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TONGA NATIONAL FORM SEVEN CERTIFICATE 2020

BIOLOGY

QUESTION AND ANSWER BOOKLET

Time allowed: 2 Hours + 15 minutes

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	TOPICS	TOTAL SKILL LEVEL
Α	ANIMAL BEHAVIOUR	21
В	GENE EXPRESSION	24
С	BIOTECHNOLOGY APPLICATIONS	8
D	PROCESSES AND PATTERNS OF EVOLUTION	17
	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 spaces 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 2-23 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 1: ECOLOGICAL NICHE

The *Anolis cristatellus* is an insectivorous species of lizards. In the Caribbean Islands, these anoles can be categorized into six groups according to their body characteristics (morphology) and the ecological niches they occupy. These groups are referred to as ecological morphotypes, or ecomorphs. These species live in diverse habitats and vary greatly in size and other obvious physical features such as leg and tail length, as shown in the table below:

cro	own-giant
	£ ()
	Trunk-crown
	Twig
	Trunk
	Trunk-ground
	Grass-bush

Ecomorphs	Habitat	Body	Limb	Toe	Tail	Colour
		length	length	pad	length	
Crown –	High trunks	130 -	Short	Large	Long	Usually
giant	and	191mm				green
(canopy)	branches					
Trunk-	Trunks,	44 –	Short	Very large	Long	Green
crown	branches,	84 mm				
	leaves					
Trunk	Trunks	40 –	Intermediate	Intermediate	Short	Gray
		58 mm				
Twig	Narrow	41 –	Very short	Small	Short	Gray
	twigs	80 mm				
Trunk-	Lower	55 –	Long	Intermediate	Long	Brown
ground	trunk and	79 mm				
	ground					
Grass-bush	Bush and	33 –	Long	Intermediate	Very	Brown
	grasses	51 mm			long	

Figure 1: Habitats of anoles in different parts of a tree

 $\textbf{Source:}\ \underline{https://www.biointeractive.org/sites/default/files/Lizard-Phylogeny-Teacher.pdf}$

Describe the features of the green anole's structural adaptation.		
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QUESTION 2: ORIENTATION AND NAVIGATION

The Pacific Ocean is an important breeding ground for humpback whales. When winter descends on the Antarctic, the average day-time temperature falls to around 20°C. The humpback whale migration begins a journey of over 6,000kms. This journey takes them up the east coast of New Zealand in the waters of the South Pacific and then along the sub-sea volcanic arch that leads to the Tongan group.

These epic humpback whale migrations are integral to their very survival as a species as the waters of the Antarctic are too cold for newly-born calves to survive. So the pregnant females swim all the way to Tonga to give birth in the warm waters and sheltered bays of the Tongan islands.

The whales know the time is approaching for them to leave the Southern Ocean and head north in what is known as one of the world's largest and longest animal migrations.



<u>Figure 2</u>: Migration pathway for humpback whales

Source: https://idopacificimages.com

a) Humpback whales migrate very long distances from their feeding ground in the Antarctic to their breeding area in the South Pacific.

Define migration.	Skill le	vel 1
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b) Humpback whales do not have the luxury of a smart phone to help them navigate through this vast distance in the open ocean.

Explain how different types of navigation are beneficial for the whale to achieve this long distance migration with great accuracy.

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em predict time to prepare for changes that come with migration.		le

QUESTION 3: INTRASPECIFIC INTERACTION

Wolves are social animals and they instinctively form packs consisting of a pair of breeding wolves and their offspring. On occasion, there may be another wolf that is not part of their lineage accepted into their pack. There is a distinct pecking order in the wolf pack, namely alpha, beta, omega and the rest of the pack. The alpha wolf pairs are usually monogamous with each other, but alpha males have been known to stray with other pack members, especially if they are closely related.



Figure 3: A wolf pack

Source: http://wolffacts.org/wolf-pack-hierarchy.html

Define monogamous mating.	Skill le	evel 1
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Wolf packs hold their territory fiercely and mark it with urine and scats, a behaviour called scent-marking.		
Describe the difference between territory and home range .		
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SECTION B: GENE EXPRESSION

QUESTION 1: PROTEIN SYNTHESIS

The diagram below illustrates protein synthesis. Use it to answer the questions that follow:

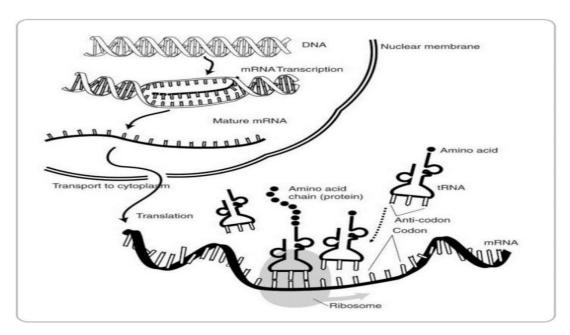


Figure 4: Process of Protein Synthesis

Source: https://en.ppt-online.org/275671

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QUESTION 2: MUTATION

This table shows the 64 codons and the amino acid that each codon codes for.

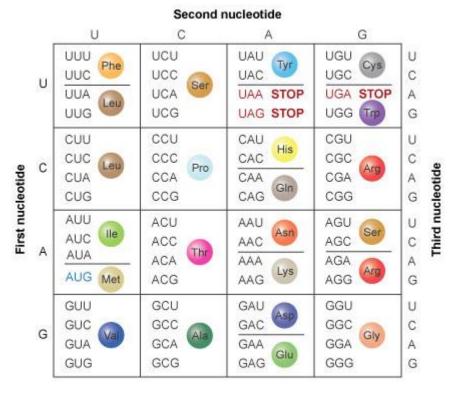
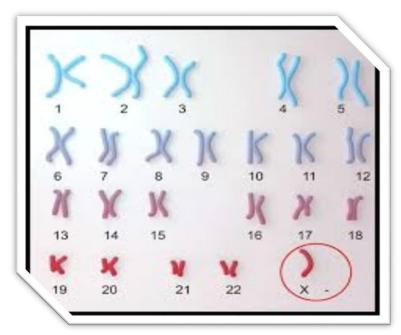


Figure 5: mRNA Codon Table

Source: https://www.nature.com/scitable/topicpage/the-information-in-dna-determines-cellular-function-6523228/

Define redundancy in terms of genetic code.	Skill le	evel 1
	1	
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	NR	
Explain how redundancy of the genetic code buffers gene mutation.		
	Skill lo	evel 3
	3	
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The diagram below is a karyotype showing the arrangement of chromosome in a female that illustrates mutation on chromosome number 23. Use it to answer the questions that follow:



<u>Figure 6:</u> Karyotype showing the arrangement of chromosomes in a female with Turner's syndrome

Source: https://www.picfair.com/pics/05719547-turner-s-syndrome-karyotype-illustration

Define chromosomal mutation .	Skill le	evel 1
	1	
	0	
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The type of chromosome mutation shown in the diagram above is monosomy which is one example of aneuploidy. Explain the effect of this monosomy chromosome mutation on gene expression.		
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QUESTION 3: METABOLIC PATHWAYS

Metabolic pathways are typically organised into chains or cycles of enzyme-catalysed reactions such as glycolysis and Krebs cycle, as illustrated below. Use it to answer the questions that follow:

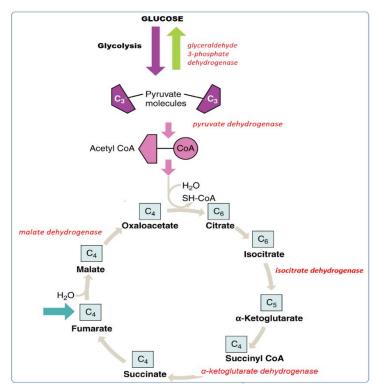


Figure 7: Glycolysis and Krebs cycle

Source: https://opentextbc.ca/anatomyandphysiology/chapter/24-4-protein-metabolism/

Skill level 1

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Identify	the substrate and the products of the glycolysis pathway show	
	e the reactions in the Krebs cycle and the enzymes involved in lic pathways.	the

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QUESTION 4: GENE INTERACTION

In sweet pea ($Lathyrus\ odoratus$), two varieties of white flowering plants were seen. Each variety bred true and produced white flowers in successive generations. When two such white varieties of sweet pea were crossed, the offspring were found to have purple coloured flowers in F_1 . When F1 offspring were self-crossed, the results illustrate complementary gene-gene interaction, as shown in the punnet square below. Use it to answer the questions that follow.

F1 Generation: CcPp

(Purple Colour)

F1 Self-cross: F1 x F1 CcPp X CcPp

(Purple Colour) (Purple Colour)

F1 Gametes: CP Cp cP cp X CP Cp cP cp

F2 Generations: Refer to Punnet Square below:

X	СР	Ср	cP	ср
СР	ССРР	ССРр	CcPP	СсРр
Ср	ССРр	ССрр	СсРр	Ссрр
сР	CcPP	СсРр	ccPP	ссРр
ср	СсРр	Ссрр	ссРр	ссрр

Describe the features of complementary genes as illustrated by the cross above.		
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Describe the re	ationship between pheno	otype and genotype	€.		
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QUESTION 5: LINKED GENES

In cats, one of several genes controlling fur colour is located on the X chromosome of the sex chromosome. The gene has two versions, one form codes for orange fur (X^B) and the other form codes for black fur (X^b) . A cat inheriting one copy of each gene (X^BX^b) has a patchwork of orange and black coat, known as tortoiseshell.



Figure 8: A tortoiseshell female cat

Source: https://letstalkscience.ca/educational-resources/stem-in-context/science-behind-calico-cats-colours

Describe how the inheritance of a tortoiseshell colour in a female cat illustrates sex-linkage.		
	Skill le	evel 2
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SECTION C: BIOTECHNOLOGY APPLICATIONS

QUESTION 1: TRANS-GENESIS

Recombinant DNA technology is the joining together of **DNA** molecules from two different species. The recombined **DNA** molecule is inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture, and industry.

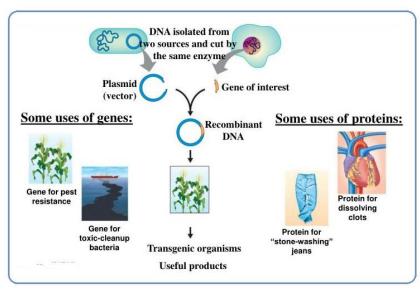


Figure 9: Recombinant DNA

Source: https://www.slideserve.com/katoka/recombinant-dna-technology

a)	State the purpose of using bacteria plasmid.	Skill le	vel 1
		1	
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b)	Describe how recombinant DNA is formed using techniques of restriction enzymes and ligation.		
		Skill le	evel 2
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QUESTION 2: DNA PROFILING.

DNA Profiling is a technique used by scientists to distinguish between individuals of the same species using only samples of their DNA to reveal its unique patterns. From a crime scene, the DNA pattern of the victim and suspects are shown below as well as the DNA from the specimen found at the crime scene.

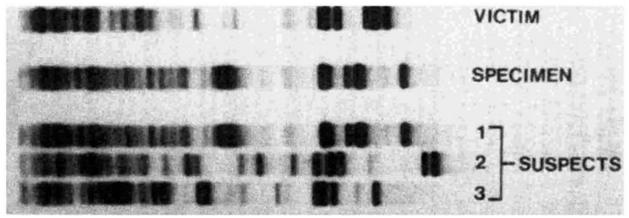


Figure 10: DNA patterns for victim and suspects

Source: https://slideplayer.com/slide/6419498/

a)	Describe the process which forms the DNA profiles above using the technique of gel electrophoresis.		
		Skill le 2 1 0 NR	vel 2
b)	Explain the possible impacts of DNA profiling.		
		Skill le	evel 3
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SECTION D: PROCESSES AND PATTERNS OF EVOLUTION

QUESTION 1: NATURAL SELECTION

The Brahman cattle are known for their extreme tolerance to heat and are widespread in the tropical regions. They were artificially selected to mate with the English shorthorn cattle which naturally has good beef. They produced the desirable breed of Santa Gertrudis cattle, shown below:

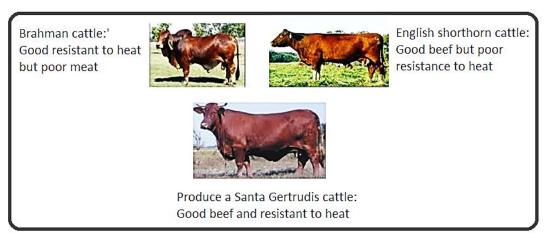


Figure 11: Selective breeding in cows

Source: https://www.slideshare.net/BUHLETHOYANE/selective-breeding-and-genetic-engineering-69660722

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QUESTION 2: GENE POOL

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n contributing to changes in the gene pool.		
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QUESTION 3: SPECIATION

Speciation is the process by which new species form. It occurs when groups in a species become reproductively isolated and diverge.

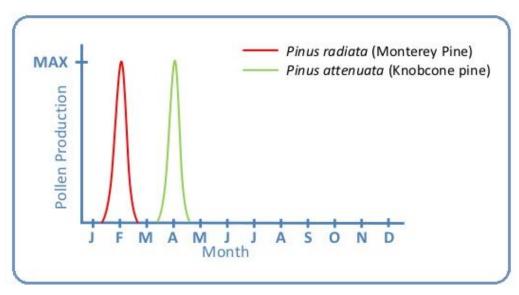


Figure 12: Graph showing months of pollen production in species of Pines

Source: https://www.slideshare.net/diverzippy/bioknowledgy-presentation-on-103-gene-pools-and-speciation-ahl

Describe the features of the type of pre-zygotic isolating mechanism shown by the two

species of pine in the graph above.		
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QUESTION 4: EVOLUTION PATTERNS

Scientists study the similarities and differences in the structure of different species as shown below, to be homologous structures.

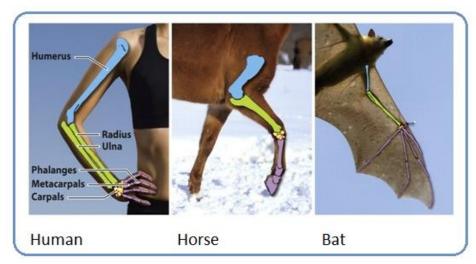


Figure 13: Forelimbs of human, horse and bat

Source: https://slideplayer.com/slide/6286249/

Use the example above to explain clearly how divergent evolution occurs. Skill 3 2 1	kill le
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