)

(b) (i) Apple trees can be reproduced so that the apples from the new trees will taste the same as the apples from the parent trees.

Give **one** method used to reproduce apple trees in this way.

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(1)

(ii) Explain why the method you have suggested in part **(b)(i)** will produce apples that taste the same as the apples from the parent trees.

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(2)
(Total 5 marks)

Q25. The picture shows a zebra fish.

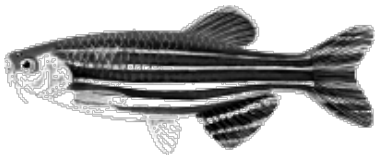

Illustration © Emily S. Damstra

Zebra fish are small freshwater fish that usually have black and silver stripes.
Zebra fish can tolerate a wide range of environmental conditions.

(a) Scientists have genetically modified zebra fish to act as pollution indicators.
The genetically modified zebra fish have a gene transferred from a jellyfish.
The gene allows the stripes of the zebra fish to change colour.

Describe how the scientists produced the genetically modified zebra fish.

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(3)

(b) Some scientists are worried about the production of genetically modified zebra fish.

Suggest reasons why.

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(2)
(Total 5 marks)

Q26. (a) Animal breeders use sexual reproduction to produce new strains of animals.

How does sexual reproduction produce variation?

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(2)

(b) A salmon is a type of fish.

Scientists have created a GM (genetically modified) 'super' salmon.

The scientists transferred a gene from a fish called a pout into a salmon. The gene increases the secretion of growth hormone in the salmon. The GM salmon grows much faster than an ordinary salmon, reaching market size up to one year earlier. Many more GM salmon will be grown in fish farms.

(i) Describe how a gene can be transferred from a pout into a salmon.

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(3)

(ii) The government might not allow the production of GM salmon.

Suggest **one** reason why.

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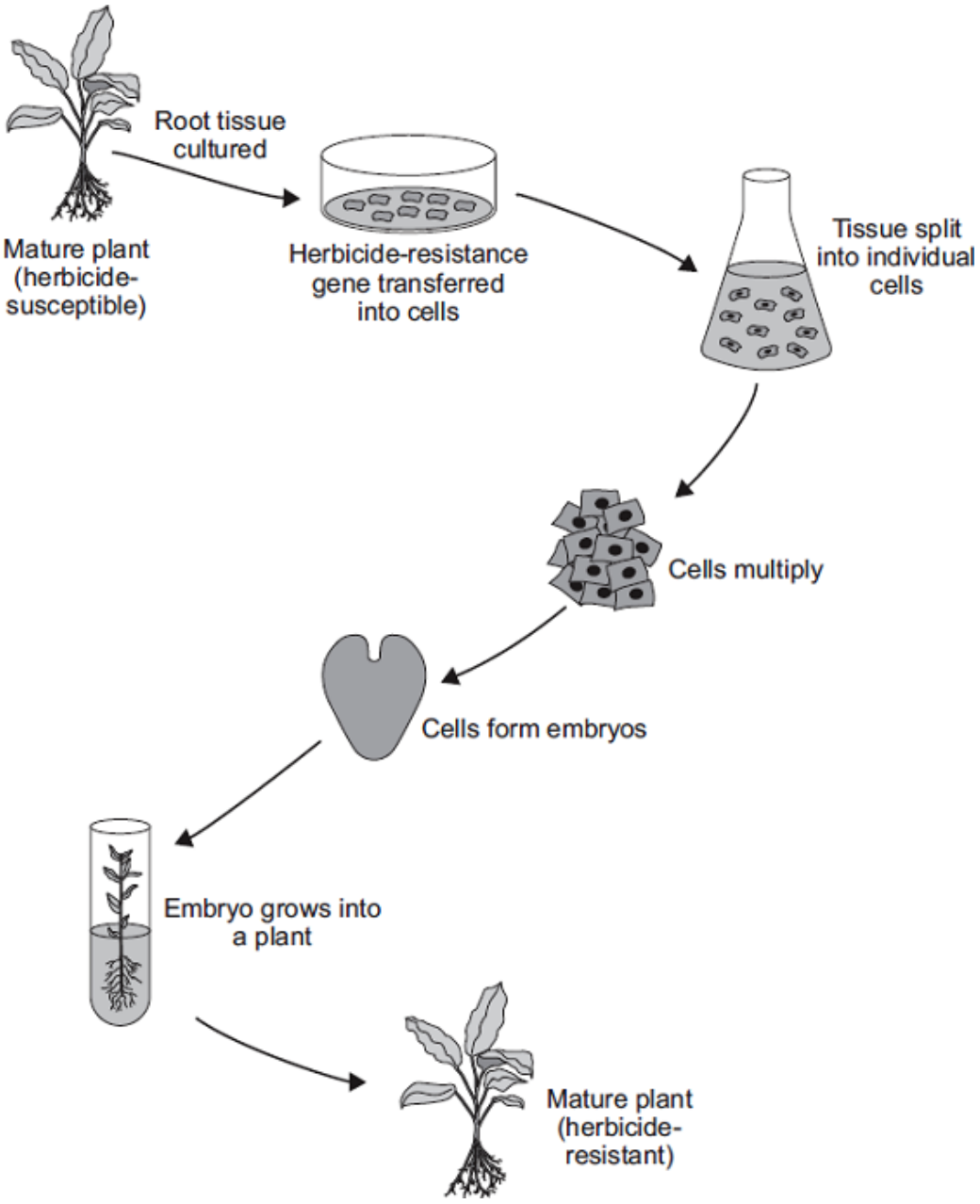
(1)
(Total 6 marks)

Q27. The diagram shows one method of producing herbicide-resistant crop plants.



(a) The herbicide-resistance gene is cut out of a chromosome of a herbicide-resistant plant.

How is the herbicide-resistance gene cut out of the chromosome?

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(1)

(b) Apart from having the herbicide-resistance gene, the herbicide-resistant plants are identical to the herbicide-susceptible plants.

Explain why.

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(2)

(c) Suggest **one** advantage to a farmer of growing herbicide-resistant crops.

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(1)

(d) Many people are opposed to the growing of herbicide-resistant crops produced in this way.

Suggest **one** reason why.

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(1)

(Total 5 marks)

Q28. The drawings show two different species of butterfly.

Amauris

Hypolimnas

- Both species can be eaten by most birds.
- *Amauris* has an unpleasant taste which birds do **not** like, so birds have learned **not** to prey on it.
- *Hypolimnas* does **not** have an unpleasant taste but most birds do **not** prey on it.

(a) Suggest why most birds do **not** prey on *Hypolimnas*.

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(2)

(b) Suggest an explanation, in terms of natural selection, for the markings on the wings of *Hypolimnas*.

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(3)
(Total 5 marks)

Q29. Plant hormones are used in horticulture.

(a) Name **one** plant hormone.

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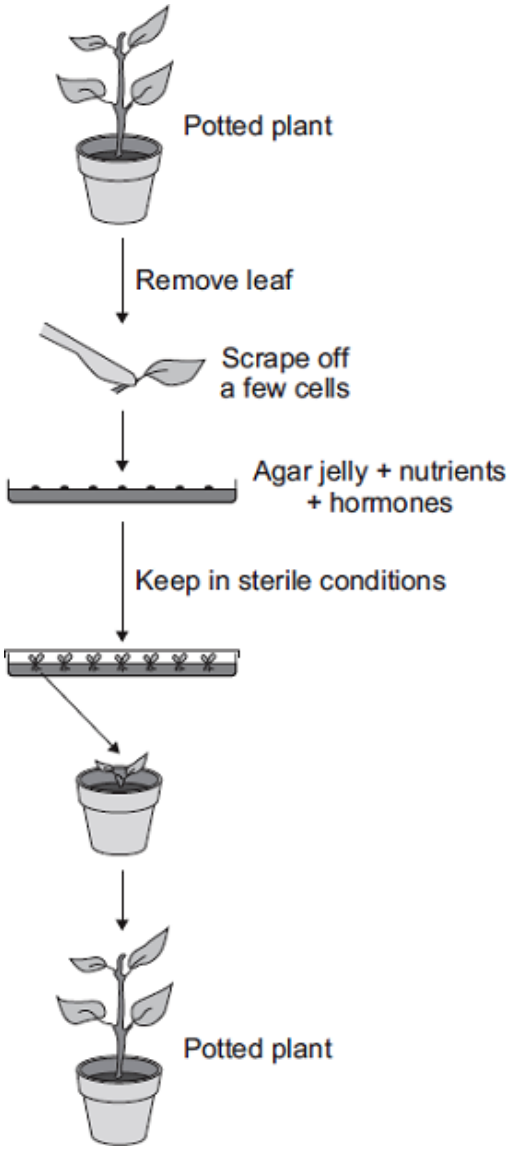
(1)

(b) The diagram shows how new plants are produced using tissue culture.



(i) Tissue culture is a type of *asexual reproduction* .

Give the main features of *asexual reproduction* .

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(3)

(ii) Another method of producing new plants is by taking cuttings.

Suggest **one** advantage of using tissue culture and **not** using cuttings to produce plants.

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(1)
(Total 5 marks)