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STUDENT ENROLMENT NUMBER (SEN)

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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
B	Gene Expression	25
C	Biotechnology Application	7
D	Processes and Patterns of Evolution	21
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.

YOU MUST HAND IN THIS BOOKLET TO THE SUPERVISOR BEFORE YOU LEAVE THE EXAMINATION ROOM.

SECTION A:**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.

- a. Describe the orientation features of the innate behavior of dung beetles.

Skill level 2	
2	
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NR	

- b. Describe the navigation features of dung beetles which uses stellar patterns.

Skill level 2	
2	
1	
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NR	

Skill level 3	
3	
2	
1	
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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.

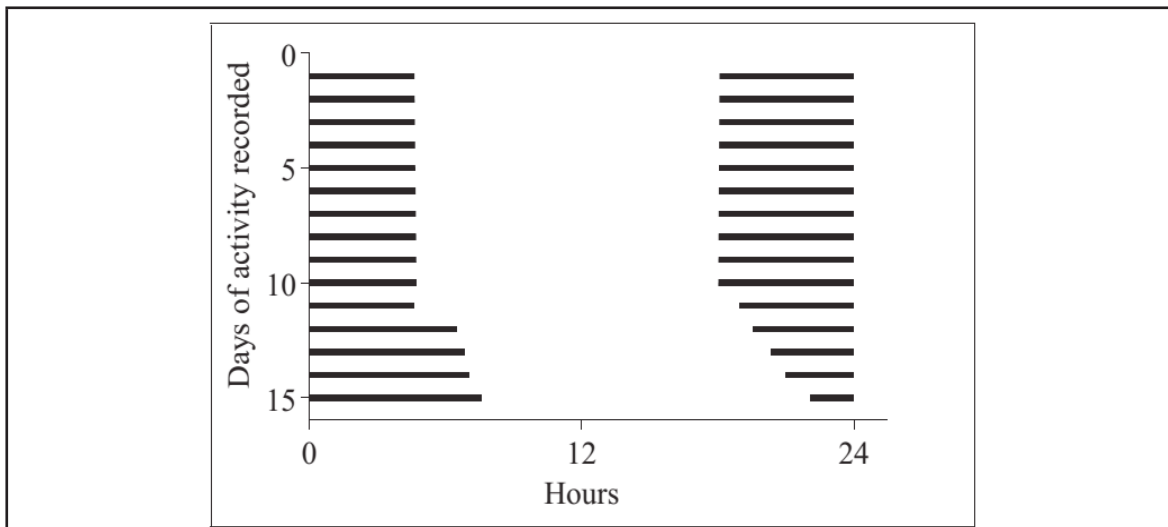


Figure 3: The great spotted kiwi activity of 10 days in normal environmental conditions followed by another 5 days in constant darkness.

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

- a. Describe the features of circadian rhythm shown by the actogram.

Skill level 2	
2	
1	
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NR	

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

Define **endogenous control**.

Skill level 1	
1	
0	
NR	

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.

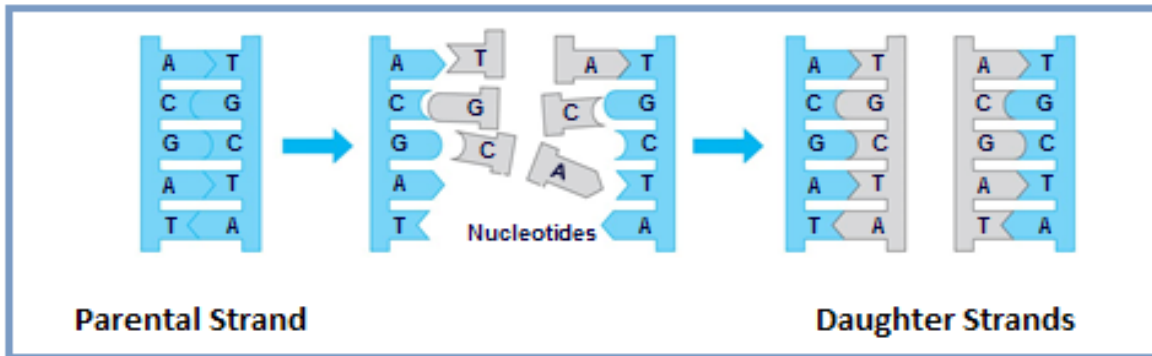


Figure 4: DNA Replication

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

- a. Use the illustration above to explain why the DNA replication is considered as **semi-conservative**.

[illegible]

Skill level	
3	
2	
1	
0	
NR	

- b. Discuss the importance of the structure and replication of DNA for gene expression.

[illegible]

Skill level	
3	
2	
1	
0	
NR	

- c. Describe the structure of primary protein.

Skill level 2	
2	
1	
0	
NR	

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	Second Base				Third Base
	U	C	A	G	
U	UUU } Phenylalanine (Phe)	UCU }	UAU } Tyrosine (Tyr)	UGU } Cysteine (Cys)	U
	UUC }	UCC } Serine (Ser)	UAC }	UGC }	C
	UUA } Leucine (Leu)	UCA }	UAA } Stop	UGA } Stop	A
	UUG }	UCG }	UAG }	UGG } Tryptophan (Trp)	G
C	CUU }	CCU }	CAU } Histidine (His)	CGU }	U
	CUC } Leucine (Leu)	CCC } Proline (Pro)	CAC }	CGC } Arginine (Arg)	C
	CUA }	CCA }	CAA } Glutamine (Glu)	CGA }	A
	CUG }	CCG }	CAG }	CGG }	G
A	AUU }	ACU }	AAU } Asparagine (Asn)	AGU } Serine (Ser)	U
	AUC } Isoleucine (Ile)	ACC } Threonine (Thr)	AAC }	AGC }	C
	AUA }	ACA }	AAA } Lysine (Lys)	AGA } Arginine (Arg)	A
	AUG } Start Methionine (Met)	ACG }	AAG }	AGG }	G
G	GUU }	GCU }	GAU } Aspartic Acid (Asp)	GGU }	U
	GUC } Valine (Val)	GCC } Alanine (Ala)	GAC }	GGC } Glycine (Gly)	C
	GUA }	GCA }	GAA } Glutamic Acid (Glu)	GGA }	A
	GUG }	GCG }	GAG }	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'

Skill level 1	
1	
0	
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	
0	
NR	

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.

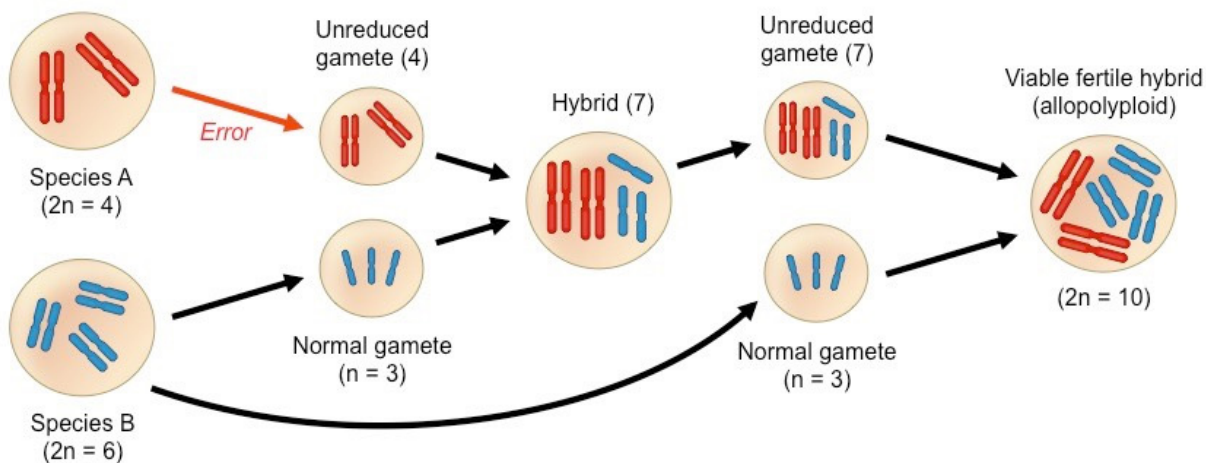


Figure 6: Allopolyploidy

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

- a. Define **polyploidy**.

Skill level 1	
1	
0	
NR	



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Skill level 3	
3	
2	
1	
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Skill level 3	
3	
2	
1	
0	
NR	

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:

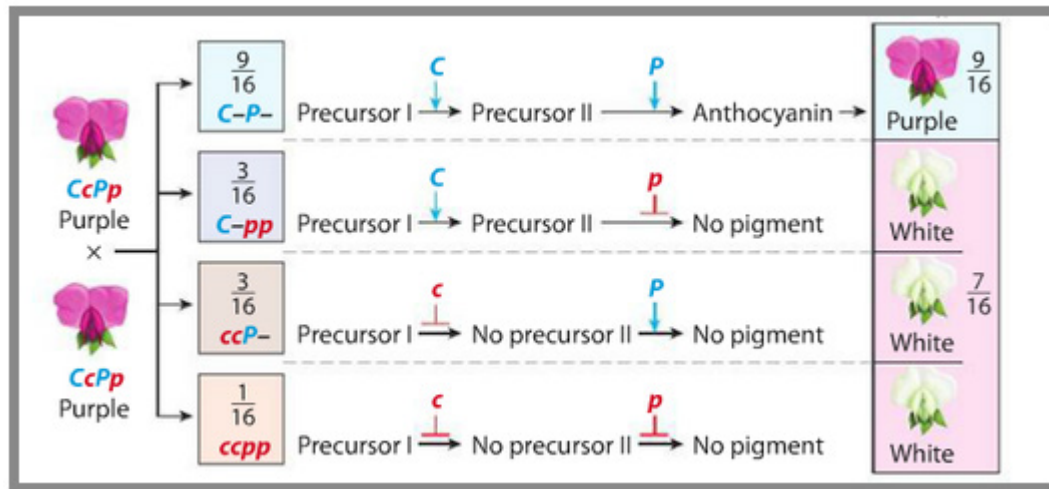


Figure 9: Complimentary Gene Interaction

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

Describe the features of complementary genes as a gene-gene interaction.

Skill level 2	
2	
1	
0	
NR	

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 effects of the environment on the size of eastern tiger snake's jaws.

Skill level 3	
3	
2	
1	
0	
NR	

Skill level 3	
3	
2	
1	
0	
NR	

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This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Skill level 4	
4	
3	
2	
1	
0	
NR	

Skill level 3	
3	
2	
1	
0	
NR	

Question Two: Natural Selection

- a. Describe the main ideas of the theory of **natural selection** as proposed by Darwin.

Skill level 2	
2	
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	
3	
2	
1	
0	
NR	

Question Three: Allele Frequency

- a. Define **allele frequency**.

Skill level 1	
1	
0	
NR	

- b. List the factors that affect allele frequency.

Skill level 2	
2	
1	
0	
NR	

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**.

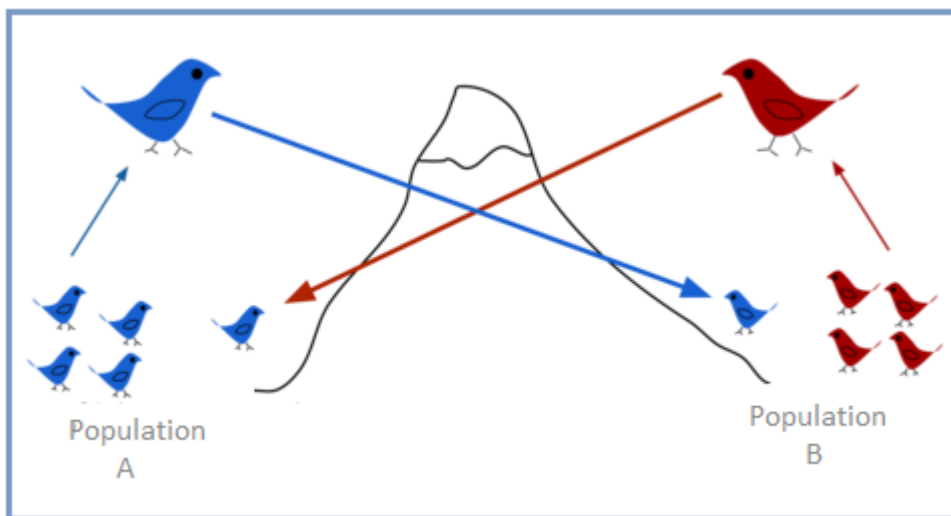


Figure 15: Speciation

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

- a. Define **sympatric speciation**.

Skill level 1	
1	
0	
NR	

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

Skill level 1	
1	
0	
NR	

- c. Use the example in **Figure 15** to explain how divergent evolution occurs.

Skill level 3	
3	
2	
1	
0	
NR	

- d. Describe the features of divergent evolution.

Skill level 2	
2	
1	
0	
NR	

- e. Describe the features of **EITHER** hybrid inviable **OR** hybrid sterile **OR** hybrid breakdown.

Skill level 2	
2	
1	
0	
NR	