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BIOLOGY

THE CONTROL OF GENE EXPRESSION

Level & Board	AQA (A-LEVEL)
TOPIC:	RECOMBINANT DNA
PAPER TYPE:	QUESTION PAPER - 1
TOTAL QUESTIONS	6
TOTAL MARKS	33

Recombinant DNA - 1

1.

Transgenic zebrafish were created by a scientist.

A gene from silverside fish was acquired by her. Growth hormone is encoded by this gene (GH).

She put this GH gene in duplicates into plasmids. She subsequently microinjected these recombinant plasmids into zebrafish egg cells that had been fertilized.

(a) Explain the process by which the GH gene could be inserted into a plasmid using enzymes**. (2)**

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(b) To create transgenic fish, microinjection of DNA into fertilized egg cells is a common technique. The transplanted gene may, however, take longer to

incorporate into nuclear DNA. As a result, transgenic fish might not produce progeny with the desired trait.

Provide an explanation for how delayed GH gene insertion could result in transgenic fish progeny lacking the desired trait. **(2)**

2.

The researcher looked into whether transgenic zebrafish grew faster after receiving the GH gene. She left 2000 fertilized egg cells untreated and microinjected the GH plasmid into 2000 of the egg cells. She calculated the mean mass of the transgenic and non-transgenic fish after a year.

The table that follows displays the scientist's findings.

Approximately 95% of the data falls within a range of ±2 × SD from the mean.

Type of zebrafish	Mean mass of zebrafish / g (± 2 × SD)
Transgenic	1.79 (± 0.37)
Non-transgenic	0.68 (± 0.13)

(a) What conclusions can you draw regarding the impact of the GH gene on zebrafish growth based on the above table? **(2)**

(b) Describe how two aspects of this investigation's design contributed to ensuring the reliability of any results drawn.

In your response, do not compute the mean or SD**. (2)**

3.

Many processed foods contain soybeans. However, some people experience an allergic reaction to a protein called P34 found in soybeans.

Researchers have produced transgenic soybeans that don't allow the P34 gene to transcribe by producing single-stranded cDNA. Recombinant plasmids were employed as vectors to modify soybean cells. They cultivated the altered cells to create soybean plants after screening these cells for the development of the P34 protein.

(a) Explain how single-stranded cDNA might stop the P34 gene from transcription. **(2)**

(b) What functions do the two types of enzymes have that are used to insert DNA fragments into plasmids? **(2)**

(c) To check for the presence of the P34 protein, the soybean cells were screened. In this procedure, proteins isolated from soybean cells were separated using gel electrophoresis.

Provide two structural characteristics of distinct proteins that allow for their separation via gel electrophoresis. **(2)**

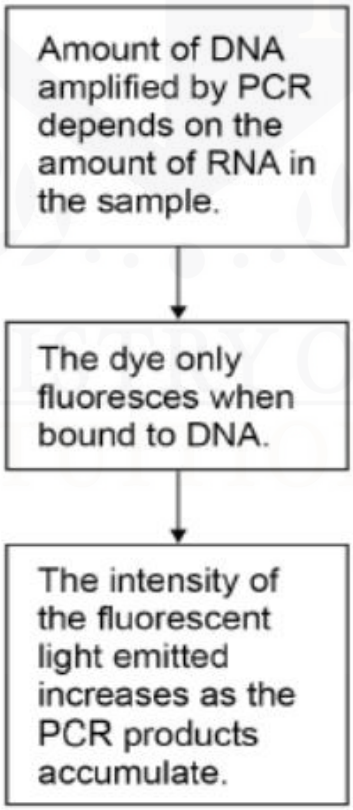
4.

Reverse transcriptase-polymerase chain reaction, or RT-PCR, is one method for precisely identifying and quantifying the amount of RNA in a tissue sample.

The reaction mixture used in RT-PCR includes the following ingredients: reverse transcriptase, primers, fluorescent dye, DNA polymerase, and DNA nucleotides.

Figure 1 illustrates this method's underlying premise.

Figure 1



(a) Describe reverse transcriptase's function in RT-PCR. **(2)**

(b) Describe DNA polymerase's function in RT-PCR. **(2)**

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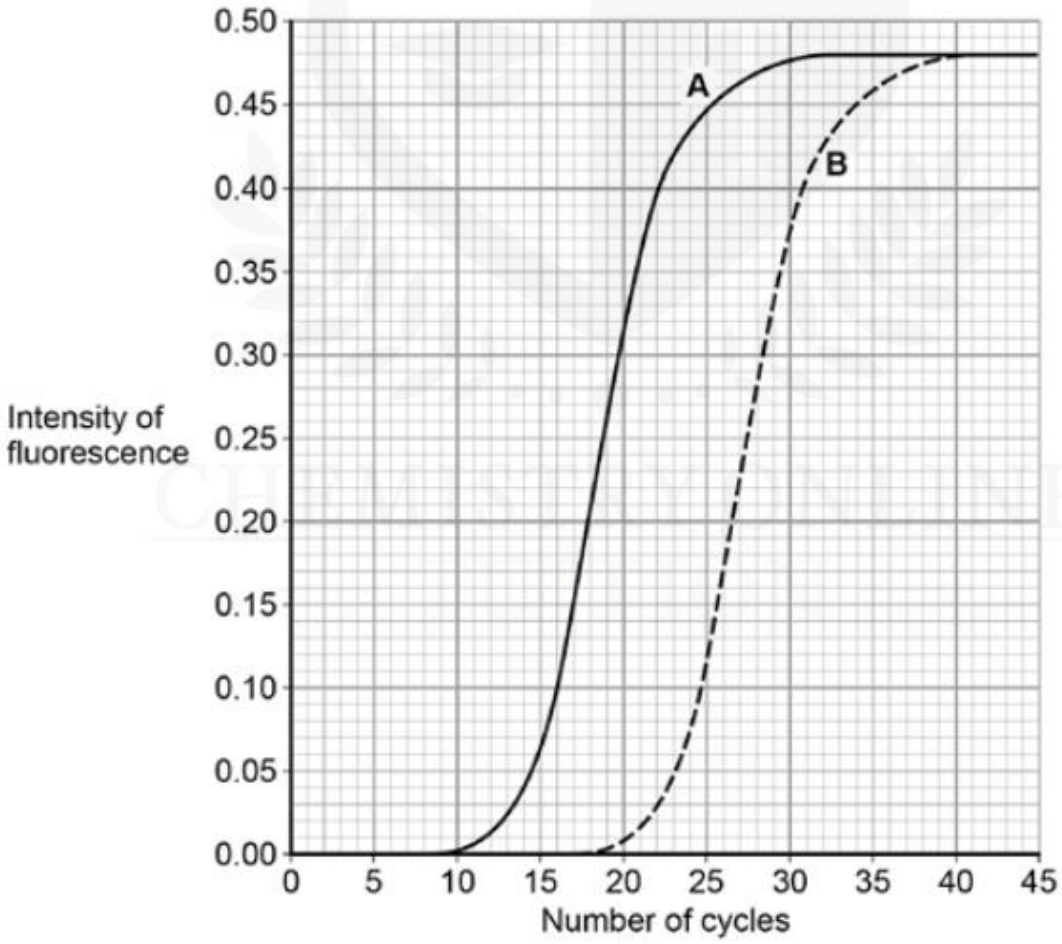
(c) Before the sample is introduced to the reaction mixture, any DNA present in it is hydrolyzed by enzymes.

Describe your reasoning. **(2)**

5.

(a) The outcomes of utilizing RT-PCR to identify RNA in two distinct samples, A and B, are displayed in Figure 2.

Figure 2



The quantity of RNA in samples A and B can be quantitatively compared. This entails figuring out how many cycles are needed to get DNA (C) to a maximum concentration of 50%.

One way to gauge a sample's RNA concentration is to:

Determine the ratio of the RNA content in sample A to the RNA content in sample B using this information. **(2)**

(b) Give a possible explanation for the polymerase chain reaction's termination of DNA replication. **(2)**

(c) Researchers have employed the RT-PCR technique to find distinct RNA viruses in individuals with respiratory illnesses.

For this process, the scientists created a range of primers.

Describe your reasoning. **(2)**

6.

Individuals with pituitary dwarfism have insufficient production of human growth hormone (HGH). HGH injections are one possible treatment for them.

A geneticist wants to transfer the gene encoding for human growth hormone (HGH) to Escherichia coli in order to transform the bacteria.

There are three ways the geneticist could get the HGH gene.

1. Extract a section of the human genome containing the HGH gene using restriction enzymes.

2. Use reverse transcriptase to convert HGH mRNA into cDNA.

3. Use a "gene machine" to create the HGH gene.

(a) The geneticist made the decision not to remove a section of the human genome carrying the HGH gene using restriction enzymes. She took this action because only procedures 2 and 3 would result in DNA that E. coli could employ to manufacture human growth hormone.

Describe why only the DNA produced by steps 2 and 3 might be used by E. coli to create HGH. **(2)**

(b) The geneticist came to the conclusion that generating the HGH gene artificially with a gene machine would be a faster method than converting the hormone's mRNA to cDNA using reverse transcriptase.

Give a reason for the geneticist's conclusion. **(2)**

(c) The geneticist will try to introduce copies of the HGH gene into plasmid vectors once they have them.

Explain the geneticist's plan for putting duplicates of the HGH gene into these plasmids. **(3)**

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