

Exercise walk-through

5.6

Gene switching and transcription factors (statement 7.22)

Pearson Edexcel · International A-Level · Biology

Four stages, one purpose

Stage	Where	Yield
Glycolysis	cytoplasm	2 ATP + 2 reduced NAD
Link reaction	matrix	CO ₂ + reduced NAD
Krebs cycle	matrix	ATP + reduced NAD + reduced FAD
Oxidative phosphorylation	cristae	most ATP; O ₂ to water

Recombinant DNA: cut, paste, select

Cut : the same restriction enzyme opens plasmid and gene



Paste : complementary sticky ends sealed by DNA ligase



Transform : heat shock carries plasmids into bacteria



Select : antibiotic marker - only transformants survive

Check yourself

Your turn

Why is the human insulin gene made from mRNA before inserting into bacteria?

- ☐ A. bacteria cannot splice introns, and mature mRNA has none
- ☐ B. mRNA is more stable than DNA
- ☐ C. mRNA is double-stranded and easier to cut
- ☐ D. restriction enzymes only cut RNA

Exercises 2.1·2.3

2.1 State what a transcription factor does.

[1]

2.2 Name the two epigenetic mechanisms that silence genes without changing the base sequence.

[2]

2.3 Explain how a steroid hormone can alter transcription through an intracellular receptor, whereas adrenaline first binds a cell-surface receptor.

[2]

Exercises 2.1·2.3

2.1 State what a transcription factor does. [1]

2.1 Binds the gene's promoter and switches transcription on or off.

2.2 Name the two epigenetic mechanisms that silence genes without changing the base sequence. [2]

2.2 DNA methylation and histone modification (deacetylation).

2.3 Explain how a steroid hormone can alter transcription through an intracellular receptor, whereas adrenaline first binds a cell-surface receptor. [2]

2.3 Steroids are lipid-soluble and can enter the cell; the activated intracellular receptor binds regulatory DNA in the nucleus; adrenaline is amino-acid derived and water-soluble - it binds a surface receptor and acts through intracellular signalling; this can also affect gene expression indirectly.

Exercises 3.1·3.2

3.1 Explain how a gene can be switched on by a transcription factor, naming where the factor binds and what changes at the gene. [4]

3.2 The RASSF1 gene is a tumour suppressor. In some cancer cells its promoter is heavily methylated. Explain how this methylation leads to uncontrolled cell division. [5]

Exercises 3.1·3.2

3.1 Explain how a gene can be switched on by a transcription factor, naming where the factor binds and what changes at the gene. [4]

3.1 A transcription factor binds the promoter region upstream of the gene; the bound factor assists RNA polymerase attachment and assembly of the transcription complex; transcription of the gene begins and mRNA appears.

3.2 The RASSF1 gene is a tumour suppressor. In some cancer cells its promoter is heavily methylated. Explain how this methylation leads to uncontrolled cell division. [5]

3.2 In the model described, heavy promoter methylation reduces transcription-factor binding; less transcription machinery assembles, reducing RASSF1 mRNA and protein production. Loss of protective protein weakens cell-cycle control and can contribute to uncontrolled division. Maintenance of the methylation pattern through cell division can pass reduced gene expression to daughter cells.

Exercise 3.3

3.3 One gene can produce several different proteins in different tissues. Explain how, referring to post-transcriptional processing of the pre-mRNA. [4]

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3.3 The gene is transcribed to a pre-mRNA containing all exons and introns; different tissues splice the pre-mRNA differently, keeping different exon combinations; the mature mRNAs translate to proteins with different amino-acid sequences and functions.