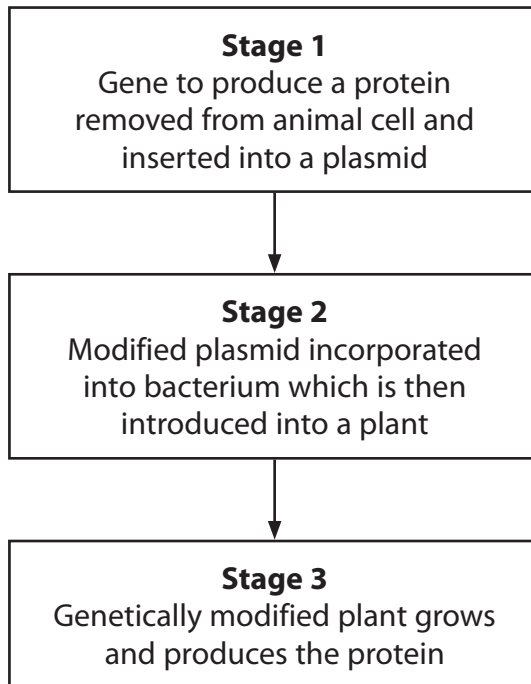


- 1 Some organisms have been genetically modified to produce proteins including hormones and vaccines.

The flow diagram below shows part of a process to produce a protein, using genetically modified plants.



(a) Describe and explain the role of the enzymes involved in stage 1.

(5)

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(b) Describe the structure of the modified plasmid used in stage 2.

(2)

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(c) Suggest why plants rather than bacteria are used to produce the protein in stage 3.

(2)

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(d) Describe **two** risks associated with the use of genetically modified organisms.

(2)

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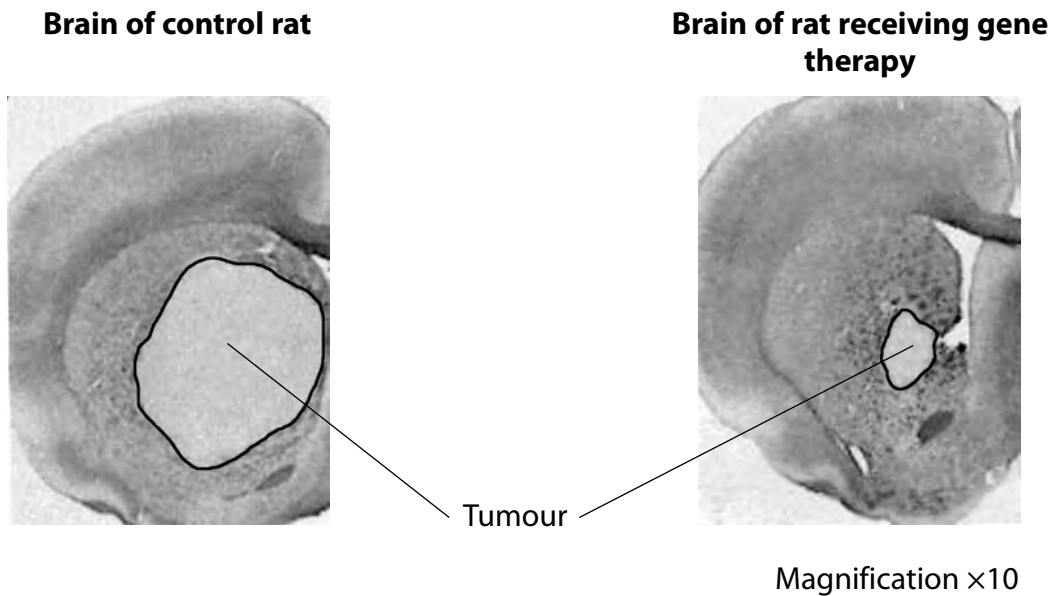
**(Total for Question 1 = 11 marks)**

- 2 Some types of cancer lead to the production of tumours (a group of rapidly-dividing cancer cells).

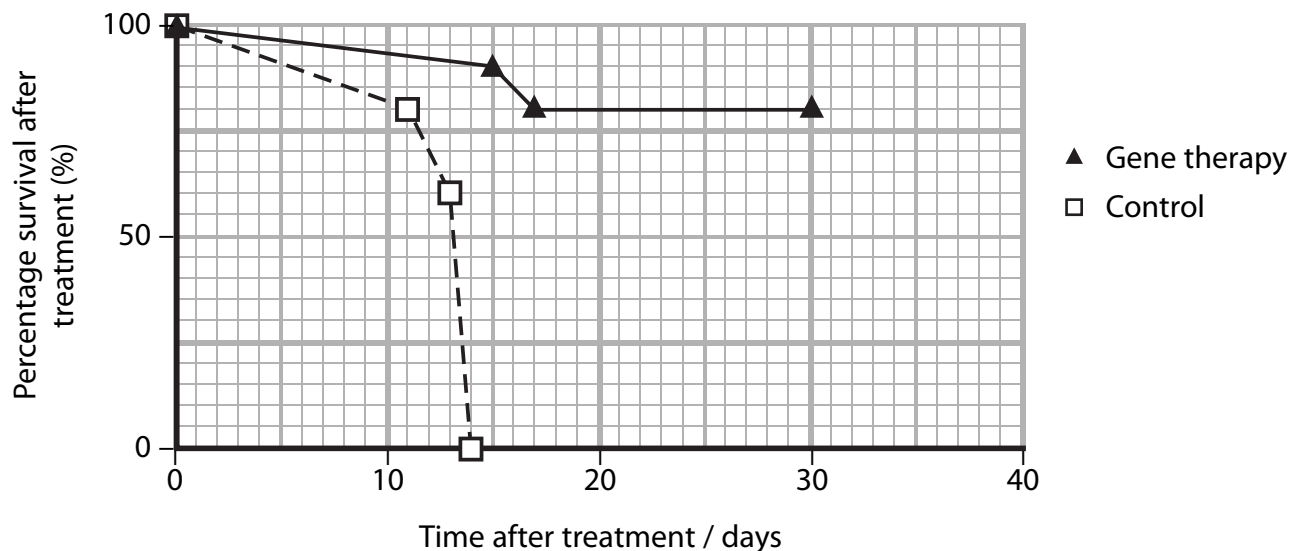
Gene therapy has the potential to cure a number of human diseases, including cancer. At present, research into gene therapy relies on animal models of diseases.

- (a) In one investigation, brain tumours were induced in two groups of rats. One group of rats was given gene therapy and the other group of rats acted as a control.

The photographs below show the appearance of a tumour in the brain of a control rat and in a rat given gene therapy. Both photographs have the same magnification.



The graph below shows the percentage survival after treatment of the rats in the two groups.



Using the information shown in the photographs and in the graph, describe the effects of gene therapy on these rats.

(3)

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(b) Cancer can cause a lot of pain. Pain can be reduced by a chemical called endorphin that is made by cells in the brain and spinal cord. Endorphin reduces the activity of neurones that carry impulses from pain receptors.

Gene therapy has been used in rats to increase the tolerance to pain. Viruses, containing a gene coding for endorphin, were developed. These viruses were injected into the spinal cords of a group of rats. The level of tolerance to pain was tested in these rats and in the rats in a control group.

(i) Describe the role of the viruses in this investigation.

(2)

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(ii) Suggest why the injection was made into the spinal cord.

(1)

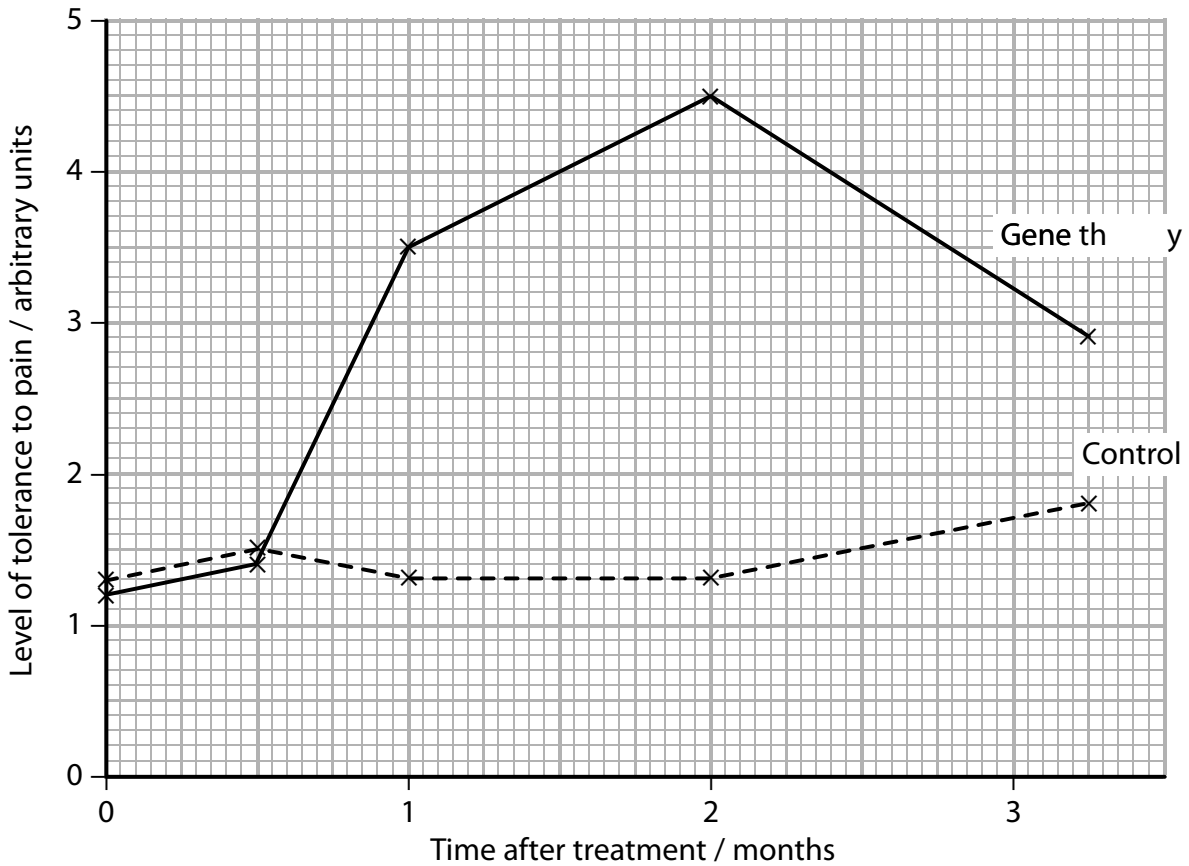
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(iii) Suggest why a gene coding for an endorphin was used in this investigation.

(1)

(iv) The results of this investigation are shown in the graph below.



Using the information in the graph, compare the levels of tolerance to pain in the rats given gene therapy with the control group.

(3)

(Total for Question 2 = 10 marks)



(b) The bacterium *Mycoplasma* has the 'shortest known genome' (paragraph 13). This bacterium contains only 525 genes.

Calculate the mean number of bases per *Mycoplasma* gene.

Show your working.

(2)

Answer = ..... bases

(c) (i) Describe how 'building a stretch of DNA' would differ from 'building a stretch of RNA' (paragraph 21).

(3)

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(ii) Suggest why the scientists would 'insert the whole thing into a circular strand of DNA until they need it' (paragraph 21).

(1)

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(f) Weiss and his team are 'working to harness a virus that could be used to test the idea in mice' (paragraph 40).

Suggest **two** features of the virus selected for this role.

(2)

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(g) After 'testing the idea in mice', phase 1 testing must be carried out (paragraph 40).

Explain why phase 1 testing must be carried out before using this treatment on a patient with cancer.

(3)

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(h) 'Synthetic gene circuits could steer stem cells to develop into insulin-producing cells' (paragraph 41).

Describe **three** differences between a stem cell and an insulin-producing cell.

(3)

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2. ....

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(i) Suggest why it is necessary to 'keep track of exposure to things like radiation within a cell' (paragraph 45).

(1)

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**(Total for Question 3 = 30 marks)**

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