What is Gene Expression Regulation?

Worksheet

Gene expression regulation is the set of mechanisms cells use to control when, where, and how much a gene product is made - via transcription factors, epigenetic marks, RNA processing, and protein modification.

Questions

1. Which molecule turns off the lac operon when lactose is absent?

A) RNA polymerase
B) The lac repressor
C) Sigma factor
D) cAMP

2. DNA methylation of a promoter typically

A) increases transcription
B) has no effect
C) silences the gene
D) only affects translation

3. Which level of regulation controls mRNA splicing and stability?

A) Transcriptional
B) Post-transcriptional
C) Translational
D) Post-translational

4. If Ct = 3, what is the approximate fold change (2^Ct)?

A) 3
B) 6
C) 8
D) 0.3

5. Using qPCR: Ct(target, treated)=20, Ct(reference, treated)=18, Ct(target, control)=24, Ct(reference, control)=18. Find the fold change.

6. A repressor protein binds the operator of the lac operon in the absence of lactose. What happens to transcription?

7. DNA methylation adds methyl groups to a gene's promoter CpG island. Predict the effect on expression.

8. Define: What is gene expression regulation?

9. Define: What is a transcription factor?

10. Define: What is an operon?

Answer Key

1. B) The lac repressor - The lac repressor binds the operator and blocks transcription without lactose.

2. C) silences the gene - Methylated CpG islands recruit chromatin-condensing proteins, blocking transcription factors.

3. B) Post-transcriptional - Post-transcriptional regulation includes splicing, editing, and mRNA degradation/stability (e.g., by miRNAs).

4. C) 8 - 2^(3) = 2^3 = 8-fold higher expression.

5. Ct(treated) = 20 18 = 2 Ct(control) = 24 18 = 6 Ct = 2 6 = 4 Fold change = 2^(4) = 2^4 = 16 16-fold higher expression in the treated sample

6. The repressor binds the operator, blocking RNA polymerase No mRNA is made for the lac genes Genes stay OFF until lactose (the inducer) binds the repressor and removes it

7. Methylated CpG islands recruit proteins that condense chromatin Transcription factors can no longer access the promoter Gene expression is silenced (turned off)

8. The mechanisms that control when, where, and how much a gene is transcribed and translated.

9. A protein that binds DNA regulatory sequences (promoters/enhancers) to activate or repress transcription.

10. A cluster of bacterial genes controlled by one promoter/operator, e.g., the lac operon.