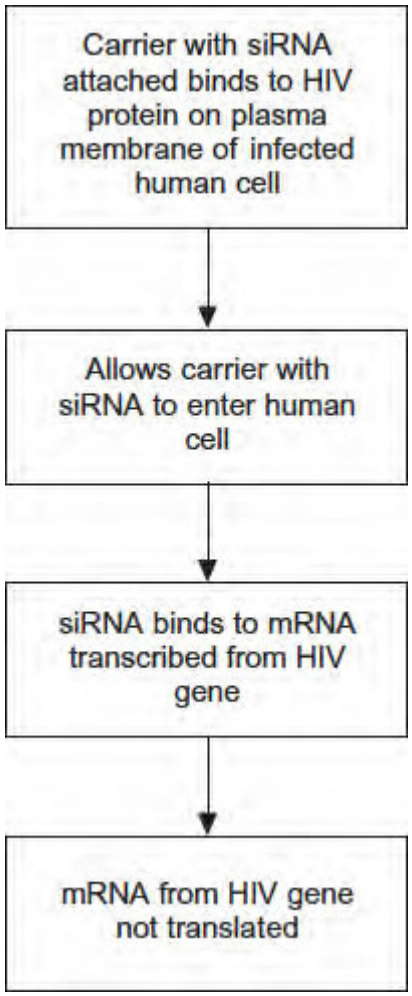
Q1. Human immunodeficiency virus (HIV) particles have a specific protein on their surface. This protein binds to a receptor on the plasma membrane of a human cell and allows HIV to enter. This HIV protein is found on the surface of human cells after they have become infected with HIV.

Scientists made siRNA to inhibit expression of a specific HIV gene inside a human cell. They attached this siRNA to a carrier molecule. The flow chart shows what happens when this carrier molecule reaches a human cell infected with HIV.



(a) When siRNA binds to mRNA, name the complementary base pairs holding the siRNA and mRNA together. One of the bases is named for you.

.....with.....

.....**Adenine**.....with.....

(1)

(b) This siRNA would **only** affect gene expression in cells infected with HIV.

Suggest **two** reasons why.

1.....

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2.....

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(4)

(c) The carrier molecule on its own may be able to prevent the infection of cells by HIV.

Explain how.

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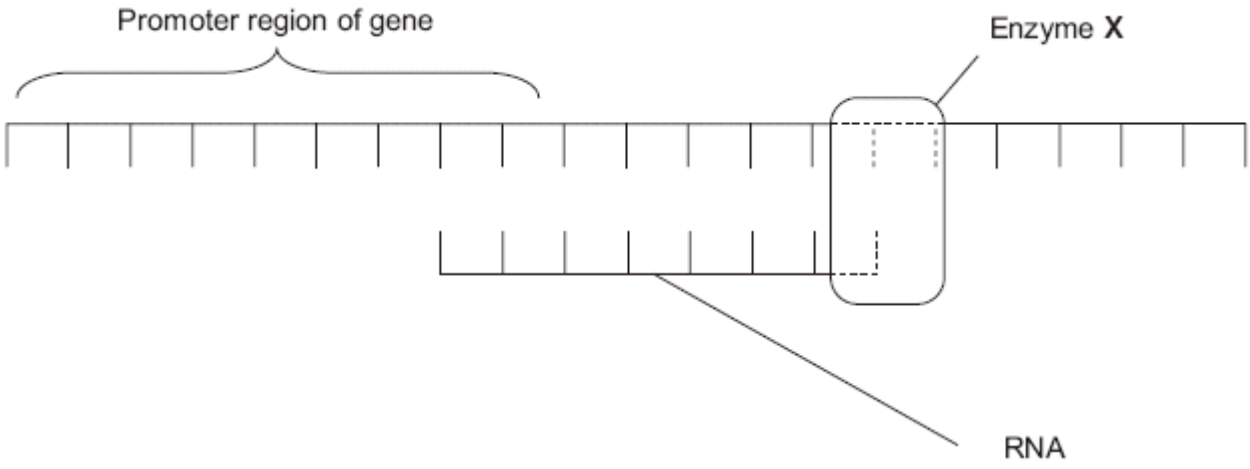
(2)
(Total 7 marks)

Q2.Figure 1 shows part of a gene that is being transcribed.

Figure 1



(a) Name enzyme **X**.

.....

(1)

(b) (i) Oestrogen is a hormone that affects transcription. It forms a complex with a receptor in the cytoplasm of target cells. Explain how an activated oestrogen receptor affects the target cell.

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(2)

(ii) Oestrogen only affects target cells. Explain why oestrogen does not affect other cells in the body.

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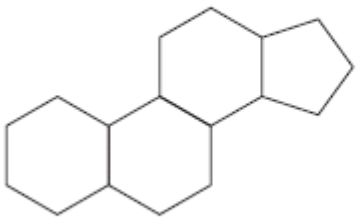
(1)

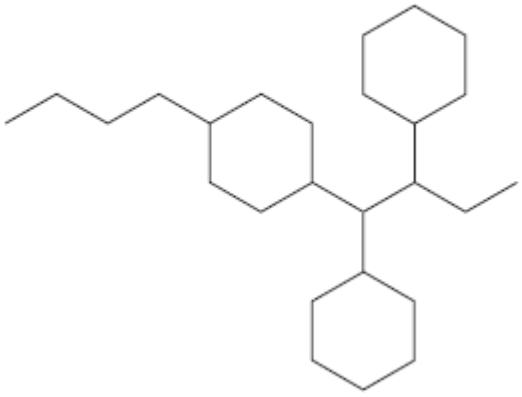
(c) Some breast tumours are stimulated to grow by oestrogen. Tamoxifen is used to treat these breast tumours. In the liver, tamoxifen is converted into an active substance called endoxifen. **Figure 2** shows a molecule of oestrogen and a molecule of endoxifen.

Figure 2

Oestrogen



Endoxifen



Use **Figure 2** to suggest how endoxifen reduces the growth rate of these breast tumours.

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(2)
(Total 6 marks)

Q3. Scientists found a correlation between prostate cancer and exposure to cadmium ions.

The scientists investigated the effects of cadmium ions on cells from a human prostate gland.
They grew a culture of these cells in liquid growth medium and removed samples at intervals.

For each sample they measured

- how much DNA was not methylated,
- the activity of the enzyme methyltransferase.

Methyltransferase is an enzyme that adds methyl groups to some of the bases in DNA.
The addition of a methyl group is called methylation.

(a) The scientists set up another culture as a control.

Describe how the scientists would have set up a control experiment for this investigation.

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(2)

(b) **Figures 1** and **2** show the scientists' results.

Figure 1

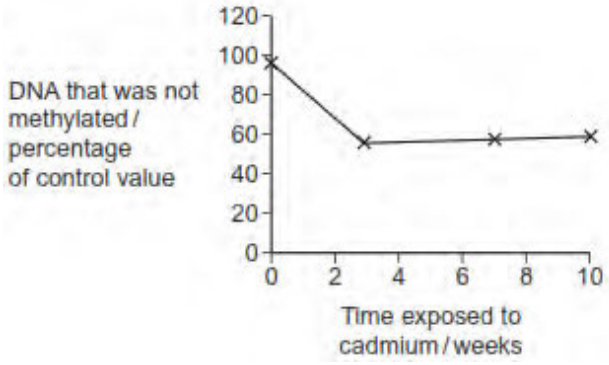
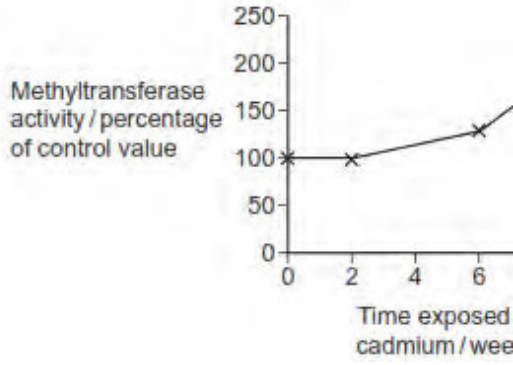


Figure 2



(i) The scientists expressed their results as percentages of the control values. Suggest why.

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(1)

(ii) Use information from **Figure 1** to describe how exposure to cadmium ions affected the methylation of DNA.

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(1)

(iii) Use information from **Figure 2** to suggest what caused the change to the DNA shown in **Figure 1**.

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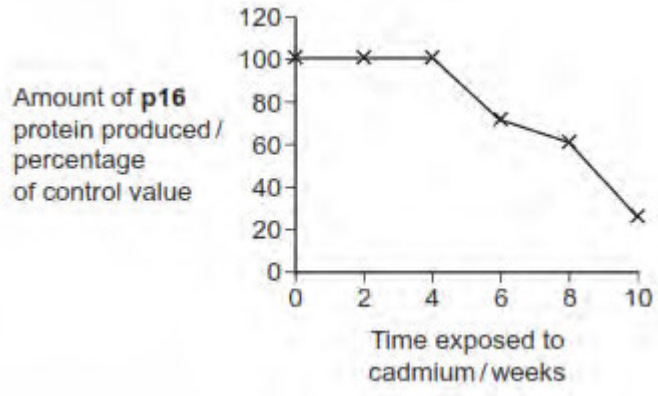
(1)

(c) Prostate gland cells contain a tumour suppressor gene called **p16**.
During the investigation, the scientists also measured the amount of **p16** protein produced.

Figure 3 shows their results.

Figure 3



The scientists found that the promoter DNA of the **p16** gene had become methylated. The promoter is the sequence of bases where the enzyme RNA-polymerase binds to a DNA molecule.

Explain how methylation of the promoter sequence of the **p16** gene could cause the changes shown in **Figure 3**.

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(Extra space) .....

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(2)

(d) Each week of the investigation, the scientists took samples of the cadmium-treated prostate cells from the laboratory cultures. They injected these cells into mice and monitored the mice for the growth of tumours.

It was only the samples taken in the tenth week that caused tumours to begin to grow in the mice.

Use information from **Figures 1, 2** and **3** to suggest why.

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(Extra space) .....

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(4)
(Total 11 marks)

Q4.Essay

You should write your essay in continuous prose.

Your essay will be marked for its scientific accuracy.

It will also be marked for your selection of relevant material from different parts of the specification and for the quality of your written communication.

The maximum number of marks that can be awarded is

Scientific	16

Breadth of knowledge	3
Relevance	3
Quality of written communication	3

Write an essay on the following topic:

Using DNA in science and technology

(Total 25 marks)