

Regulation of Transcription and Translation

These practice questions can be used by students and teachers and is

Suitable for AQA A Level 7402 Biology Topic Question

Level: AQA A LEVEL 7402

Subject: Biology

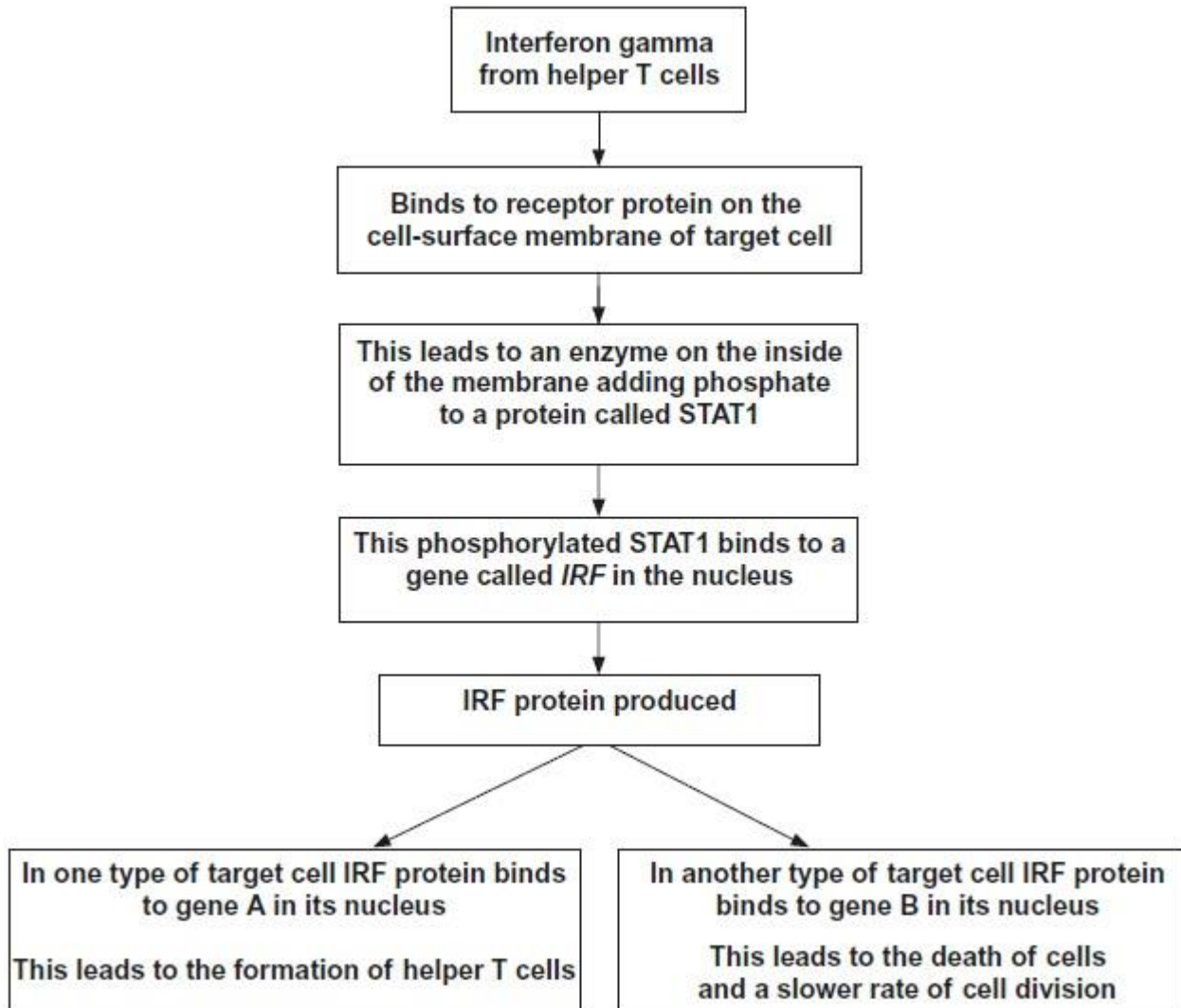
Exam Board: AQA A Level 7402

Topic: Regulation of Transcription and Translation

1

cells. It regulates the production of a number of proteins by target cells. Which protein is produced depends on the type of target cell.

The diagram shows how interferon gamma regulates three genes.



(a) Use information in the diagram to suggest how the binding of interferon gamma to its receptor protein leads to the production of phosphorylated STAT1.

(2)

(b) Name the **two** transcription factors in the diagram.

1. _____

2. _____

(2)

(c) The regulation of the formation of helper T cells by interferon gamma is an example of positive feedback.

Explain why it is an example of positive feedback.

(2)

(d) The *IRF* gene can be a tumour suppressor gene.

Use the information in the diagram to explain how the *IRF* gene acts as a tumour suppressor gene.

(3)

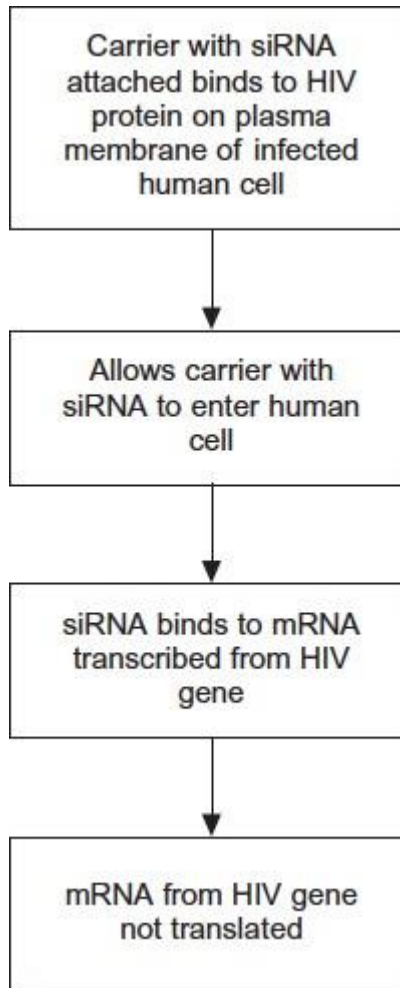
(Total 9 marks)

2

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. _____

2. _____

(4)

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

(2)

(Total 7 marks)

3

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

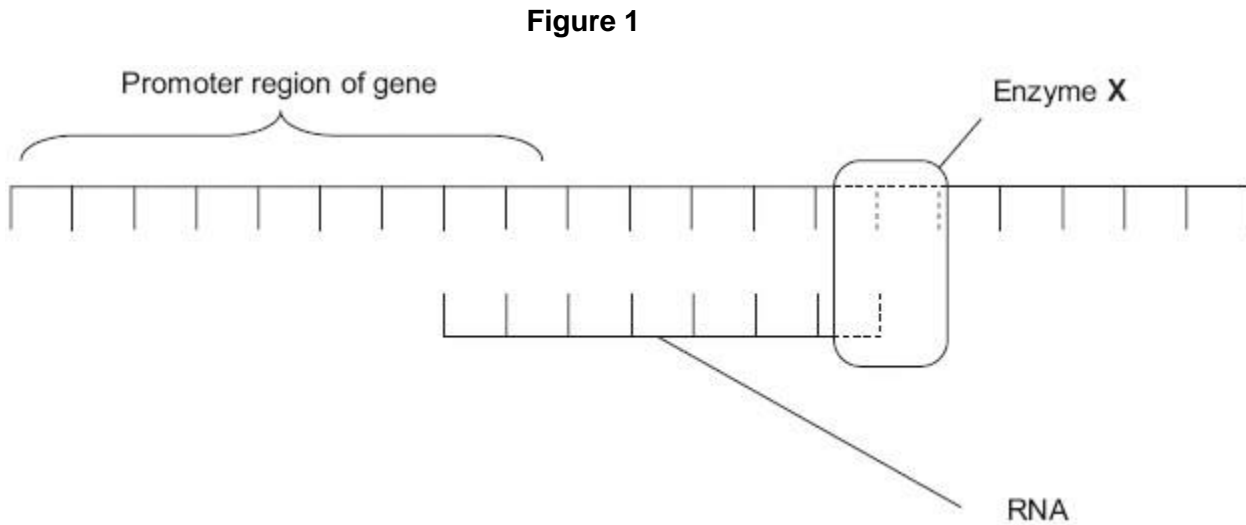
Write an essay on the following topic:

Using DNA in science and technology

(Total 25 marks)

4

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



(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.

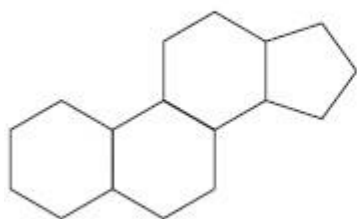
(2)

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

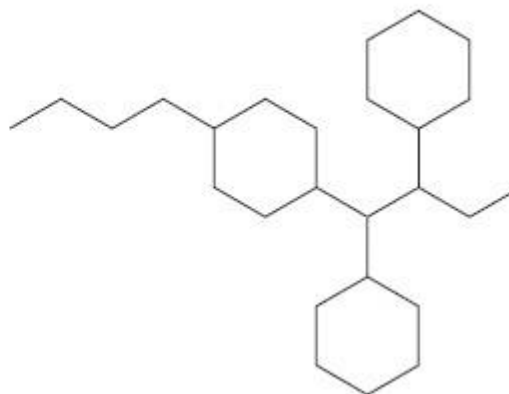
(1)

- (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.

(2)

(Total 6 marks)

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

5

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

For more help, please visit exampaperspractice.co.uk

- 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.

(2)

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

Figure 1

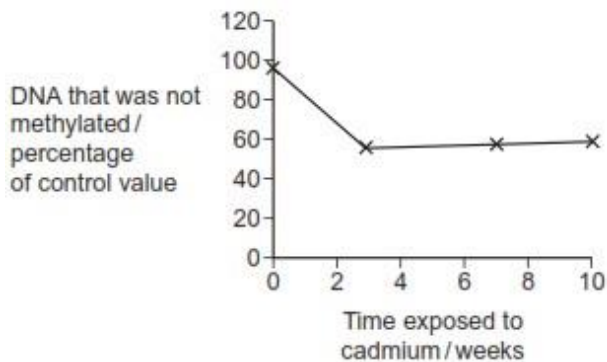
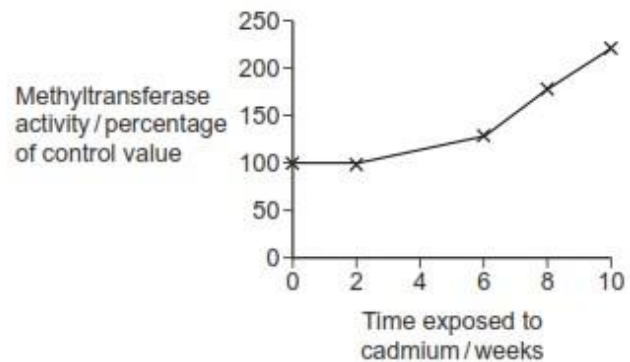


Figure 2



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

(1)

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

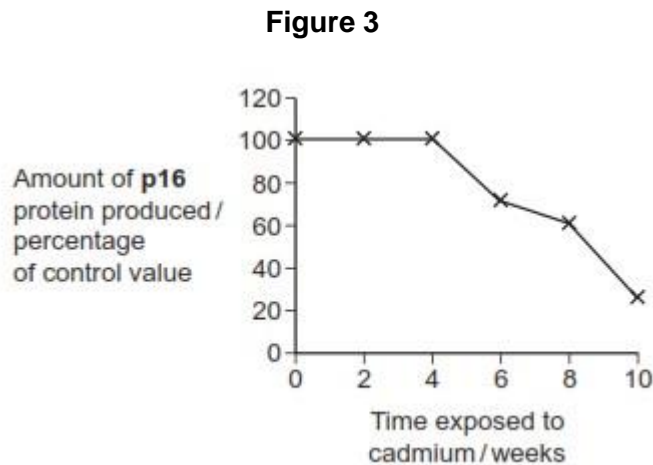
(1)

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

(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.



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**.

(Extra space) _____

(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.

(Extra space) _____

(4)

(Total 11 marks)

Mark schemes

1

- (a) 1. Binding (of interferon gamma) changes shape/tertiary structure of receptor (protein);
2. This activates/switches on the enzyme;
3. Use of ATP (to phosphorylate STAT1);

1. Accept reference to second messenger mechanism/process3.

Context is important

2 max

- (b) 1. Phosphorylated STAT1;
 2. IRF (protein);
Accept in either order
 1. *Must be phosphorylated but accept STAT1P*
 2. *Ignore references to phosphorylated* 2

- (c) 1. Causes more helper T cells to form;
 2. (So) more interferon (gamma) production (by helper T cells);
 1. *and 2. require idea of more* 2

- (d) 1. (Tumour suppressor gene) slows cell division/causes death of damaged/tumour/cancer cells;
 2. *IRF* gene leads to formation of IRF (protein) that binds to gene B;
 3. (Gene B protein) causes death of damaged/mutated cells OR slows division;
 2. *'It' means IRF gene*
 3. *Context is important*
 3. *If clearly stated **and** includes the protein, scores 2 marks because it subsumes point 1* 3

[9]

2

- (a) Cytosine with Guanine and (Adenine) with Uracil;
Ignore G, C and U 1

- (b) Two reasons, with suitable amplification;;
Q

Only infected cells have HIV protein on surface;

So carrier only attaches to / specific to these cells / siRNA can only enter these cells;

OR

siRNA (base sequence) complementary / specific to one mRNA;

Accept idea of specificity

Only infected cells contain mRNA of HIV / this gene / stops translation of this gene / only binds to this mRNA / destroys this mRNA;

Accept could not inhibit other / non-HIV mRNA

4 max

- (c) 1. Carrier binds to (protein on) HIV;
1. *Accept references to HIV membrane*
2. Prevents HIV / it binding to (receptor on human) cell;
2. *Reject references to binding to HIV protein on human cell*

2

[7]

Essay Using DNA in science and technology

3

DNA and classification

2.2 Structure of DNA

2.3 Differences in DNA lead to genetic diversity

2.9 Comparison of DNA base sequences

Genetic engineering and making useful substances

2.5 Plasmids

5.8 The use of recombinant DNA to produce transformed organisms that benefit humans

Other uses of DNA

2.5 Cell cycle and treatment of cancer

5.8 Gene therapy;

Medical diagnosis and the treatment of human disease;

The use of DNA probes to screen patients for clinically important genes.

(a) RNA polymerase;

4

DNA polymerase is incorrect

Ignore references to RNA dependent or DNA dependent

Allow phonetic spelling

1

(b) (i) (Receptor / transcription factor) binds to promoter which stimulates RNA polymerase / enzyme X;

Transcribes gene / increase transcription;

2

- (ii) Other cells do not have the / oestrogen / ER α receptors;
But do not accept receptors in general.

1

- (c) Similar shape to oestrogen;

Binds receptor / prevents oestrogen binding;

Receptor not activated / will not attach to promoter / no transcription;

Accept alternative

Complementary to oestrogen;

Binds to oestrogen;

Will not fit receptor;

2 max

[6] (a) No cadmium;

5

Other conditions same as cadmium-treated group;

2

- (b) (i) As a measure of the effect due to cadmium /to make a comparison;

1

- (ii) Becoming more methylated;

Ignore later slight decrease/no change

1

- (iii) Production of more methyltransferase enzyme /increased activity of transferase;

Extra incorrect relevant information - cancel

1

- (c) RNA-polymerase could not bind (to DNA / to promoter);mRNA of p16 could not be made / no transcription of p16 gene;

2

- (d) Any four from:

1. Cadmium causes expression of methyltransferase gene / increased activity transferase (from 2 to 3 weeks in);
2. Methyl groups on to promoter / p16 gene / suppressor (gene);
3. (p16) normally suppresses tumour growth;
4. p16 protein / p16 expression falls after 4 weeks / after methylation; 5. Tumour formation occurs (after 10 weeks) after p16 falls / after suppressor gene activity falls;

4 max

