Level 3 Biology, 2006

90715 Describe the role of DNA in relation to gene expression

Credits: Four
9.30 am Thursday 30 November 2006

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–9 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

For Assessor's use only	Achievement Criteria	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe the role of DNA in relation to gene expression.	Explain the role of DNA in relation to gene expression.	Discuss the role of DNA in relation to gene expression.
Overall Level of Performance	N	

because they don't clearly state that daughter cells have identical DNA to parents & each other

OR

replication to allow cell division to occur.

~~M because~~

~~DNA is replicated~~

Don't use this example... I now think it is only an A

Has not clearly indicated

- 3' & 5' ends
- Shown H bonds

Has shown

A-T ; G-C

Marginal for antiparallel nature without the 3' & 5' ~~ends~~ ends labelled

You are advised to spend 40 minutes answering the questions in this booklet.

Assessor's use only

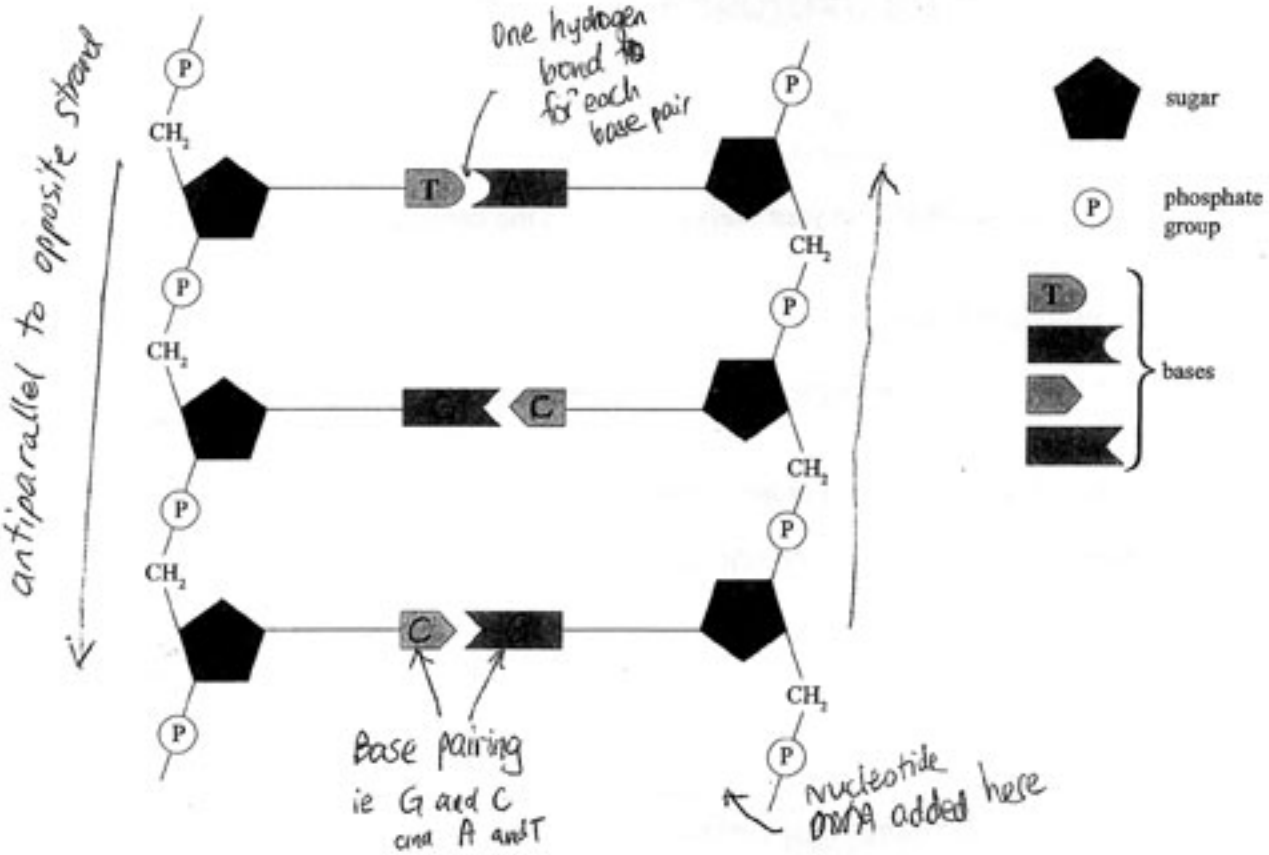
QUESTION ONE: DNA STRUCTURE, FUNCTION, AND REPLICATION

DNA is a polymer, made up of a large number of sub-units (nucleotides).

(a) The unlabelled diagram below shows the basic structure of a DNA molecule. Complete the diagram by giving information that clearly identifies:

- the four bases and their positions (one base has been identified in the diagram)
- the number of hydrogen bonds between bases
- the anti-parallel nature of the molecule
- which end of the DNA strand new nucleotides are added to.

Simplified structure of part of a DNA molecule



(b) Explain why DNA replication is necessary.

Because DNA Contains all our genetic material. We need DNA because it is what determines things in our body. DNA Replication is crucial because these information must be replicated to pass on to offspring otherwise they would be nothing without DNA and through replication the 'parent' does not lose theirs while providing DNA for offspring.

This is an M because the process is complete (unwinds, DNA polymerase enables base pairing, leading & lagging strand replication, ligase joins Okazaki fragments together)

+ explains why it is necessary for Okazaki fragments to form.

This not at excellence because the candidate does not <u>explain</u>

semi-conservative.

GPA

(c) Discuss how DNA replicates. In your discussion, you should explain:

- how replication begins
- the roles of the main enzymes involved
- leading and lagging strands
- Okazaki fragments
- the source of materials for replication.

Assessor's use only

DNA first begins replication by unwinding its structure with the enzyme helicase. Then DNA polymerisation occurs to help with the base pairing to follow. One side of DNA is leading strand where the DNA replication direction can follow its desired 5' to 3' end. As all the coreiponding matching are carried out, the opposite strand to the original DNA is ultimately the lagging strand. This lagging strand is antiparallel to the leading strand and therefore will result in the DNA replication taking place from the 3' to 5' end. Because this is not possible, it must create short segments to make up for this awkward direction. These segments of new DNA are whats called Okazaki fragments. When DNA replication is complete, ligase enzyme joins these fragments together. These sources are found within the nucleus. Then new ~~two~~ strands of DNA winds up again to produce two strands which are semi-conservative.

m

Only at A because candidate has not explained that

sequence of bases determines the amino acid sequence in the protein/polypeptide formed.

There is confusion as to which process is which here.
←

Place →

For A needed to cover 3 of place, purpose, assoc. molecule or nucleic acid structure

In this response:
place is correct
associated molecules is OK (mRNA, tRNA, RNA polymerase)

but does not show clear understanding or describe clearly in terms of

nucleic acid structure or purpose. (see marking schedule for an example of response relating to purpose)

GPA

QUESTION TWO: GENE EXPRESSION AND PROTEIN SYNTHESIS

Assessor's use only

Deoxyribonucleic acid (DNA) is found in almost all cells, and carries the genetic code that controls many aspects of cellular structure and function.

(a) Explain how the DNA molecule carries genetic information.

The DNA molecule has three main features: sugar, phosphate and nitrogenous base. These base found on DNA provide the genetic information as the order at which these Bases are in determines what it represents. The triplets of nucleotide form a codon. These codons are part of what the genetic information is for. Since the base pairing allows easy replication and DNA molecule can carry many genetic information in a small space, it can be used to express the person the DNA belongs to.

A

(b) Compare and contrast the processes of **transcription** and **translation**.

- Transcription and translation occur in different parts of the cell. In transcription, it happens in the nucleus whereas translation takes place in the cytoplasm. Both have different 'functions': one is concerned with unwinding DNA and producing a strand for translation and one is the production of amino acids and the formation of polypeptide link. This also leads to the difference that transcription is a 'process' which is taken place prior to translation and leads to it.
- In both processes, both have the presence of mRNA. In transcription the mRNA synthesises to produce the mRNA strand. Because this is taken to the cytoplasm, this mRNA takes place also in translation. In addition, both are carried out for the same overall proves of protein synthesis. And even though translation may use tRNA and while transcription deals with RNA polymerase, the end result is for same process

NS

This response is very vague. Does not relate enhancers to the process of transcription.

Description of repressor too vague. Does not make it clear that the repressor binds to the operator/DNA to prevent transcription.

Description of inducer OK for A.

The proteins that some genes code for are constantly expressed, eg those involved in cellular respiration. Other proteins are produced only as needed, ie the expression of these genes is controlled.

Assessor's use only

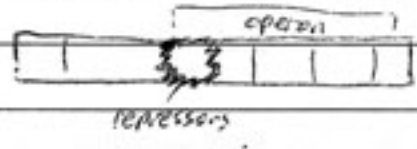
(c) Explain the role of **enhancers** in **eukaryote** gene expression.

Enhancers take a great role in eukaryotic gene expression When this occurs, The original DNA contains both introns and exons. The exons are what we desire for final protein. Enhancers are placed in this 'reaction' to stimulate and allow the full process to take place. Without these enhancers, other processes within the gene expression cannot occur, such as splicing. They provide the gene expression to be shown and expressed right for what it is for and determines how well it is expressed.

NS

(d) Discuss reasons for the role of **inducers** and **repressors** in **prokaryote** gene expression.

These inducers and repressors are part of the Operon Theory. When gene expression occurs in prokaryotes, repressors come and bind on a segment of the Operon.



because these repressors repress and somewhat stop the further process taking place, the rest of the reaction cannot happen! This seems to be the main function of repressors. However, inducers come and removes the repressors. Often this changes the shape and no longer allows interruptions to occur.

Therefore, inducers remove repressors in order for the rest of process to take place.

A

Incorrect as response shows X-linked gene on Y chromosome.

Incorrect as response shows X-linked gene on Y chromosome.

GPA

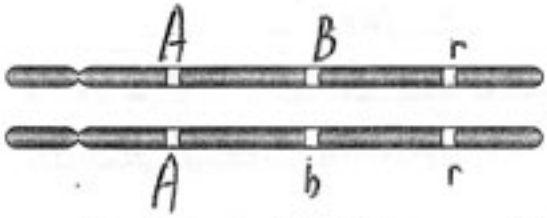
QUESTION THREE: PHENOTYPE DETERMINATION

Assessor's use only

Genes are found on chromosomes, and eukaryote cells usually contain two copies of each chromosome.

The members of a pair of chromosomes have the same sequence of genes, but the genes may come in slightly different forms.

(a) On the diagram below, show the position of alleles for an individual who is:
- homozygous dominant for gene A
- heterozygous for gene B
- homozygous recessive for gene R.



A

People affected by Duchenne muscular dystrophy (DMD) lose muscle function from an early age and rarely survive to adulthood. The disease is caused by a mutation in a gene found on the short arm of the human X chromosome. The dominant allele (M) results in normal muscle function, while the recessive allele (m) produces the slow, irreversible muscle wasting that is characteristic of this disease.

(b) Give ALL the possible genotypes for the phenotypes listed below:

(i) female not affected X^MX^M and X^MX^m

(ii) female affected X^mX^m

(iii) male affected X^mY^m and X^mY^M

(iv) male not affected X^MY^m and X^MY^m

NS

(c) (i) A female who is heterozygous for the DMD allele has children with an affected male. Use a Punnett square to show all possible genotypes for the offspring of this couple.

	X^M	X^m
X^m	X^MX^m	X^mX^m
Y^m	X^MY^m	X^mY^m

does not matter whether Y^M or Y^m

1 x X^MX^m not affected female

1 x X^mX^m affected female

1 x X^MY^m not affected male

1 x X^mY^m affected male.

NS

(ii) From your Punnett square, list the phenotypic and genotypic proportions for male and for female offspring.

Assessor's use only

Phenotypic proportions

male: $\frac{1}{4}$ of 'lost' function of muscle $\frac{1}{4}$ of normal muscle

female: $\frac{1}{4}$ of normal muscle $\frac{1}{4}$ of lost function muscle

Genotypic proportions

male: $\frac{1}{4}$ of X^mY^m $\frac{1}{4}$ of X^MY^m

female: $\frac{1}{4}$ of X^MX^m $\frac{1}{4}$ of X^mX^m

NS

(d) Explain why more males than females are affected by Duchenne muscular dystrophy.

Although the alleles are carried ~~Be~~ on the X chromosome, there is ~~a~~ only 50% chance whether a male will get DMD or not because ~~they~~ ~~a~~ males only possess one X and one Y chromosome. Because it affects only X, it could be ~~the~~ either of only recessive or dominant one. However with females, there are $\frac{1}{3}$ chance they have recieve it. They could have homozygous dominant or heterozygous or homozygous recessive. as females have 2 X chromosomes.

A

(ii)
Incorrect as response shows X-linked gene on Y chromosome.

(d)
Response not clear as to which female is affected but A because because says the DMD only affects the X c/s.

Note that this question continues on the next page.

Many metabolic pathways are controlled by multiple genes. An example is the metabolic pathway that produces normal skin pigmentation. Albinism, which is the total lack of pigment, can be caused by a mutation in any one of the genes controlling this pathway.

Assessor use only

(e) Discuss the fact that it is possible for two albino parents to have a child with normal skin pigmentation.

Metabolic pathway is series of enzyme controlled reactions where the product of one is a substrate of the other. Although albinism is due to lack of pigment, the pathway could well be reversed by the same chances of a mutation, like what ~~have~~ happened to the parents. However, it could be controlled by multiple genes meaning that other genes in parents could give that their albino parents possess. does not give a child with albinism. (like silent gene). In addition, other factors in the metabolic pathway could result not in albinism but the production of pigment. and the path at which it takes could be different to how it was for other parent. Because metabolic pathway provides different 'ways' to result in a child not having ~~an~~ albinism, and only chance that mutations occur to this child, it is why it is possible to have normal skin child.

Does not make sense.

NS

Candidate defines a metabolic pathway but fails to describe how a mutation may affect the pathway.