

33.1 Gene expression: regulate products, not just genes

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS transcription factor • epigenetic modification

Objective

Gene expression: regulate products, not just genes. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

■ What would explain this observation?

- Two cells with the same genome make different proteins. Regulation changes which information is used and when.
 - Start with a prediction. State the quantities or features you would compare, then decide what evidence could distinguish two explanations.
-

■ Build the model

- Gene expression can be regulated at transcription and later stages. A **transcription factor** can affect transcription through interactions with DNA and other proteins. **Epigenetic modifications** can influence expression without changing the underlying DNA sequence.
- transcription factor: A protein that influences transcription; epigenetic modification: A change affecting expression without changing the DNA sequence.



■ Choose evidence that can test it

- Distinguish a measured mRNA change from a protein or functional change. Translation, degradation and protein modification can all intervene. Regulation is specific to a cell context and environmental conditions.
- Compare treated and control expression data after checking normalization and replicates. Use evidence from a supplied perturbation to discuss causal models, rather than equating every association with a direct mechanism.

■ Work from known quantities

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- Known: normalized transcript abundance is 12 in treatment and 3 in control. Fold change = $12/3 = 4$. Equal normalized abundance does not require equal absolute cell counts in the two raw samples.

Example:

Transcript abundance is 15 in treatment and 5 in control. Find fold change. Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ Check the conclusion and its limits

- An epigenetic change is not automatically a DNA-sequence mutation. More mRNA does not guarantee proportionally more active protein.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

Every change in gene expression is a mutation. This claim is false: An epigenetic change is not automatically a DNA-sequence mutation. More mRNA does not guarantee proportionally more active protein.

Key:

Gene expression: regulate products, not just genes: Distinguish a measured mRNA change from a protein or functional change. Translation, degradation and protein modification can all intervene. Regulation is specific to a cell context and environmental conditions.

2 Practice

2.1 What is justified by higher measured mRNA abundance? Choose one answer.

- **A** More of that transcript under the measured conditions
- **B** A guaranteed equal increase in protein activity
- **C** Proof that the gene sequence mutated

[1]

2.2 Transcript abundance is 15 in treatment and 5 in control. Find fold change. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: Every change in gene expression is a mutation.

[2]

2.4 A protein that influences transcription: write the technical term.

[1]

3 Exam-style questions

3.1 Normalized expression changes from 4 to 12 units. Distinguish fold change from percentage increase. What can be inferred about absolute transcript counts? [4]

Solutions

2.1 A Distinguish a measured mRNA change from a protein or functional change. Translation, degradation and protein modification can all intervene. Regulation is specific to a cell context and environmental conditions.

2.2 fold change=treatment/control=15/5=3.

2.3 False. An epigenetic change is not automatically a DNA-sequence mutation. More mRNA does not guarantee proportionally more active protein.

2.4 transcription factor. transcription factor means A protein that influences transcription.

3.1 Fold change3; increase $(12-4)/4 \times 100 = 200\%$. Absolute counts need normalization and sample-size information. Expression association alone does not demonstrate a causal regulatory mechanism.