

- 1. In 2004, researchers at the coffee gene bank in Brazil found three plants of *C. arabica* from Ethiopia with a very low caffeine content thanks to a mutation in the gene for caffeine synthase. It is hoped that the three plants may be cultivated to produce a commercial variety. This process might be speeded up by the use of cloning using tissue culture.

Outline the main steps involved in cloning plants using tissue culture.

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[Total 5 marks]

2. In this question, one mark is available for the quality of the use and organisation of scientific terms.

Micropropagation (tissue culture) is one method used for the artificial propagation of new plants. Small amounts of tissue are obtained from plants and used to produce clones.

The information below is about some of the steps in the process.

- Tissue from apical or lateral buds is used.
- The surface of the tissue is cleaned using a sterilising agent.
- The growth medium contains cytokinins.
- The growth medium contains magnesium ions, nitrate ions and sucrose.
- When shoots form they are transferred to a medium containing auxins.

Explain the importance of each of the above steps.

*(Allow one lined page)*

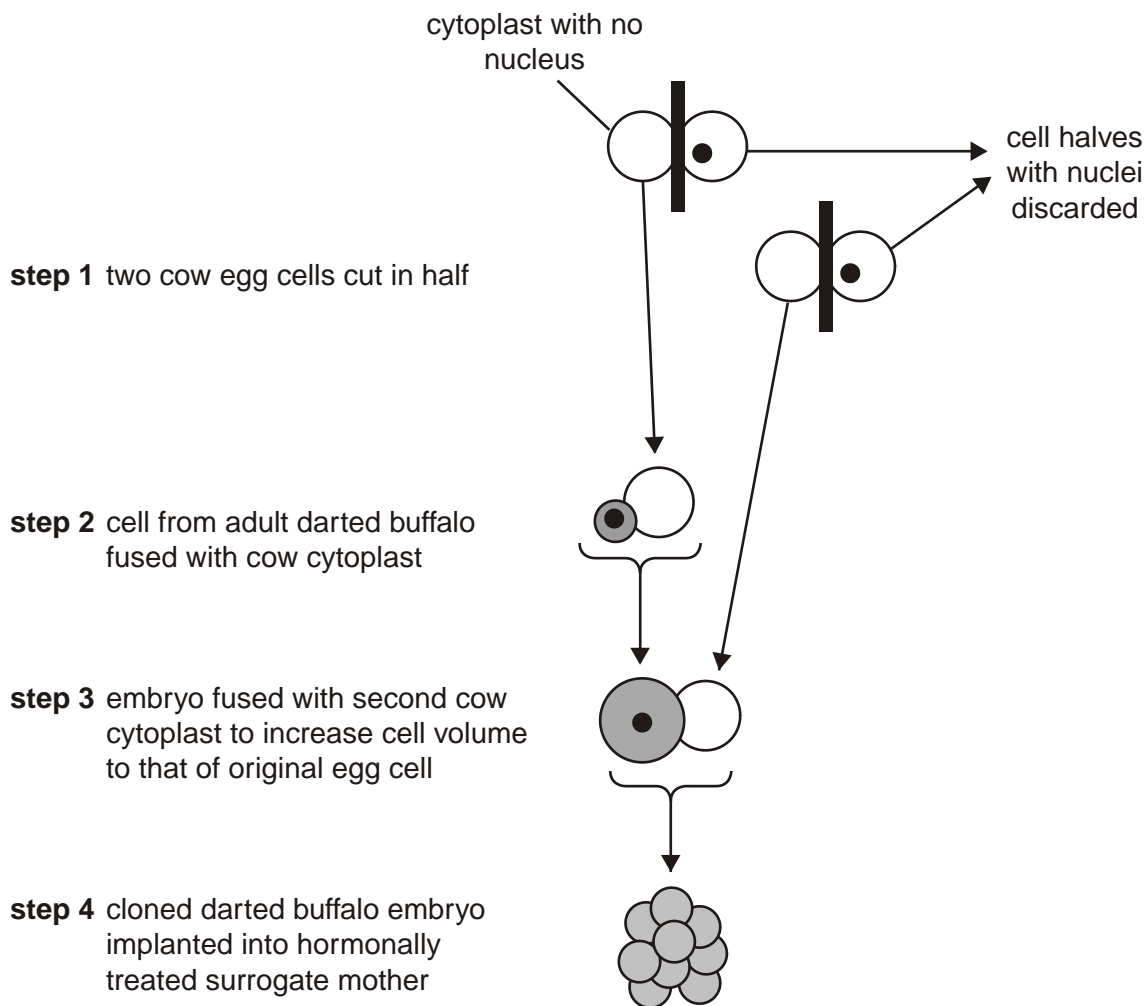
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Quality of Written Communication [1]

[Total 7 marks]

3. (a) The Endangered Wildlife Trust in South Africa uses a cloning technique to help conserve endangered species of mammal such as the darter buffalo.

A cell from an adult darter buffalo was fused with egg cells from domesticated cows, using the procedure outlined in the following figure.



With reference to the figure, explain

- (i) how a supply of cow egg cells is obtained for **step 1**;

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(ii) why the cloned darted buffalo embryo produced in **steps 2** and **3** does **not** have exactly the same DNA as the adult darted buffalo from which a cell was taken;

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[2]

(iii) why it is necessary to treat the surrogate mother with hormones in **step 4**.

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(b) Explain how a procedure such as that shown in the figure above can help save an endangered species of mammal.

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[4]

(c) State **three** ways of setting up a gene bank for the darted buffalo.

- 1 .....
- 2 .....
- 3.....

[3]

[Total: 15 marks]

4. (a) A great deal of tropical rainforest has been destroyed as trees are cut down to make way for agriculture and also for the wood that they yield. Replanting the rain forests might take 100 years so scientists are using other techniques to speed the process.

They are able to take cuttings from rainforest trees and then to clone them. The clones are from trees best suited to restore the rainforest and are attractive to foresters because of their rapid growth. Cloned trees are planted and grow far more quickly than saplings grown from seed.

(i) Explain the meaning of the term *clone*.

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[2]

(ii) State **two** advantages of using clones instead of saplings grown from seed.

- 1 .....
- .....
- 2 .....
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[2]

- (iii) Each cutting is given a coating of auxin on its cut surface before it is planted in a rooting medium. This encourages the rooting process.

State **two other** commercial uses of auxin.

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[2]

- (iv) Auxin stimulates the growing roots to develop root hairs. These are projections from specialised epidermal cells.

Explain in detail why it is important for the cuttings to develop root hairs.

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[4]

- (b) Micropropagation has been used to produce clones of some pine trees. New plants are grown by culturing tissues from trees with high productivity. The tissues from the trees are grown in artificial conditions in a culture medium.

List **three** constituents of the culture medium.

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2 .....

3 .....

[3]

- (c) One disadvantage of micropropagation is that it can be more expensive than traditional methods.

Suggest **three** factors which may contribute to this extra cost.

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[3]

- (d) Name **one** technique for producing clones of trees, other than taking cuttings, or micropropagation.

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[1]

[Total 17 marks]

5. The synthesis of caffeine in coffee plants involves enzymes which add methyl groups ( $\text{CH}_3$ ) to convert xanthosine to caffeine:



In an attempt to produce caffeine-free coffee, cells of a coffee plant, *Coffea canephora*, were grown in tissue culture and genetically modified to suppress expression of the gene for theobromine synthase.

DNA was constructed to code either for short or for long lengths of RNA with the **complementary** base sequences to parts of the messenger RNA (mRNA) produced by the gene for theobromine synthase.

- (a) Explain how lengths of RNA that are complementary to mRNA may suppress the expression of a gene.

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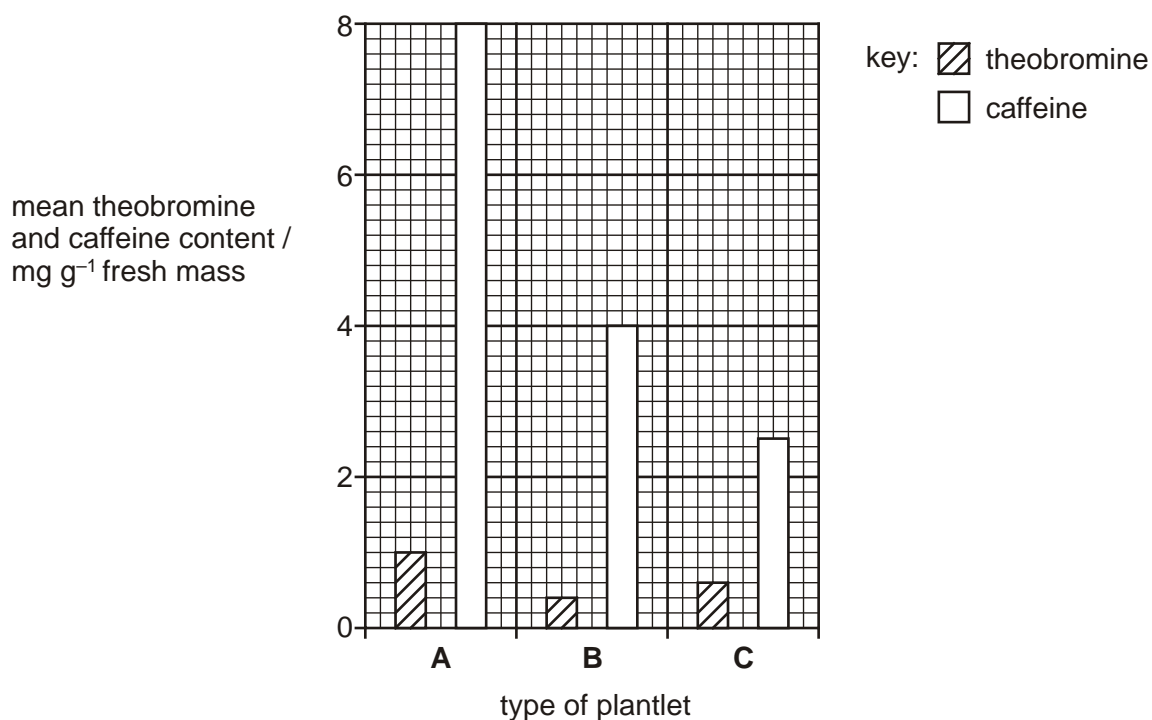
(b) Three types of cell were then cloned in tissue culture into plantlets:

**A** - unmodified (control) cells

**B** - genetically modified cells with the DNA code for short lengths of RNA complementary to mRNA for theobromine synthase

**C** - genetically modified cells with the DNA code for long lengths of RNA complementary to mRNA for theobromine synthase.

Samples of each of the three types of plantlet were analysed to measure their theobromine and caffeine content. The results of the analysis are shown below.



(i) Describe the results shown in the figure above.

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(ii) Suggest an explanation for the difference in the results of the two experimental treatments, **B** and **C**.

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(iii) Describe briefly how plants are cloned by tissue culture.

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(iv) Explain the advantages of using cloned plants in experiments such as this.

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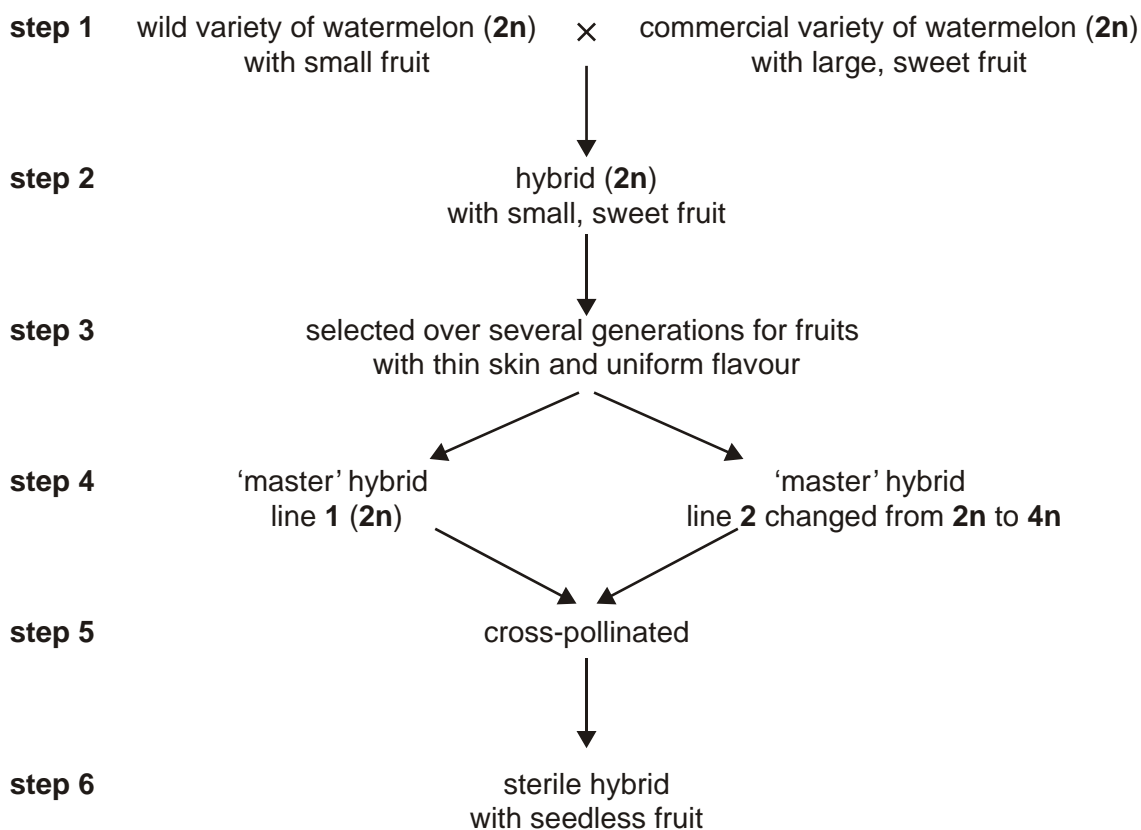
[Total 15 marks]

6. State **three** advantages of plant tissue culture.

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- 2 .....
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- 3 .....
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[Total 3 marks]

7. A variety of watermelon with small, sweet, seedless fruit has been produced by selective breeding in the USA. The melons, which also have thin skin and a uniform flavour throughout the fruit, first went on sale in 2002. The selective breeding programme followed the sequence shown in the figure below.



(a) With reference to the figure above,

(i) explain why several generations were needed in **step 3**;

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(ii) suggest how, in **step 4**, 'master' hybrid line **2** was changed from **2n** to **4n**;

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(iii) describe the process of cross-pollination in **step 5**;

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[2]

(iv) explain why the hybrid produced in **step 6** is sterile and seedless.

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[2]

(b) At first, the supply of seeds for growing sterile watermelons with seedless fruit (**step 6**) was very limited. Cloning plants from tissue culture allowed more of these melons to be grown.

(i) Outline the process of cloning plants from tissue culture.

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(ii) Explain how using this process could increase the supply of seedless watermelons.

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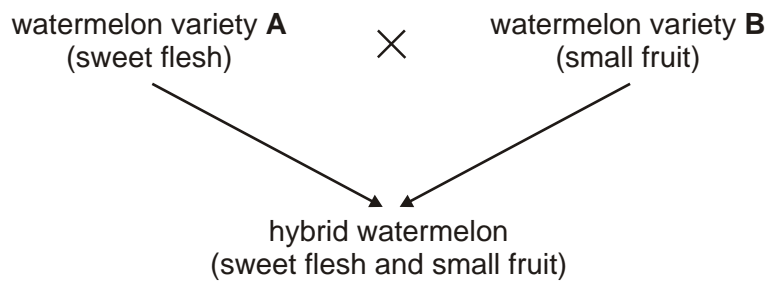
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[Total 15 marks]

8. Artificial selection has been used for many years to produce plants and animals with characteristics valued by breeders.

A hybrid variety of watermelon has been produced which is small, sweet and seedless. This was achieved by selectively breeding two different varieties of watermelon plant, as shown in the figure below.



The hybrid from this cross is sterile because it is triploid (3n). Tissue culture may be used to clone more of this hybrid variety.

(a) Explain why the hybrid is sterile.

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(b) Describe how plants that produce watermelons with sweet flesh and small fruits could be obtained by cloning from tissue culture.

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(c) Discuss the advantages **and** disadvantages of using the technique of tissue culture for cloning plants.

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[Total 12 marks]