



Gene expression: practice questions

6 questions • 19 marks • mark scheme at the back

For IB Diploma Biology, Standard Level and Higher Level (first assessment 2025). **HL only** is additional higher level content, for HL students only.

Name

Total / 19

1 PAPER 1A STYLE

[1 mark]

HL only

Which statement correctly compares a liver cell and a skin cell from the same person?

- A. ☐ They have different genomes and the same proteome
- B. ☐ They have the same genome and different transcriptomes
- C. ☐ They have the same transcriptome and different proteomes
- D. ☐ They have different genomes and different transcriptomes

2 PAPER 1A STYLE

[1 mark]

HL only

What is the effect of methylation of cytosine bases in the promoter of a gene?

- A. ☐ The base sequence of the gene is changed
- B. ☐ Transcription of the gene is repressed
- C. ☐ Translation of the mRNA is increased
- D. ☐ The mRNA is broken down more quickly by nucleases

3 PAPER 2A STYLE

[4 marks]

HL only

Outline two ways in which a cell can regulate the amount of a protein it produces.

HL only

Researchers measured differences in DNA methylation between the two members of pairs of monozygotic twins. A higher score means the twins' methylation patterns are more different (the data are for practice). (a) Describe the trend shown by the data. [1] (b) Explain why monozygotic twins are used to investigate the effect of the environment on gene expression. [2] (c) Suggest why twins who had lived apart for longer showed larger differences. [1]

Difference in methylation between members of twin pairs (arbitrary units, means)

Age of twins / years	Mean difference in methylation	Mean years lived apart
3	0.8	0
18	1.9	1
35	3.4	14
50	4.6	27

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HL only

Explain how the presence of lactose changes gene expression in *E. coli*.

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HL only

Explain how epigenetic tags can affect the phenotype of cells and offspring without changing the genotype. Refer to tigers and ligers in your answer.

[illegible]

Mark scheme

One mark for each point unless a maximum is given. Words in brackets are not needed for the mark.

1. [1] **HL only**

B B

2. [1] **HL only**

B B

3. [4] **HL only**

- transcription factors bind to specific base sequences in DNA [1]
- at the promoter, where RNA polymerase binds [1]
- activators binding to enhancers increase transcription / repressors decrease it [1]
- control of the rate of mRNA degradation (by nucleases) [1]
- mRNA may persist for minutes up to days [1]
- longer-lasting mRNA can be translated more times, so more protein is made [1]
- max 4

4. [4] **HL only**

- (a) difference in methylation increases with age (and years lived apart) [1]
- (b) monozygotic twins have identical genomes / same base sequences [1]
- so differences in methylation / gene expression must be caused by the environment [1]
- (c) more time in different environments / diets / exposures to pollutants alters methyl tags differently [1]

5. [3] **HL only**

- without lactose, a repressor protein binds to the operator (of the lac operon) [1]
- this blocks RNA polymerase so the genes are not transcribed [1]
- lactose / allolactose binds to the repressor, changing its shape [1]
- repressor detaches from the operator, so RNA polymerase transcribes the genes [1]
- enzymes for uptake / breakdown of lactose / β -galactosidase are produced [1]
- max 3

6. [6] HL only

- epigenetic tags do not change the base sequence of DNA, so the genotype is unchanged [1]
- methylation of cytosine in a promoter represses transcription [1]
- methylation of histones can repress or activate transcription [1]
- changes the pattern of gene expression / which proteins are made, so changes the phenotype [1]
- patterns of tags lead to differentiation / epigenesis [1]
- tags can remain in place during mitosis / be passed to daughter cells [1]
- most but not all tags are removed from the ovum and sperm [1]
- so some tags pass to offspring / effect depends on which parent an allele came from (imprinting) [1]
- liger (male lion × tigress) is larger than tigon (male tiger × lioness) though both have lion and tiger genes [1]
- strong paternal growth-promoting imprinting from the lion father is not balanced by the weaker maternal growth-restraining imprinting of a tigress OWTTE [1]
- tigon: strong maternal growth restraint from the lioness and weak paternal growth promotion from the tiger, so not enlarged [1]
- max 6