

Gene expression

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

This handout covers selected HL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

Gene expression: regulate products, not just genes

■ What would explain this observation?

- Two cells with the same genome make different proteins. Regulation changes which information is used and when.

■ 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.



Gene expression can be controlled at transcription, at translation and by breaking down the product

■ 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.

In the lab: 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

- 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.

Your turn: Transcript abundance is 15 in treatment and 5 in control. Find fold change.

■ 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.

Not true: Every change in gene expression is a mutation. Expression changes are regulatory - the same DNA is read more or less often. A mutation is a change in the DNA sequence itself; most changes in expression involve no mutation at all.

Key:

- Gene expression can be regulated at transcription and later stages.
- Distinguish a measured mRNA change from a protein or functional change.
- Watch for: an epigenetic change is not automatically a DNA-sequence mutation.

■ Write from a transcript fold change of 5

- Normalized transcript abundance is 20 in the treatment and 4 in the control.
- Find the fold change. An mRNA change is not automatically a protein change.