

Exercise walk-through

5.12

Genetically modified organisms, microarrays and bioinformatics (statements 8.20–8.21)

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 fluorescent spot on a microarray shows about a gene. [1]

2.2 Name the process by which cDNA binds to its probe on the chip. [1]

2.3 Give one use of bioinformatics other than gene activation. [1]

Exercises 2.1·2.3

2.1 State what a fluorescent spot on a microarray shows about a gene. [1]

2.1 The gene was being transcribed (active) in the sample - its mRNA hybridised to the probe.

2.2 Name the process by which cDNA binds to its probe on the chip. [1]

2.2 Hybridisation (complementary base pairing).

2.3 Give one use of bioinformatics other than gene activation. [1]

2.3 Any one: comparing species relatedness; identifying disease alleles; primer design; drug-target discovery.

Exercises 3.1·3.2

3.1 Describe how a microarray identifies which genes are active in a tissue sample, including how the mRNA is prepared and how the result is read. [5]

3.2 Scientists compare the DNA sequences of a gene in three species: A and B differ in 2 bases per thousand, A and C in 14, B and C in 15. Deduce the relationships between the species and explain the reasoning. [4]

Exercises 3.1·3.2

3.1 Describe how a microarray identifies which genes are active in a tissue sample, including how the mRNA is prepared and how the result is read. [5]

3.1 Extract mRNA from the tissue; reverse-transcribe to cDNA with fluorescent nucleotides; wash the chip so cDNA hybridises to complementary probes; scan for fluorescence - a glowing spot marks a gene whose mRNA was present, i.e. active; with two colour dyes, red/green/yellow compares two samples.

3.2 Scientists compare the DNA sequences of a gene in three species: A and B differ in 2 bases per thousand, A and C in 14, B and C in 15. Deduce the relationships between the species and explain the reasoning. [4]

3.2 A and B are the closest relatives - fewest base differences (2/1000), so they diverged most recently; C diverged from the common ancestor of A and B earlier, accumulating differences with both.

Exercise 3.3

3.3 Bt maize carries a bacterial gene for an insect toxin. Discuss the benefits and risks of growing Bt maize, giving one piece of evidence for each side. [6]

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3.3 Benefits: the toxin kills the European corn borer without spraying, raising yield and reducing insecticide use and its costs. Risks: pollen bearing the toxin can affect non-target insects - the monarch butterfly study - and pest resistance can select toxin-resistant borers; gene flow to wild relatives or contamination of non-GM crops. Judgement: benefits are largest where borer damage is severe and refuges are planted to slow resistance.