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BIOLOGY

THE CONTROL OF GENE EXPRESSION

Level & Board	AQA (A-LEVEL)
TOPIC:	DNA PROBE & GEL ELECTROPHORESIS
PAPER TYPE:	QUESTION PAPER - 2
TOTAL QUESTIONS	6
TOTAL MARKS	30

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DNA probe and Gel Electrophoresis - 2

1.

Fly populations are evolving resistance to insecticides meant to eradicate them.

Researchers created a technique to determine if a fly carries the recessive gene, r , which confers insecticide resistance. This gene's dominant allele, R , does not confer resistance.

The researchers crossed flies carrying the genotype RR with flies carrying the genotype rr .

They collected DNA samples from both parents and children; to extract DNA fragments, the identical restriction endonuclease enzymes were applied to each sample.

(a) Give an explanation of why the researchers treated every DNA sample with the same restriction endonuclease enzymes. **(2)**

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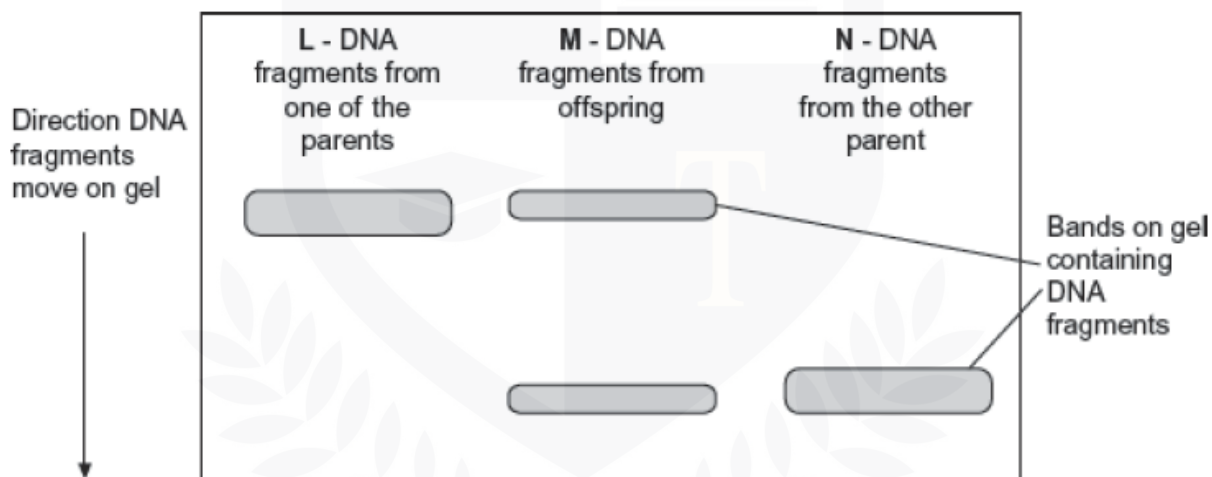
Each sample of DNA fragments was treated with two distinct primers by the scientists in preparation for the polymerase chain reaction (PCR).

- Only a 195 base-pair fragment from allele r is bound by primer A3.
- Only a 135 base-pair fragment from allele R can be bound by primer A4.

On a gel, where shorter pieces travel farther in a given amount of time, the scientists separated the DNA fragments generated by the PCR.

Figure 1 displays their findings.

Figure 1



(b) Describe the reason why primers A3 and A4 only attach to particular segments of DNA. **(2)**

(c) Explain the findings in Figure 1 using all the available information. **(3)**



2.

(a) The question that the scientists had was which chromosome the gene containing alleles R and r was on. They took cells in mitosis from the flies with genotype RR and introduced a labeled DNA probe specific for allele R. After that, they used an optical microscope to examine the cells.

Describe the rationale behind the employment of mitotic cells. **(2)**

3.

Another team of researchers believed that elevated P450 monooxygenase (PM) activity was connected to pesticide resistance in certain flies.

Insecticides are broken down by this enzyme.

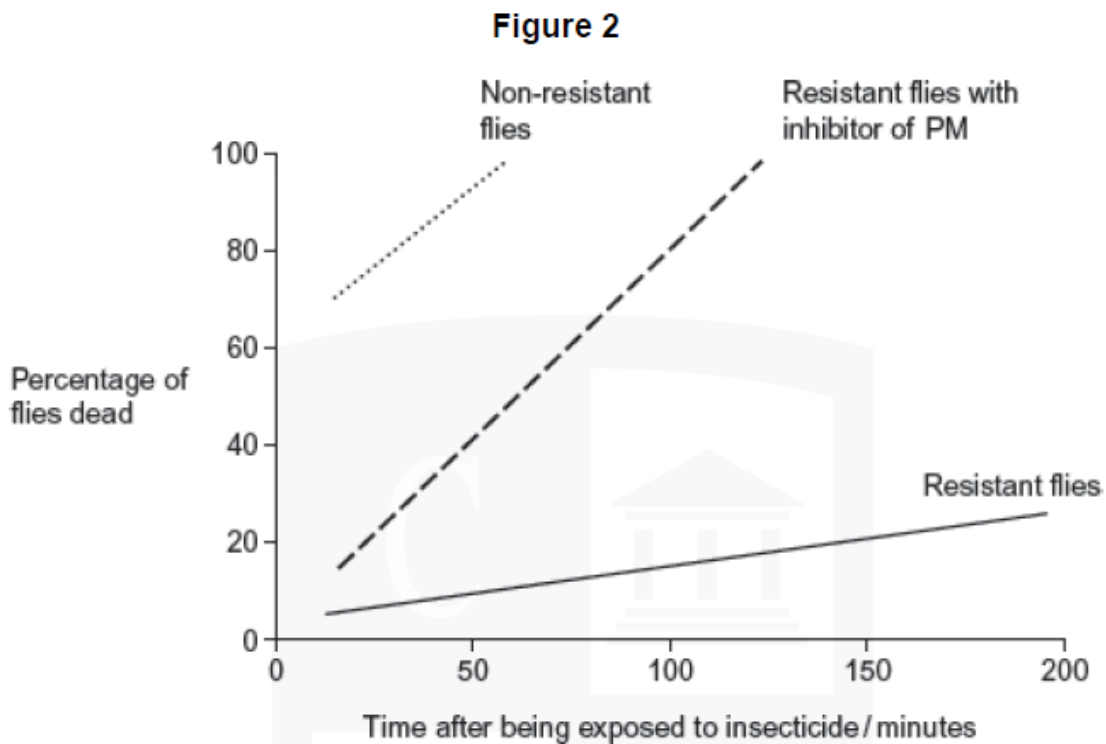
Both resistant and non-resistant flies were collected in great quantities by the investigators. They then organized the subsequent studies.

- Flies that are not resistant to insecticides;
- Flies that are resistant to insecticides; and
- Flies that are resistant to pesticides after being treated with a PM inhibitor.

The proportion of dead flies at various intervals following insecticide exposure was then calculated.

Their findings are displayed in Figure 2.

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(a) Justify the scientists' choice to use non-resistant flies in the control experiment. **(2)**

(b) The scientists came to the conclusion that while increased PM activity is a contributing component, there are other factors that also play a role in the flies' resistance to the insecticide.

Describe how this conclusion is supported by the evidence. **(4)**

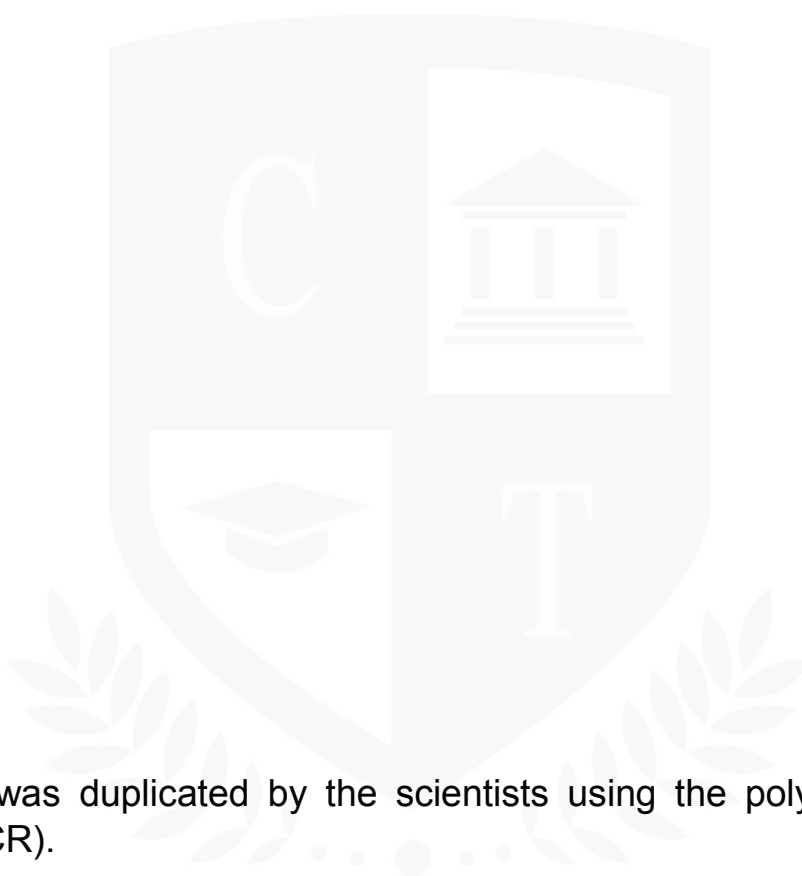


4.

The goal of the study was to quantify the amount of mRNA that was produced in a sample of cells from a gene's allele A. There are two variations of this gene: A and a.

From the cells, the scientists separated the mRNA. To create cDNA, they combined mRNA with an enzyme.

(a) Name the kind of enzyme that was utilized to create the cDNA . **(2)**



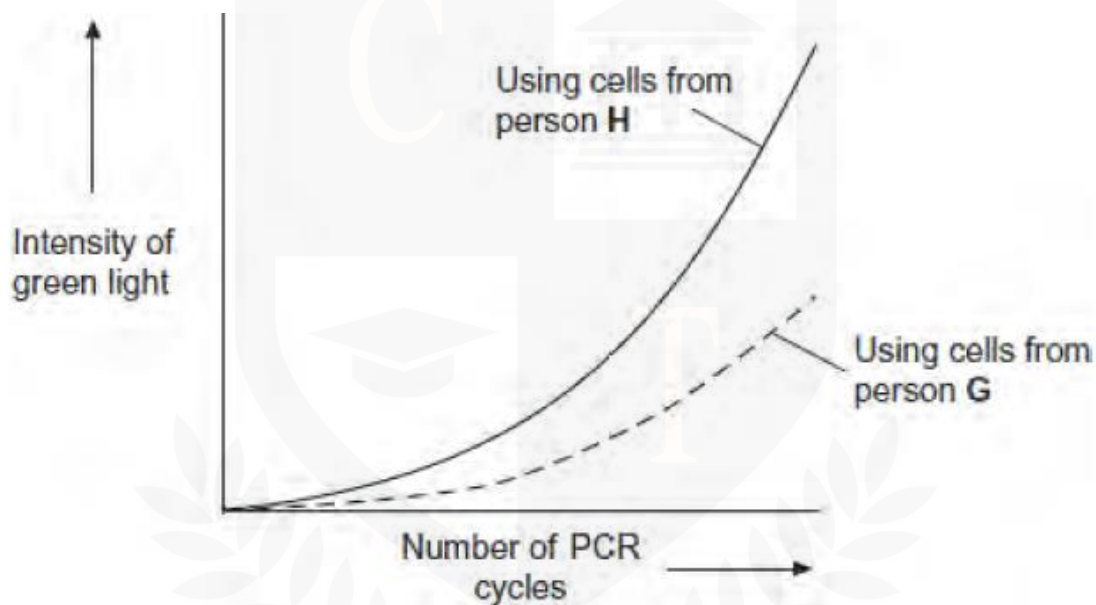
The cDNA was duplicated by the scientists using the polymerase chain reaction (PCR).

To the cDNA copies, they inserted an allele A DNA probe. There was a dye on this DNA probe. Only after the target cDNA is linked to the DNA probe does this dye begin to glow green.

(b) Describe why only allele A will be detected by this DNA probe. **(2)**

5.

Utilizing cells from two individuals, H and G, one of whom was homozygous, AA, and the other heterozygous, Aa, the researchers employed this technique using PCR and a DNA probe specific for allele A on the cDNA from each individual. The results are displayed in the figure.



(a) Please describe the curve to person H. (3)

(b) Which individual, Aa, was heterozygous—H or G? Give an explanation for your response. **(2)**



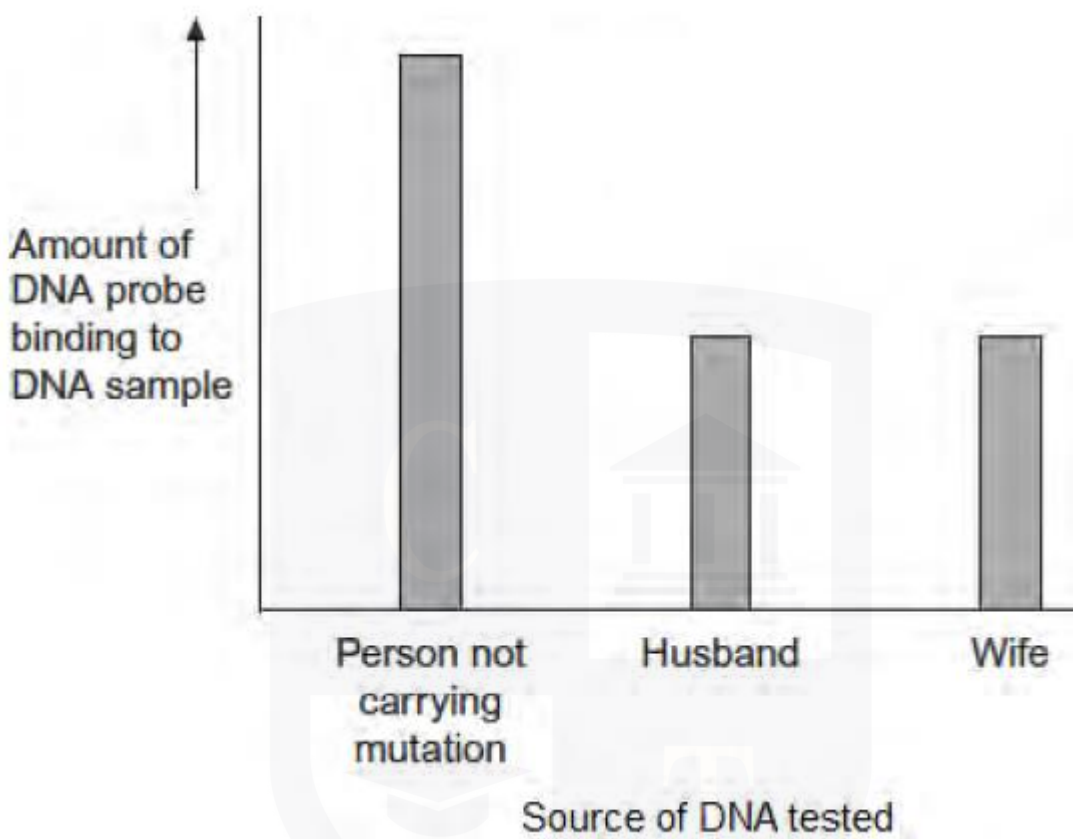
6.

A married couple was curious if they carried the mutant version of a gene. In homozygous individuals, this mutation, which is a deletion, results in a severe hereditary genetic condition.

The spouses' DNA samples were collected by a geneticist. He searched for the deletion mutation using a DNA probe. The DNA probe was unique to a certain base pair in a gene's exon. A gene's coding segments are called exons.

The couple's DNA was matched to that of a person who is known not to have this mutation by the scientist.

It displays the geneticist's findings in a chart.



(a) The couple was informed by the scientist that they both carried the defective gene.

Describe how he came at this decision. **(3)**

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(b) The geneticist's DNA probe targeted an exon rather than an intron in the DNA.

Describe your reasoning. **(3)**



(c) The geneticist needed to determine the normal gene's base sequence in order to create the DNA probe. How would he determine the gene's nucleotide sequence once he obtained copies of the gene? **(2)**



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