7.2 Transcription & Gene Expression

Question Paper

Course	DP IB Biology
Section	7. Nucleic Acids (HL Only)
Topic	7.2 Transcription & Gene Expression
Difficulty	Hard

Time allowed: 70

Score: /56

Percentage: /100
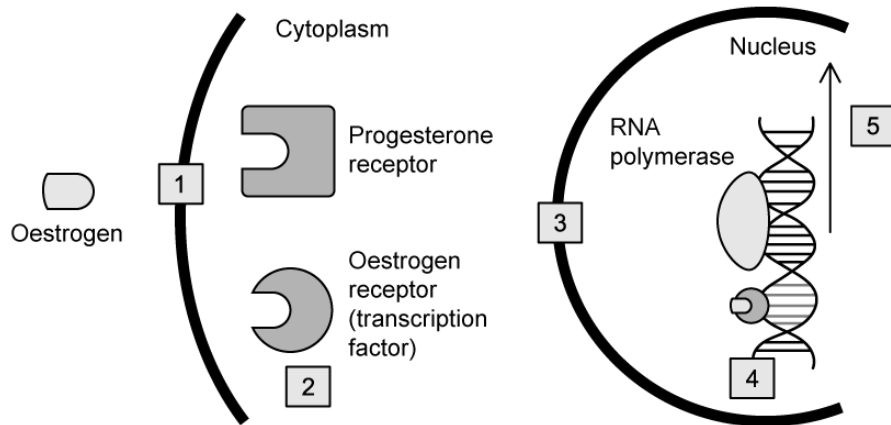
Question 1a

a)

Explain how transcription factors stimulate the expression of a gene.

[3 marks]

[3 marks]

Question 1b

b)

The diagram below shows the mechanism by which oestrogen initiates gene expression.

Compare and contrast the mechanism of action shown in the diagram with the process of non-competitive enzyme inhibition.
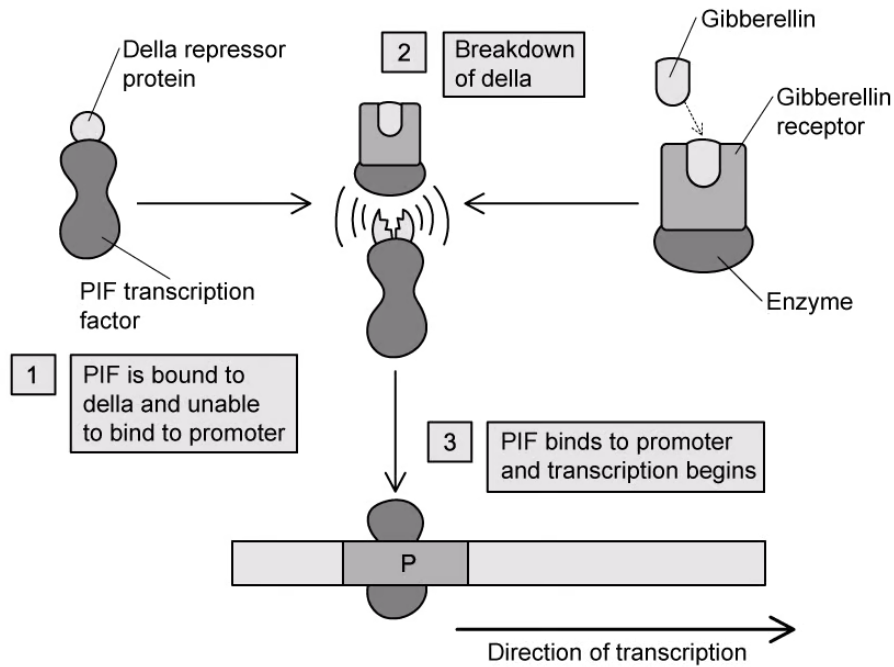
[3 marks]

[3 marks]

Question 1c

c)

Plant cells use transcription factors in a similar way to animal cells. One transcription factor found in plant cells is called PIF. When activated, PIF binds to the promoter region which triggers transcription of the amylase gene. PIF is inhibited by the presence of a repressor protein called DELLA. The plant hormone gibberellin stimulates the breakdown of DELLA to activate PIF. This process is shown in the diagram below.

Using the information above, suggest how the application of gibberellin hormone could facilitate the germination of seeds.

[4 marks]

[4 marks]

Question 1d

d)

Totipotent cells from one organism are genetically identical, however, not all of these genes are ultimately expressed.

Explain how differential gene expression forms an organism with specialised cells.

[4 marks]

[4 marks]

Question 2a

a)

In the 1800s Jean Baptiste Lamarck published his theory of inheritance of acquired characteristics which suggested that an organism can inherit characteristics that had been acquired during its parent's lifetime. Lamarck's theory has been much debated in the scientific world over the years, but more recently, advances in the understanding of epigenetics have led scientists to reconsider Lamarck's ideas.

Outline how the field of epigenetics supports the theory of inheritance of acquired characteristics.

[3 marks]

[3 marks]

Question 2b

b)
Explain how changes to DNA methylation and acetylation can activate gene expression.

[5 marks]

[5 marks]

Question 2c

c)
Epigenetic therapy could be used to treat diseases resulting from epigenetic changes by reversing changes to the acetylation of histones and methylation of DNA.

Suggest how knowledge of epigenetics could lead to the development of more effective treatments for diseases such as cancer.

[2 marks]

[2 marks]

Question 3a

a)
Outline the mechanism by which interactions between the genome and epigenome determine the proteome of an organism.

[3 marks]

[3 marks]

Question 3b

b)
Explain why the genome of a bacterium is more simple to determine than the genome of a human.

[2 marks]

[2 marks]

Question 3c

c)
The human genome project established that the human genome is made up of 26 564 genes and these genes contain 233 785 exons and 207 344 introns.

Use this information to calculate the average ratio of exons to introns per gene in the human genome.

[2 marks]

[2 marks]

Question 4a

a)

A scientist obtained the mitotic index for a tissue sample taken from a patient.
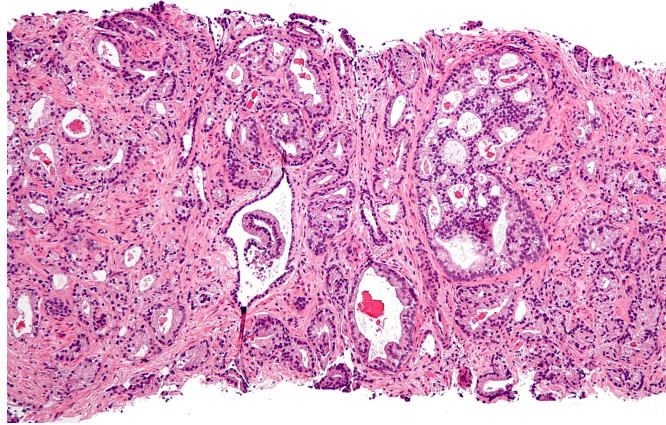

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i)

Define the term mitotic index.

[1 mark]

ii)

Suggest how the mitotic index could be used to indicate the presence of cancer in a tissue sample.

[2 marks]

[3 marks]

Question 4b

b)

DNA contains several non-coding regions.

State **two** functions of these regions.

[2 marks]

[2 marks]

Question 4c

c)

DNA methylation plays a vital role in gene regulation by affecting transcription. Tissue samples were obtained from two prostate cancer tumours (T1 and T2) and two normal prostate samples (X1 and X2). A specific gene was indicated as a plausible cause of cancer. The promoter of this specific gene was cloned several times (A–J). The data below shows the DNA methylation patterns from these samples. The numbers (29–271) represent different markers in the promoter region.
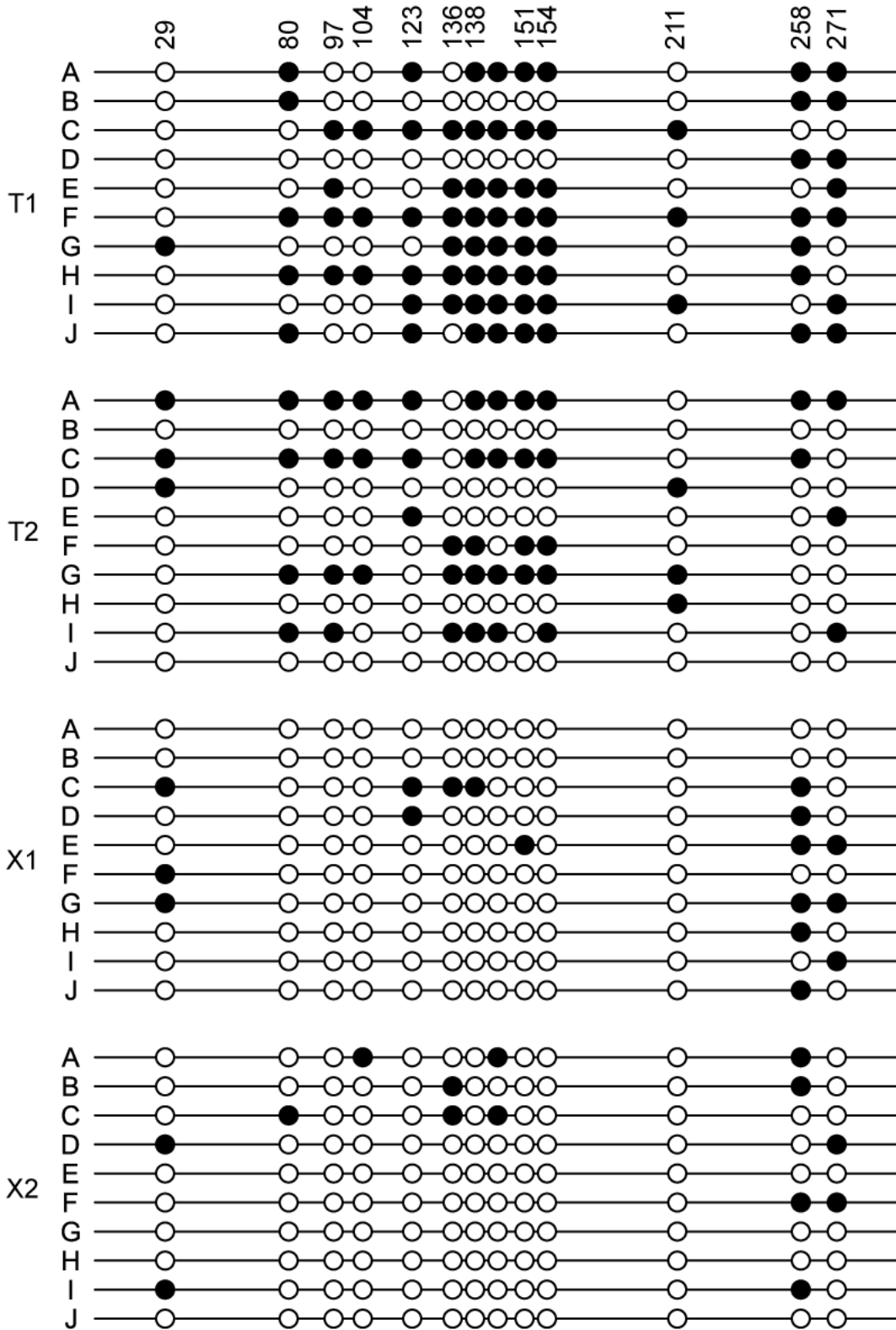
Key: ○ = no methylation   ● = methylation

Use the information above to compare and contrast the methylation patterns in tumorous and normal tissue samples.

[3 marks]

[3 marks]

Question 4d

d)
Predict the effect DNA methylation could have on tumour cell genes.

[2 marks]

[2 marks]

Question 5a

One mark is available for clarity of communication in this question.

a)
Contrast the differences between translation and transcription.

[4 marks]

[4 marks]

Question 5b

b)
The process of alternative splicing can result in the production of several polypeptides from a single gene.

Draw an annotated sketch to illustrate this process.

[3 marks]

[3 marks]

Question 5c

c)
Describe the control of gene expression in eukaryotes.

[8 marks]

[8 marks]