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BIOLOGY

THE CONTROL OF GENE EXPRESSION

Level & Board	AQA (A-LEVEL)
TOPIC:	REGULATION OF TRANSCRIPTION AND TRANSLATION
PAPER TYPE:	SOLUTION - 1
TOTAL QUESTIONS	6
TOTAL MARKS	56

Regulation of Transcription and Translation - 1

1.

(a)

NO cadmium

Other conditions same as cadmium-treated group.

2.

(a) As a measure of the effect due to cadmium / to make a comparison

(b) Becoming more methylated; Ignore later slight decrease/no change.

(c) Production of more methyltransferase enzyme / increased activity of transferase.

3.

(a)

RNA-polymerase could not bind to DNA/to promoter.

mRNA of p16 could not be made/no transcription of p16 gene.

(b)

Cadmium causes expression of methyltransferase gene/increased activity transferase (from 2 to 3 weeks in)

Methyl groups on to promoter/p16 gene/suppressor (gene)

p16 normally suppresses tumor growth

p16 protein/p16 expression falls after 4 weeks/after methylation

Tumor formation occurs (after 10 weeks) after p16falls/after suppressor gene activity falls.

4.

(a)

Binding of interferon gamma changes shape/tertiary structure of receptor protein

This activates/switches on the enzyme

Use of ATP to phosphorylate STAT1

(b) Phosphorylated STAT1

IRF protein

(c)

Causes more helper T cells to form

So, more interferon gamma production by helper T cells

(d)

Tumor suppressor gene) slows cell division/causes death of damaged/tumor/cancer cells

IRF gene leads to formation of IRF protein that binds to gene B

Gene B protein causes death of damaged/mutated cells

5.

(a) First, transcription is controlled by limiting the amount of mRNA that is produced from a particular gene. The second level of control is through post-transcriptional events that regulate the translation of mRNA into proteins.

(b) For a cell to function properly, necessary proteins must be synthesized at the proper time. All organisms and cells control or regulate the transcription and translation of their DNA into protein. The process of turning on a gene to produce RNA and protein is called gene expression.

(c) Transcriptional regulation is a critical biological process that allows the cell or an organism to respond to a variety of intra- and extra-cellular signals, to define cell identity during development, to maintain it throughout its lifetime, and to coordinate cellular activity.

(d) The regulation of gene expression in bacteria occurs predominantly at the level of transcription, which is controlled by RNA polymerase. The specificity of this process is ensured by sigma factors, which are essential regulatory subunits of RNA polymerase conferring promoter specificity.

6.

(a)

DNA has helped find an evolutionary relationship between different organisms in order to create phylogenetic trees. Phylogenetic trees are used to show how an organism evolved by showing how closely related organisms are to one another. This allows scientists to study an entire group of organisms in order to make valid predictions for the future and develop new theories. Without this, we wouldn't be able to understand how some organisms are related to a specific species by looking at the similarities of the DNA sequences. The more similar the sequence of DNA the more closely related the two organisms are. This is important to be able to develop future predictions to know how this can affect the food chains and further diversification of species.

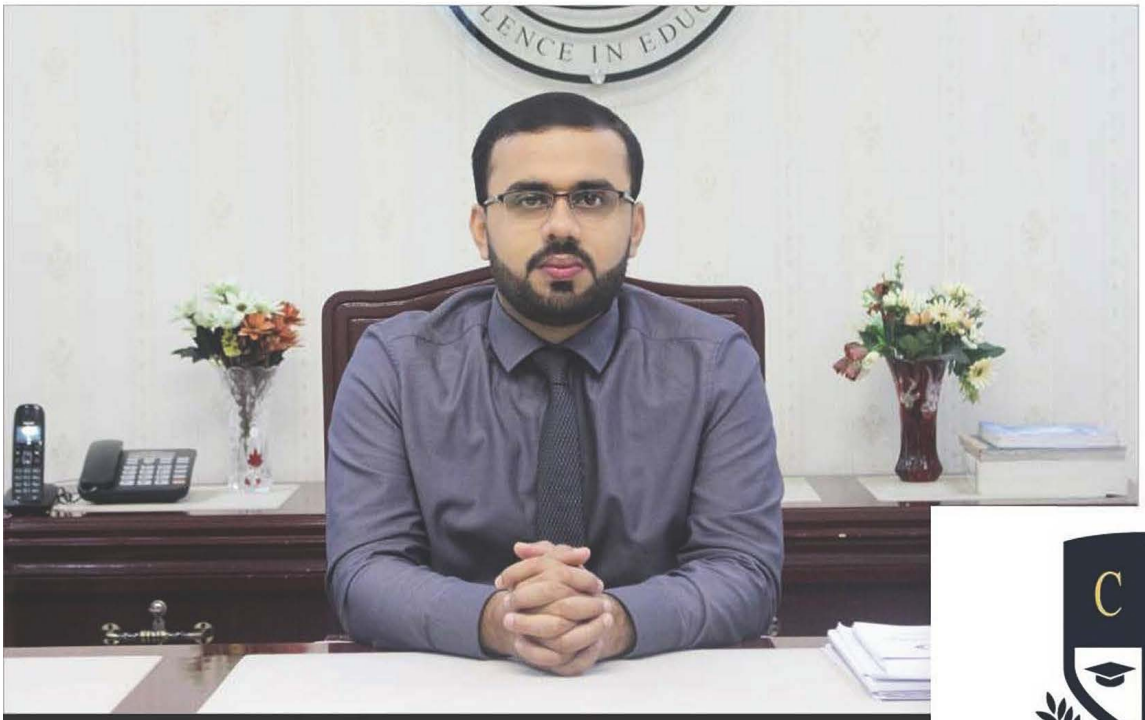
DNA screening can be used to identify any anomalies in the DNA sequence to predict possible diseases that the individual might be more likely to get. This is done using DNA probes, which can locate specific alleles on the DNA. Probes have specific bases that are complementary to the base sequence of the target allele. The probe can be fluorescent, meaning that if an individual has the mutated allele then the probe will appear fluorescent under a UV light. Without this technology and method of identifying a specific allele, the individual may not be aware that they are more at risk to developing a particular genetic disorder. Providing this information to the individual, will allow them to be more cautious and more attentive to their body and how they feel in order to identify any changes in their well-being. If any change is detected and the individual seeks help from a doctor early enough, the disease can be removed completely.

DNA can also be used in gene therapy, used to treat genetic disorders. There have been attempts to treat severe combined immunodeficiency (SCIO) using gene therapy. This disease doesn't produce an immune-response because it's unable to produce antibodies. For SCIO in particular, gene therapy isolates the normal ADA gene from healthy human tissue. Then the ADA gene is inserted into a retrovirus, which grows within host cells in the laboratory to increase their number and increase the number of copies of the ADA gene. Next, the retroviruses are mixed with the patient's T cells into which the normal ADA gene is injected into. The T cells are reintroduced into

the patient's blood to provide the coded information needed to make ADA. With this method, it enables individuals suffering from this disease to improve their way of living.

DNA technology enables scientists to manipulate, alter and transfer genes from one organism to the other in order to solve a genetic malfunction, a lack or excess of a particular element. For example, an individual who is unable to produce enough insulin may choose to undergo DNA recombination. The process of making insulin using the recombinant DNA involves five stages. First, DNA fragments with the gene that has functional insulin is isolated. Then, this DNA fragment is inserted into a vector, a bacterial plasmid. After, the vector, with the functional insulin gene, is transferred into the organism of an individual that is unable to produce enough or no insulin at all. Next, those host cells that have successfully taken up the gene are identified by gene markers and growth or cloning of the population of the desired gene in these host cells increases. This technology and method, has enabled scientists to better understand how organisms work, which allows new industrial processes to be designed for medical applications. Additionally, with this technology, doctors are able to treat several genetic disorders.

DNA is used in fingerprinting technology which has a variety of application. First, the DNA is extracted from the sample, then restriction endonucleases cut the DNA into fragments. Next, the fragments are separated using gel electrophoresis where DNA fragments are transferred from the gel to a nylon membrane. After, DNA probes are added to label the fragments and these probes attach to specific fragments. The membrane with the radioactively labelled DNA fragments is placed onto an X-ray film. The development of the X-ray film reveals dark bands where the radioactive DNA probes have attached themselves to. By taking a screen of another individual’s fingerprint and comparing it with the original fingerprint, it’s possible to determine whether the two fingerprints are related or not by counting the number of dark bands. The higher the number of similar dark bands, the more closely related the two individuals are. This technology is used to: determine the father of a child, identify a suspect who committed a crime, give a medical diagnosis and identify animals that shouldn’t breed together.



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