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91159

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2 Biology, 2016

91159 Demonstrate understanding of gene expression

9.30 a.m. Friday 18 November 2016
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of gene expression.	Demonstrate in-depth understanding of gene expression.	Demonstrate comprehensive understanding of gene expression.

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 attempt 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 2–12 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.

Merit

TOTAL 15

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QUESTION ONE: NUCLEIC ACIDS

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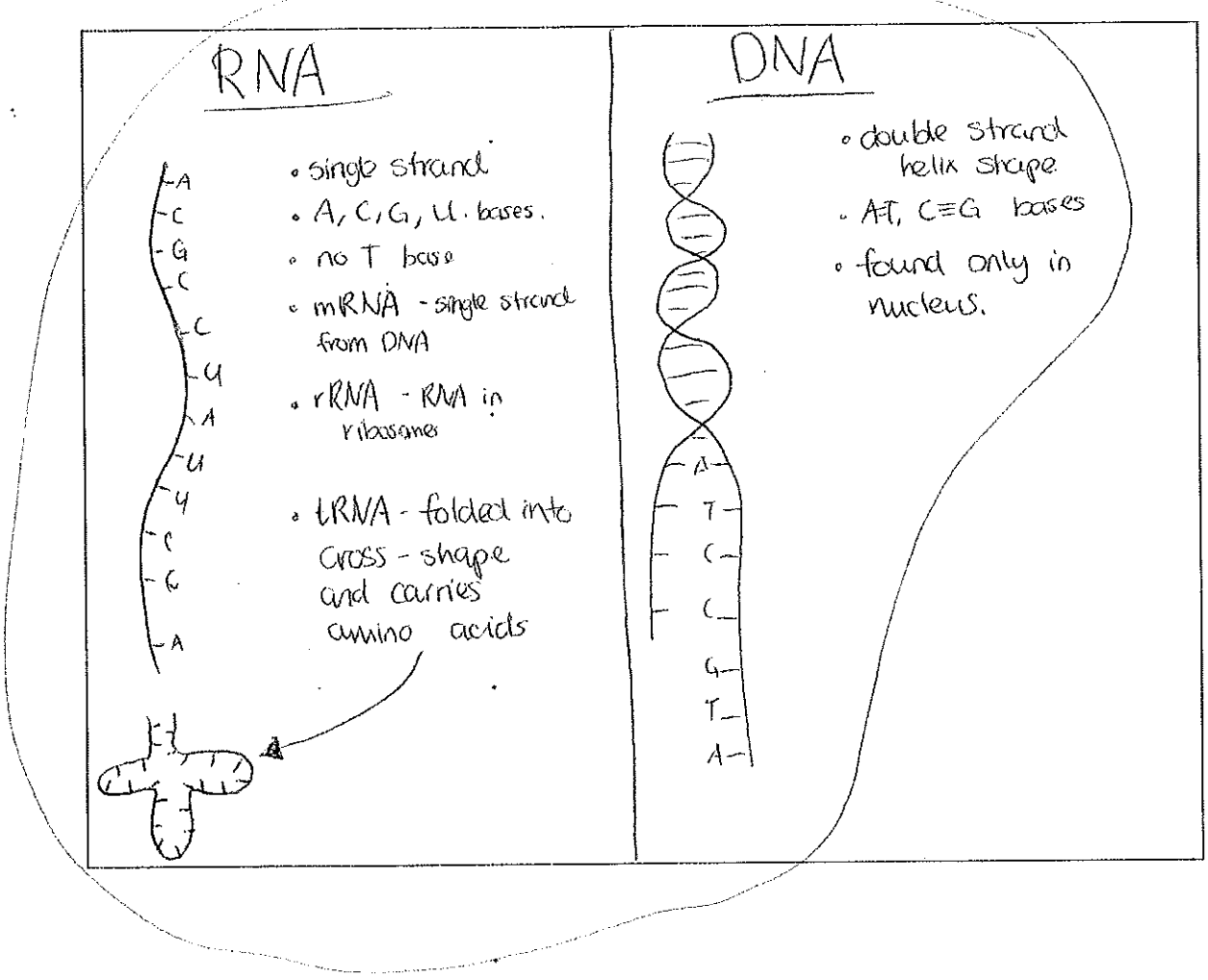
(a) Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are both involved in protein synthesis.

Describe the structure of DNA and RNA.

You may use diagrams in your answer.

DNA is a double stranded helix. RNA is a single strand used for transcription and translation which has one more oxygen in the sugar-phosplate backbone than DNA.



(b) DNA, mRNA, and tRNA are all involved in the formation of proteins.

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Discuss the significance of these molecules in forming proteins, and why the cell continually makes mRNA molecules, but not DNA molecules, during protein synthesis.

In your answer include:

- an explanation of the function of DNA, mRNA, and tRNA molecules
- an explanation of how mRNA is produced
- a discussion of the significance of DNA, mRNA, and tRNA in forming specific proteins.

DNA provides a ~~base out an order for the p~~ code for a protein which is required. It codes for the protein, and the mRNA is made corresponding to the bases on the DNA (A=U and C≡G). mRNA is a substitute for DNA as the DNA is too big and too precious to leave the nucleus. RNA polymerase reads along the DNA and produces the mRNA strand. It has an extra oxygen which allows it to be more sturdy to leave the nucleus. tRNA is the molecule that brings the anti-codon to the codon on the mRNA, and with it the correct amino acid which forms into a polypeptide chain.

DNA codes for a specific protein needed in the organism. The mRNA carefully copies the code and takes it to the ribosomes where proteins are made. Ribosomes are on the endoplasmic reticulum on the outside of the nucleus. The ribosomes read each three bases (codon) of the specific code and match them to its corresponding anti-codon which is on a tRNA. The tRNA bring a specific amino acid which the mRNA is coded//

for - ordered by the DNA. The amino acids ~~line up~~ from each codon line up and form a polypeptide chain which can then fold into a protein. This protein then goes into the area where it is needed - the place which the DNA molecule ~~order~~ ordered the protein for.

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The examination continues on the following page.

QUESTION TWO: ENVIRONMENTAL FACTORS AND GENE EXPRESSION

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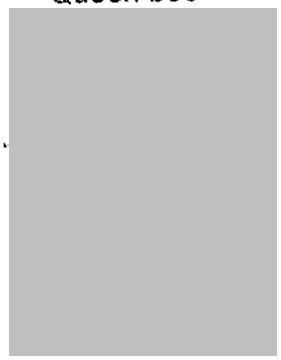
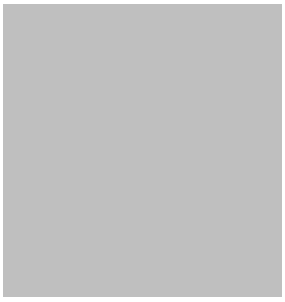
The honey bee (*Apis mellifera*) has two female phenotypes.

Female type	Larvae Diet	Adult phenotype	Genotype
Queen bee 	royal jelly	• increased ovary size • large body mass • live for 2 years	the same
Worker bee 	royal jelly for 3 days, then only pollen and honey	• infertile ovaries • smaller body mass • live for 3 – 6 weeks	

www.britannica.com/media/full/171791/141787

(a) Describe the term gene expression.

Which gene shows in the phenotype.

(b) Explain why comparing worker and queen honey bee females is ideal for experiments on environmental factors and gene expression.

Their phenotypes are so different, but yet they have the same genotypes. Comparing environmental factors on the different phenotypes can result in large variations. Comparing gene expressions on the two also shows large variation on the same genotypes. //

(c) Experiments have confirmed that royal jelly is not a mutagen.

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Discuss the effect the environment has on the expression of the phenotype in honey bee females.

In your answer include:

- a description of the environmental factor that affects honey bee phenotype
- using an example, an explanation of the difference between environmental factor and mutagen
- a discussion of how honey bee phenotype can change without changing the genotype
- a discussion of why the queen bee's phenotype is fully expressed, but the worker bee's phenotype is not.

The environmental factor that affects honey bee phenotype is the availability of nutrients. Their diets are the only thing different that results in different phenotypes for the worker bee and the Queen bee. Environmental factors are factors which do not permanently affect genotype or phenotype such as getting sunburnt - directly affects phenotype but will go away once environment changes. Mutagens create mutations which are permanent, like radiation affecting gametes which are passed on to offspring. Mutagens have much longer, lasting effects than environmental factors. Honey bee phenotype can change without changing the genotype like as the difference between Queen and worker bees by having a sufficient availability of nutrients. There are four factors which affect phenotype in the environment :- S.-

A - availability of nutrients.

L - light levels.

E - //

There is more space for your answer to this question on the following page.

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Queen bee phenotype is fully expressed because she has a full availability of nutrients due to her diet of royal jelly. Rayal jelly is fed to newborn worker bees which is a sign it is full of vital vitamins and nutrients which help growth and strength. As the Queen bee continues to grow and get stronger, she is able to live longer and produce offspring - fully express ~~genotype~~ phenotype. The worker bees do not have a supply of royal jelly to eat and therefore do not have a ready supply of good nutrients. The worker bees do not grow as much or get as strong as they could because they are not getting the right nutrients to fully express phenotype. As a result the worker bees die after 3-6 weeks and do not produce offspring. //

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QUESTION THREE: MUTATIONS

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(a) Describe what a mutation is.

A mutation is a permanent change to the base sequence of a DNA molecule, or a phenotype. Mutations can be point mutations (one base on a DNA strand) or block mutations (whole genes or parts of chromosomes are changed). //

Question Three continues on the following page.

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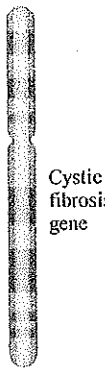
(b) There are over 1000 mutations that can cause cystic fibrosis. A common mutation is a deletion mutation that results in the absence of one amino acid in the final protein. Another mutation is a substitution mutation that results in a different amino acid in the final protein.



Chromosome 7

Discuss how these two mutations affect the cystic fibrosis gene's final protein and resulting phenotype.

In your answer include:

- an explanation of why the deletion mutation causes one amino acid to be absent in the final protein, and how this affects protein folding
- an explanation of why the substitution mutation causes a different amino acid to be present in the final protein, and how this affects protein folding
- a discussion of why the deletion mutation causes severe cystic fibrosis disease, whereas the substitution mutation causes milder cystic fibrosis disease.

Deletion mutation causes thee to be one nitrogen base missing and therefore ~~with~~ there is one base too short at the end and the final amino acid is not coded for, leaving the protein to be ~~abser~~ one amino acid short and the protein will not fold properly. Proteins are folded into specific shapes and if ~~everythi~~ one amino acid is different this affects the whole protein. Substitution mutation replaces one base with another. Sometimes this does not change an amino acid (due to degeneracy) but other times it results in a different amino acid to be formed. If a different amino acid is put into a polypeptide chain, the specific protein will not be made or will not fold properly.

Deletion mutation causes severe cystic fibrosis because the protein is missing a whole amino acid. The protein

may not 'stop' or it may stop randomly in the middle, both causing a protein to not be made correctly if at all.

Substitution mutation causes milder cystic fibrosis. As only one amino acid is changed, there are still enough amino acids on the polypeptide chain to form the right protein, but this protein may not fold entirely correctly, ~~or if~~. As the protein is still made, but slightly wrong, the cystic fibrosis disease is mild. On the other hand with a deletion frameshift mutation, the protein is ~~either~~ unfinished and therefore will not fold properly and can not make the correct protein at all, resulting in severe cystic fibrosis disease.

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Extra paper if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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MERIT exemplar for 91159 2016		Total score	05
Q	**Grade score**	**Annotation**	
1	M5 low	The student has good L2 knowledge of the structure of both DNA and RNA. The have described the process of protein synthesis and explained aspects of it , for example that the tRNA molecule will bring in a specific amino acid. More knowledge of the detail of the mRNA synthesis would make this a stronger merit.	
2	M5 low	The student has clear understanding of the difference between an environmental factor and a mutagen in relation to which alters the genotype. The aspect of the environment is correctly identified as diet and while the student knows this is what is having the effect they do not offer biological ideas as to how this could take place.	
3	M5 high	There is clear evidence that the student knows what a mutation is. They link both to base changes. They have knowledge of degeneracy, although they don't clearly describe the term. They link changes briefly to folding of proteins and the severity of CF.	