MARKER CODE						



STUDENT ENROLMENT NUMBER (SEN)							N)		

TONGA NATIONAL FORM SEVEN CERTIFICATE

2021

BIOLOGY

QUESTION AND ANSWER BOOKLET

Time allowed: 3 Hours

INSTRUCTIONS:

- 1. Write your **Student Enrolment Number (SEN)** on the top right-hand corner of this page.
- 2. This paper consists of **FOUR SECTIONS** and is out of 70 Weighted scores.

SECTION	STRANDS	TOTAL SKILL LEVEL
A	Animal Behaviour	17
В	Gene Expression	25
С	Biotechnology Application	7
D	D Processes and Patterns of Evolution	
	TOTAL	70

- 3. Answer ALL QUESTIONS. Write your answers in the spaces provided in this booklet.
- 4. Use a **BLUE** or **BLACK** ball point pen only for writing. Use a pencil for drawing if required.
- 5. If you need more space for answers, ask the supervisor for extra paper. Write your **Student Enrolment Number (SEN)** on each additional sheet, number the questions clearly and insert them in the appropriate places in this booklet.
- 6. Check that this booklet contain pages 2 19 in the correct order and that none of the pages is blank.

ANIMAL BEHAVIOUR

Question One: Navitation and Orientation

The African dung beetles (*Scarabaeus satyrus*) is a nocturnal insect that uses the Sun, Moon, and the starry sky for orientation. It is the first animal proven to use the Milky Way for orientation.



Figure 1: Dung beetle under the starry milky way galaxy

Source: http://www.sci-news.com/biology/article00844.html

They travel several miles in search of a perfect dung pat. The beetles shape a piece of dung into a ball and roll it away in a straight line as far away as possible from the dung pile. That behavior guarantees them that they will not return to the dung pile, where they risk having their ball stolen by other beetles.

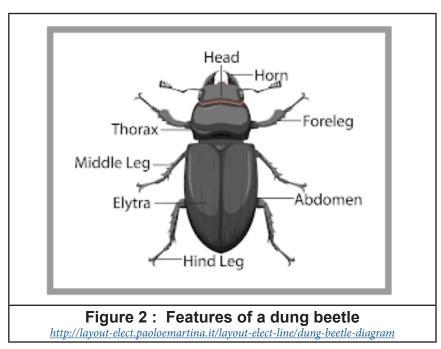
Dung beetles often dance before moving away from the dung piles, upon encountering obstacles, or if they lost control of the balls. They can orient themselves to the bright stripe of light generated by our galaxy, and move in a line relative to it.

Describe the orientation features of the innate behavior of dung beetles.		
	Skill lo	evel 2
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Describe the navigation features of dung beetles which uses stellar patterns.	Skill l	ovol 2
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Question Two: Ecological niche and Intraspecific interaction.

Dung beetles occupy desert, grasslands and savannas, farmlands, and native and planted forests on all continents except the Antarctica. They are categorized into Tunnel living beetles which build elaborate underground chambers close to or beneath the dung pats using the fibrous parts from the dung. The rollers shape pieces of dung into balls and roll them away from the pile. They bury their ball to either munch on later or to use as a place to lay their eggs. The dwellers actually live inside dung piles

They have impressive features as shown below:



a. Explain how at least **ONE** (1) adaptive feature of the dung beetle assists in their survival.

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Dung beetles are one of the few groups of insects that exhibit parental care for the young. The group Tunnelers prepare a nest as a home for their young ones. In mo cases, child-rearing responsibilities fall on the female, who constructs the nest ar provides it with food for her young.	
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Question Three: Timing Responses

The great spotted kiwi or roroa, *Apteryx haastii*, is a species of kiwi endemic to the South Island of New Zealand. In an experiment, their activity was observed over 10 days in normal environmental conditions, and they were then moved into constant darkness after day 10.

The results are displayed in the actogram below.

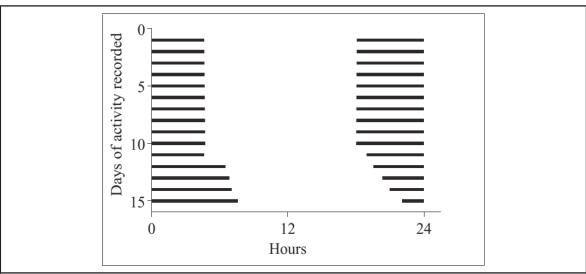


Figure 3: The great spotted kiwi activity of 10 days in normal environmental conditions followed by another 5 days in constant darkness.

Source - https://www.nzqa.govt.nz/ncea/assessment/search.do?query=Biology&view=exams&level=03

Skill	
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b. The timing behaviour of the great spotted kiwi is controlled endogenously.

Define endogenous control.

Skill le	Skill level 1		
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SECTION B:

GENE - EXPRESSION

Question One: Protein Synthesis

The diagram below represents a parental strand of DNA molecule which undergoes replication which formed two daughter strands of DNA.

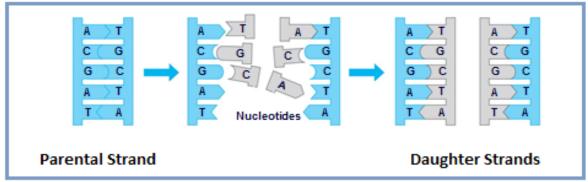


Figure 4: DNA Replication

Source: https://public.csusm.edu/DAMwebsite/Lectures/Lecture%2021%20Cloning%20and%20Recombinant%20DNA%20Technology.ppt

Use the illustration above to explain why the DNA replication is cosemi-conservative.	onsidered as	
		
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Discuss the importance of the structure and replication of DNA for	gene expression.	
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C.	Describe the structure of primary protein.					
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Question Two: Gene mutation

The table below shows the genetic code depicting the amino acids that correspond to mRNA codon. Each codon is read from 3'(first nucleotide) to 5' (third nucleotide).

First Base		Secon	d Base		Third Base	
	U	С	Α	G		
	UUU _ Phenylalanine	UCU	UAU 7 - Tyrosine (Tyr)	UGU - - Cysteine (Cys)	U	
U	UUC (Phe)	UCC -Serine (Ser)	UAC 1 Tyrosine (1917)	UGC J cysteme (cys)	С	
	UUA- -Leucine (Leu)	UCA Serine (Ser)	UAA 7 -Stop	UGA – Stop	А	
	UUG Leacine (Lea)	UCG	UAG_ TSTOP	UGG – Tryptophan (Trp)	G	
	CUU	CCU	CAU - -Histidine (His)	CGU	U	
С	CUC -Leucine (Leu)	CCC -Proline (Pro)	CAC_Triistidine (tils)	CGC -Arginine (Arg)	С	
	CUA CUA	CCA CCA		CAA Clutamine	CGA CGA	А
	CUG	CCG-	CAG (Glu)	CGG-	G	
	AUU-	ACU	AAU _ Asparagine	AGU - - Serine (Ser)	U	
А	AUC -Isoleucine (Ile)	ACC Threonine	AAC (Asn)	AGC_	С	
^	AUA	ACA (Thr)	AAA - - Lysine (Lys)	AGA -Arginine (Arg)	А	
	AUG - Start Methionine (Met)	ACG_	AAG-	AGG-	G	
	GUUT	GCU	GAU Aspartic Acid	GGU	U	
G	GUC -Valine (Val)	GCC -Alanine (Ala)	GAC (Asp)	GGC -Glycine (Gly)	С	
9	GUA GUA	GCA GCA	GAA Clutamic Acid	GGA GGA	А	
	GUG	GCG-	GAG (Glu)	GGG	G	

Figure 5: The mRNA/ Amino Acid Table

a. Use the **mRNA/ Amino Acid Table** to state the amino acid sequence that can be assembled from the mRNA associated with the given DNA strand below:

DNA template strand: 5'-T-A-C-T-T-C-A-A-A-C-C-G-C-G-T-3'	
	•
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Skill level 1			
1			
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NR			

b. A gene mutation occurred on the third triplets of the DNA template strand, where **A** is removed.

DNA template strand: 5'-T-A-C-T-T-C-A-A-C-C-G-C-G-T-3'

Describe the type of gene mutation shown above.

Skill level 2
2
1
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Question Three: Chromosome mutation

Polyploidy is common among plants and has been, in fact, a major source of speciation in the angiosperms. The diagram below illustrates the chromosomal composition and behavior of diploids and derived polyploids at different developmental times in meiosis and mitosis.

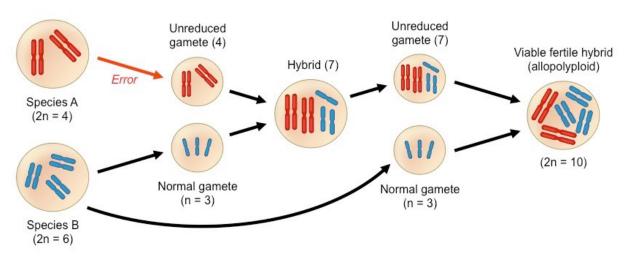


Figure 6: Allopolyploidy

Source: https://ib.bioninja.com.au/higher-level/topic-10-genetics-and-evolu/103-gene-pools-and-speciati/allopolyploidy.html

a.	Define	polve	loidy.
∽ .		P , P	, .

Skill level 1

1
0
NR

b. An example of polyploidy is Triploids which can be constructed by crossing of a 4n (tetraploid) and a 2n (diploid), as illustrated below:

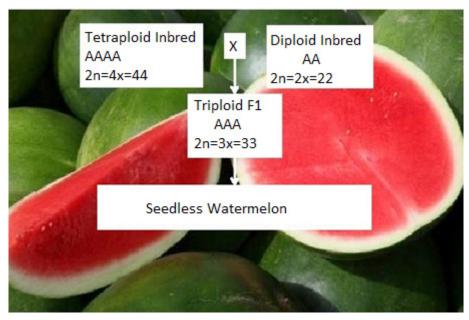


Figure 7: A triploid seedless watermelon, Citrullus lanatus Source: https://slidetodoc.com/ploidy-so-many-options-triploid-haploid-allohexaploid-autotetraploid/

plain the effects of allopolyploidy on watermelon.	2 1 0 NR
plain the effects of allopolyploidy on watermelon.	2 1
plain the effects of allopolyploidy on watermelon.	1 0
plain the effects of allopolyploidy on watermelon.	
plain the effects of allopolyploidy on watermelon.	NF
plain the effects of allopolyploidy on watermelon.	
	Skil
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Question Four: Molecular Genetics

The coat colour of rabbits shows an example of multiple alleles. There are four alleles that exist for the $\bf c$ gene:

- The wild-type version, C+C+, is expressed as brown fur
- The chinchilla phenotype, cc^hcc^h , is expressed as black-tipped white fur
- The Himalayan phenotype, $c^h c^h$, has black fur on the extremities and white fur elsewhere
- The albino, or "colorless" phenotype, *cc*, is expressed as white fur.

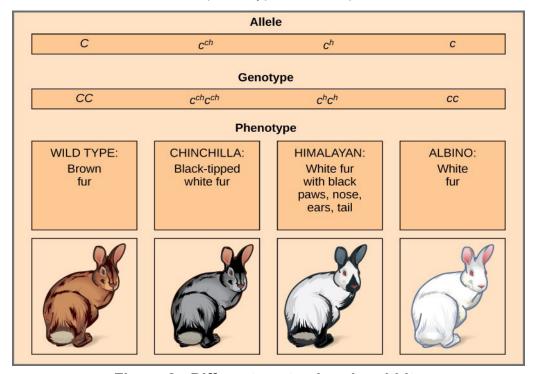


Figure 8: Different coat colour in rabbits

Source: https://courses.lumenlearning.com/bio1/chapter/reading-multiple-alleles/

Explain how this monohybrid cross with dominance, incomplete dominance and multiple alleles contribute to variations and survival of the rabbit.		
	Skill le	eve
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	1	
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Question Five: Gene-Gene Interaction

In sweet pea (*Lathyrus odoratus*), two varieties of white flowering plants were crossed. Each variety bred true and produced white flowers in successive generations. At least one dominant allele for both Gene C and Gene P are required to produce purple colour.

When two such white varieties of sweet pea were crossed, the offspring were found to have purple coloured flowers in F1 but in F2 generation, the results are shown in the table below:

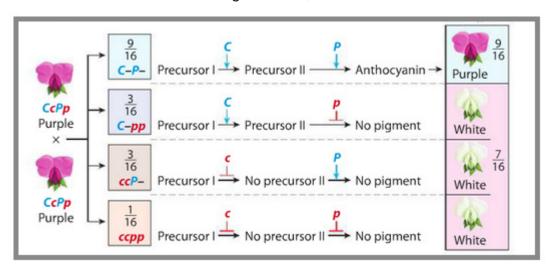


Figure 9: Complimentary Gene Interaction

Source: https://www.nagwa.com/en/explainers/ 714121243707

Describe the leatures of complementary genes as a gene-gene interaction.		
·		
	Skill I	evel 2
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Question Six: Environmental Effect on Phenotype

Eastern tiger snakes (Notechi scutatus) living on desolate islands off mainland Australia have longer jaws than the mainland populations of snakes. The diet of island snakes includes large prey, such as seagull chicks, while the diet of the mainland snakes consists of small prey, such as frogs and mice.

Researchers set up experiments using baby snakes from both locations. Snakes were fed either large or small mice over several months, until they reached maturity. The method and results are indicated in the table below.

Table 1: Diet of snakes

	experiment 1		experiment 2	
	group A island snakes	group B island snakes	group C mainland snakes	group D mainland snakes
Length of eastern tiger snakes' jaws at birth	long	long	normal	normal
Type of prey given over several months	small mice	large mice	small mice	large mice
Length of eastern tiger snakes' jaws at maturity	normal	long	normal	normal

Explain the ellects of the environment on the size of eastern tiger shake's jaws.		
	Skill le	evel 3
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BIOTECHNOLOGY APPLICATION SECTION C:

Question One: Gene Cloning

Scientists modified ordinary potatoes to carry a gene that produces a protein molecule found on the surface of the hepatitis B virus (HBV).

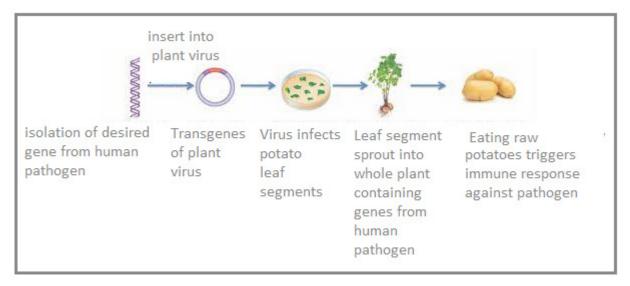


Figure 11: How to make edible vaccine

Source:	https://www.researchgate.net/figure/Development-of-edible-vaccines-from-potato_fig1_303940786		
- - - - - - - - - - - - - - - - - - -	the medical advantages of using bacterial plasmids in gene cloning.		
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Question Two: DNA Profiling

DNA profiling is the process where a specific DNA pattern is obtained from a person or sample of bodily tissue, using the techniques below:

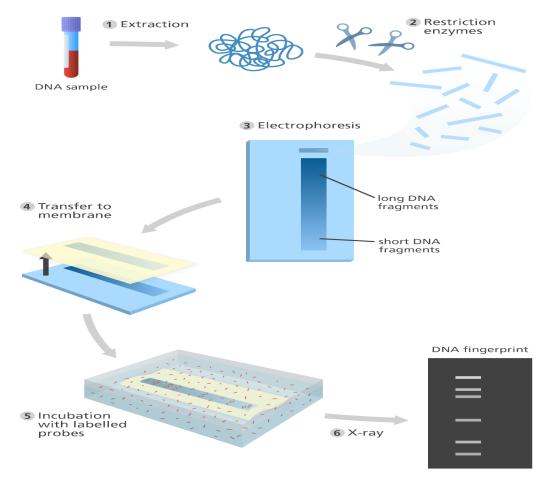


Figure 12: Techniques for DNA profiling

Source: https://microbenotes.com/dna-fingerprinting-principle-methods-applications/

Discuss at least THREE (3) applications of DNA profiles produced from the process show above.					

		
	Skill I	evel 4
	4	
	3	
	2	
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	0	
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SECTION D: PROCESSES AND PATTERNS OF EVOLUTION

Question One: Variation

Genes are arranged linearly along the length of a chromosome. During meiosis, the paternal chromosomes move and exchange parts with their maternal homologous counterparts, as illustrated below:

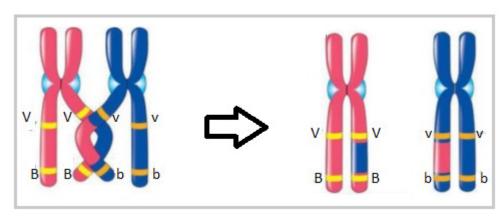


Figure 13: Homologous chromosomes exchange parts

Source: https://pt.slideshare.net/vsussmane/genetic-variation-due-to-meiosis/2

		Skill
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Explain how independ variation.	dent assortment, segregation and crossing over produces	
		Skill
		Skill 3

Question	Two:	Matural	Solo	ction
Guestion	TWO:	naturai	Seie	ction:

a.	Describe the main ideas of the theory of natural selection as proposed by Darwin.		
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		1	
		0	
		NR	

b. Modern domesticated pigs are descendants of wild boars. Through the domestication process, humans have artificially selected for certain desirable traits, as shown in the pig below:



Figure 14

Explain the impact of artificial selection (selective breeding) in domesticated pigs.	

Skill level 3

Question Three: Allele Frequency

Define allele frequency. a.

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b. List the factors that affect allele frequency.

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Question Four: Speciation

The diagram below shows a population of birds that have been separated by a physical barrier. Over the years, they became two different species, Population A and Population B. This type of speciation is referred to as sympatric speciation.

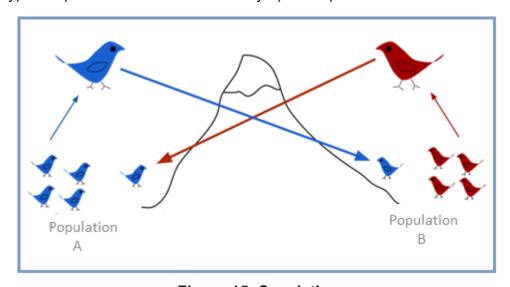


Figure 15: Speciation

Source: https://en.wikipedia.org/wiki/Gene_flow

Define sympatric speciation. Skill level 1 a. NR

Skill l	evel 1
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NR	

b.	Identity the type of reproductive isolation mechanism that keeps the two population
	reproductively isolated.

	olution occurs.
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Describe the features of divergent evolution.	
Describe the features of divergent evolution.	
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Describe the features of EITHER hybrid inviable OR hybrid	2 1 0 NR
Describe the features of EITHER hybrid inviable OR hybrid	2 1 0 NR
Describe the features of EITHER hybrid inviable OR hybrid	2 1 0 NR
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Describe the features of divergent evolution. Describe the features of EITHER hybrid inviable OR hybrid breakdown.	1 o NR I sterile OR hybrid Skil 2
Describe the features of EITHER hybrid inviable OR hybrid	1 o NR I sterile OR hybrid