

MARKER CODE				



STUDENT ENROLMENT NUMBER (SEN)									

TONGA NATIONAL FORM SEVEN CERTIFICATE

2022

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 82 weighted scores.

SECTION	STRANDS	TOTAL SKILL LEVEL
ONE	Animal Behaviour	23
TWO	Gene Expression	18
THREE	Biotechnology Applications	18
FOUR	Processes and Patterns of Evolution	23
TOTAL		82

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 **2-23** 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.

The diagram below shows two different behavioural responses by two organism to a stimulus.

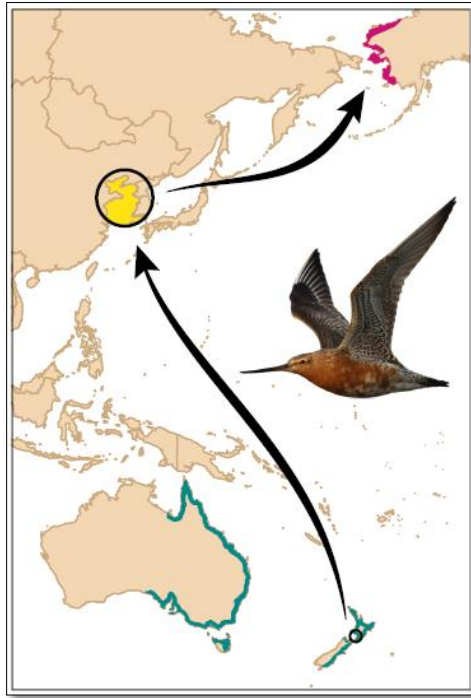
a. Differentiate between the behavioural responses (kinesis and taxis) shown in **Figure 1**.

This image shows a single 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 3	
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The Bar-tailed godwit, *Limosa lapponica* undertakes one of the world's most amazing migratory journeys. Recent research shows that some individuals from the East Asia/Australasia Flyway population made a nonstop flight of over 11,000 km, the longest continuous journey that has ever been recorded for a land bird.

Figure 2: The migration of the Bar-tailed godwit from New Zealand and Australia to Alaska in the United States with a stop-over in China.



Source: <https://www.sciencedirect.com/science/article/pii/S0003347214000542>

- b. Explain why different types of navigational methods are beneficial to the bar-tailed gotwits in its non-stop flights.

[illegible]

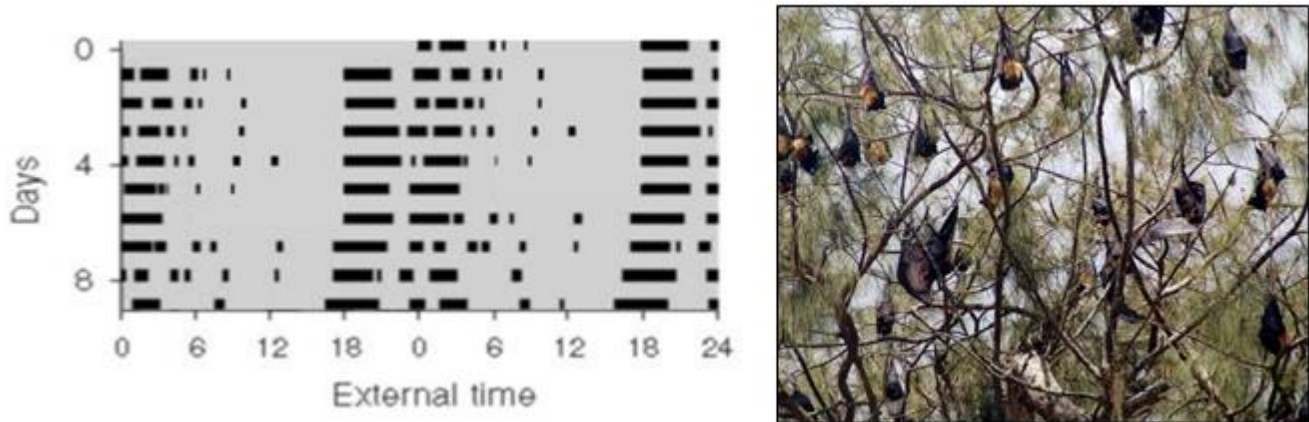
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Question Two: Timing Responses

The diagram below illustrates an actogram of a Tongan flying fox, *Pteropus tonganus*. The activity of the flying fox is under endogenous control.

Some of the distinguishing features of *Pteropus tonganus* are: big eyes, large wing and rough tongue. *Pteropus tonganus* has a fast digestive system and excretes faeces roughly 20 minutes from the time food is ingested.

Figure 3: The actogram of a Tongan flying fox, *Pteropus tonganus*



Source: <https://www.pathwayz.org/Tree/Plain/ACTOGRAMS>

- a. Describe the period of rhythm and activity pattern of the flying fox as shown on the actogram.

Skill level 2	
2	
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- b. Explain how **ONE (1)** adaptation of the flying fox, *Pteropus tonganus* increases their chances of survival in its home range.

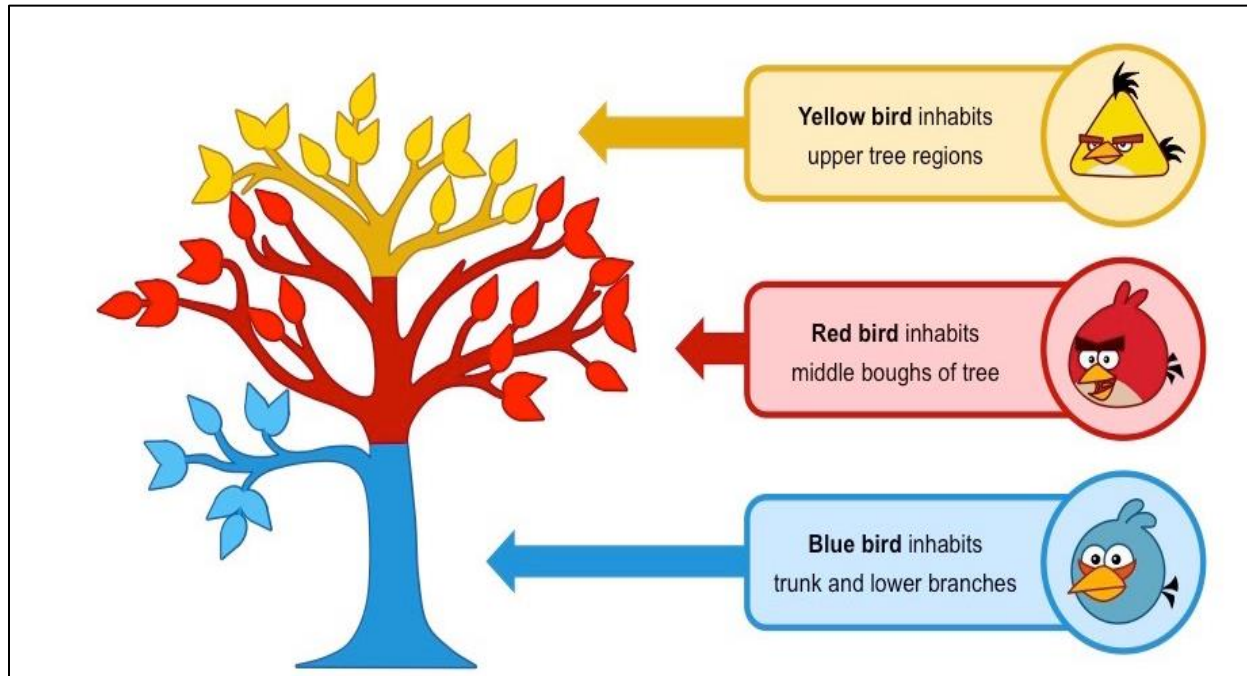
Skill level 3	
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Question Three: Interspecific Interactions

The diagram below shows an observation made by Roseta, an ecologist from the National University of Tonga. She reported that three different birds inhabited different parts of an unnamed tree in the Manamo'ui forest community.

This is a significant discovery because 20 years ago she observed that **all** the birds coexist with each other in all parts of the tree.

Figure 4: Niche differentiation as observed on a plant in a Forest community



Source: https://ib.bioninja.com.au/_Media/fundamental-vs-realised_med.jpeg

- a. Define **niche differentiation**.

Skill level 1	
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- b. Explain how **interspecific interactions** between these birds 20 years ago affected their population number and distribution pattern.

Skill level 3	
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Question Four: Intraspecific interactions

Social primates like spider monkeys can live in groups of up to 30 individuals.

When foraging during the day, these large groups may split into smaller sub-groups (between 2 and 8 animals) and they reunite again during night time.

Each group has a territory that the males use to mark with their scent glands. Anyone stumbling into spider monkey territory receives an unpleasant 'welcome' of screams, barks and rattling branches and thrown branches or faeces. Young adult males in the group protect the young ones and females from rival groups.

Figure 5: A spider monkey with an infant and is dependent on the mother's milk.



Source: <https://www.discovery.com/nature/spider-monkey>

- a. Spider monkeys are polygamous yet displayed both cooperative and competitive behaviours.
Describe EITHER ONE (1) of cooperative and competitive behaviour using spider monkeys as an example.

Skill level 2	
2	
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- b. Spider monkeys cared for their young. Describe **parental care**.

[illegible]

- c. Discuss the **impact** of intraspecific interactions on social organisation and the overall survival of spider monkeys.

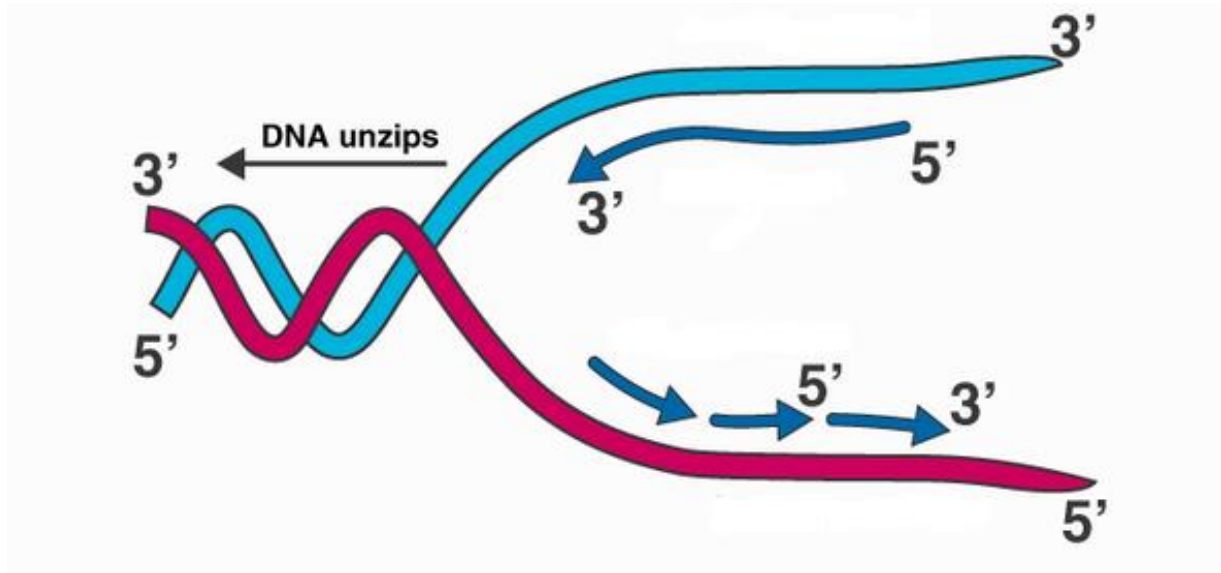
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SECTION TWO: GENE EXPRESSION

Question One: DNA Structure & Replication

The diagram below illustrates how a DNA segment is replicated in a cell. DNA replication is an important aspect of all living organisms.

Figure 6: DNA Replication



Source: <https://cdn1.byjus.com/wp-content/uploads/2018/11/dna-replication-machinery-enzymes-1.png>

Explain the **process** of DNA replication.

This image shows a single 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 3	
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Skill level 3	
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Skill level 3	
3	
2	
1	
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NR	

Figure 8: Phenylalanine metabolic pathway

[illegible]

Skill level 4	
4	
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Question Five: Sex-Linkage

A **sex-linked gene** controls fur colours in cats. **Ginger-coloured fur** is controlled by the allele **G** and **black fur** is controlled by the allele **g**. Some female cats have ginger and black patches of fur. They are described as **tortoiseshell**. Male cats cannot be tortoiseshell.

Table 2: Different coloured cats to showed sex-linked genes.

		
Tortoiseshell coloured cat	Ginger coloured cat	Black coloured cat

- a. Describe why tortoiseshell is only expressed in female cats.

		Skill level 2	
		2	
		1	
		0	
		NR	

- b. In very rare cases, a male cat can express 'Tortoiseshell' colour.

Explain this **chromosomal condition**.

		Skill level 2	
		2	
		1	
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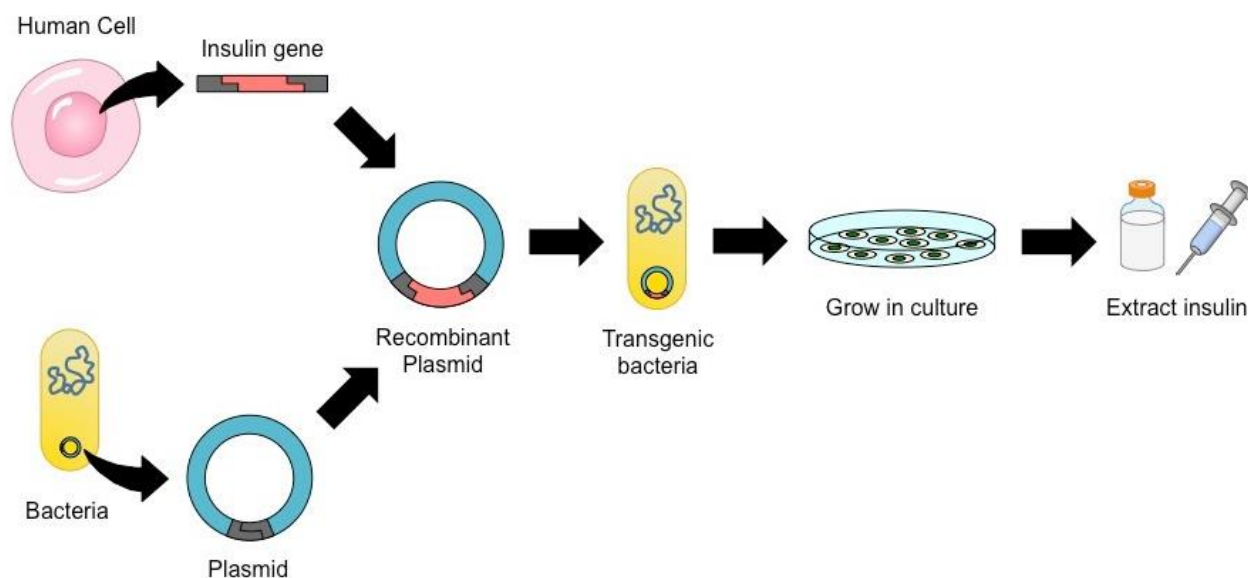
SECTION THREE:

BIOTECHNOLOGY APPLICATIONS

Question One: Transgenesis

DNA can be sliced from different sources and fused to form **recombinant DNA**. The recombinant DNA is then introduced into the genome of another organism. This is often carried out in a process known as **transgenesis**.

Figure 9 shows how insulin can be produced by transgenesis.



Source: https://ib.bioninja.com.au/_Media/insulin-production_med.jpeg

- a. State the purpose of **bacterial plasmid**.

Skill level 1	
1	
0	
NR	

- b. Describe how recombinant DNA is formed using techniques of restriction enzymes and ligation.

Skill level 2	
2	
1	
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- c. Describe transgenesis using techniques of gene gun (*agrobacterium tumefaciens*) mediated method.

	Skill level 2	
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	1	
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Question Two: Gene Cloning

Most of the insulin syringes that are available in most pharmacies were produced in large quantities through gene cloning.

Figure 10: Over the counter insulin syringes produced via gene cloning.



Source: <https://images.ctfassets.net.jpg>

- a. Define **gene cloning**.

Skill level 1	
1	
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NR	

- b. Discuss **ONE (1)** potential advantage and **ONE (1)** potential disadvantage of gene cloning using the production of insulin as an example.

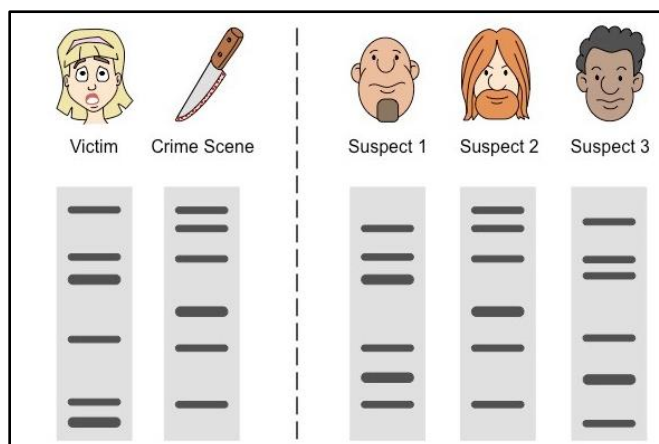
Skill level 4	
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Question Three: DNA Profiling

The Police Department reported that a victim was stabbed in her home by an unknown suspect. DNA collected from the scene were used to generate the DNA profile shown in **Figure 11** below. Three known criminals who were present in the area were also asked to provide their own DNA voluntarily.

Their DNA profiles are also shown as suspect 1, 2 and 3 respectively.

Figure 11: DNA profiles from the crime scene and 3 suspects.



Source: https://ib.bioninja.com.au/_Media/forensicafter_med.jpeg

- a. Using your knowledge of DNA profiling, identify the **suspect** who committed the crime. (Tick **ONE(1)** Choice Only)

☐ Suspect 1

☐ Suspect 2

☐ Suspect 3

Skill level 1	
1	
0	
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- b. State the **function** of PCR.

Skill level 1	
1	
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- c. Describe the process of the formation of DNA profiles using the techniques of **Gel electrophoresis**.

Skill level 2	
2	
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- d. Discuss how the application of DNA profiling may assist the Police Department in identifying the suspect.

Skill level 4	
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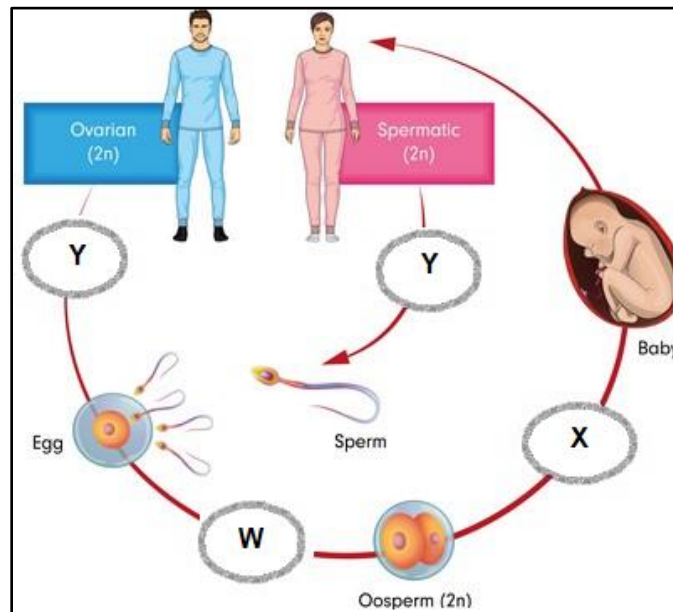
SECTION FOUR: PROCESSES AND PATTERNS OF EVOLUTION

Question One: Variation

The continuation of the human life-cycle requires both parents to produce gametes in Process **Y**. When the parents mate, it will lead to Process **W**.

The baby will be uniquely different from the parent and the rest of his siblings.

Figure 12: The processes that cause variation in the human life-cycle.



Source: <https://myscienceschool.org/uploads/1534..jpg>

a. Define Process **W**.

Skill level 1	
1	
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NR	

b. Describe the role of Process **W** in producing **variation**.

Skill level 2	
2	
1	
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Question Two: Natural Selection

Just as with natural selection, **sexual selection** can lead to changes in the genetic composition of a population that can be seen through physical changes to the way an organism looks as shown in **Figure 13**. There is a clear distinction between the male and female stag beetle in both body size and size of mandible.

Figure 13: Dimorphism in stag beetle



Source: <https://open.lib.umn.edu/app/uploads/sites.png>

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

Skill level 2	
2	
1	
0	
NR	

- b. Explain how sexual selection influences the inheritance of mandibles in stag beetle. .

Skill level 3	
3	
2	
1	
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Question Three: Hardy-Weinberg Principle

In corn, kernel color is controlled by a dominant allele for white color (W) and by a recessive yellow allele (w). A random sample of 200 kernels from a population that is in Hardy-Weinberg equilibrium reveals that 18 kernels are yellow (ww) and 182 kernels are white.

Figure 14: Allele frequency in corn



Source: <https://parkseed.com/images/xxl.jpg>

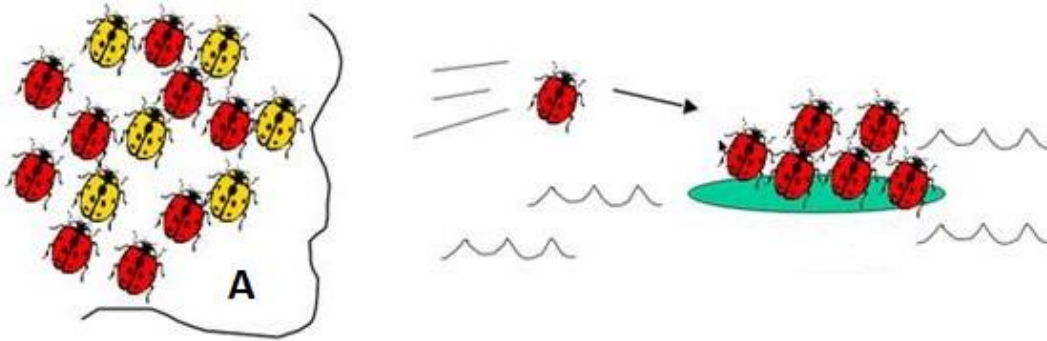
Calculate the number of kernels with **heterozygous genotype** in this population.

Skill level 3	
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Question Four: Allele frequency

The diagram below shows an example of genetic drift where a portion of the parent population in **A** is isolated and a new population is formed in another island. .

Figure 15: An example of genetic drift in aphids.



Source: <https://useruploads.socratic.org.jpg>

- a. Describe the features of **genetic drift**.

Skill level 2	
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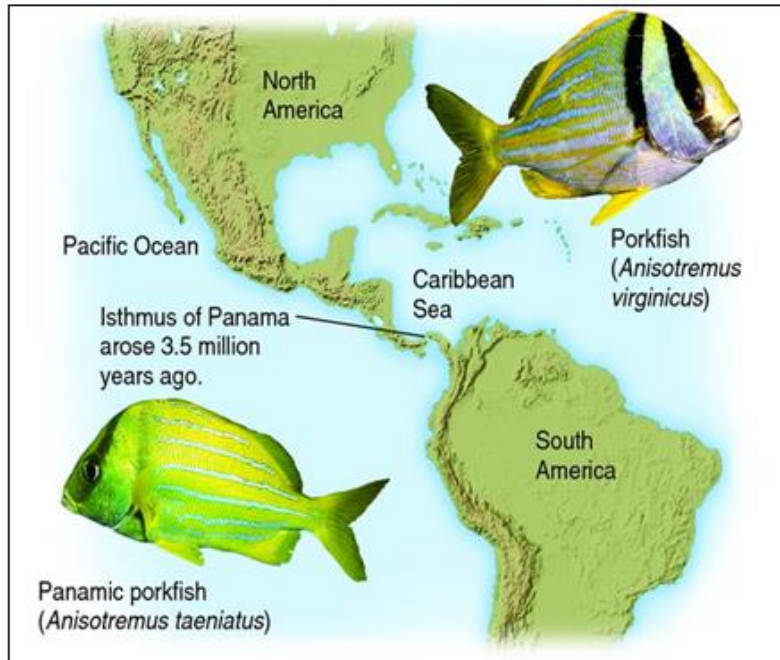
- b. Describe the features of **founder effect**.

Skill level 2	
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Question Five: Speciation

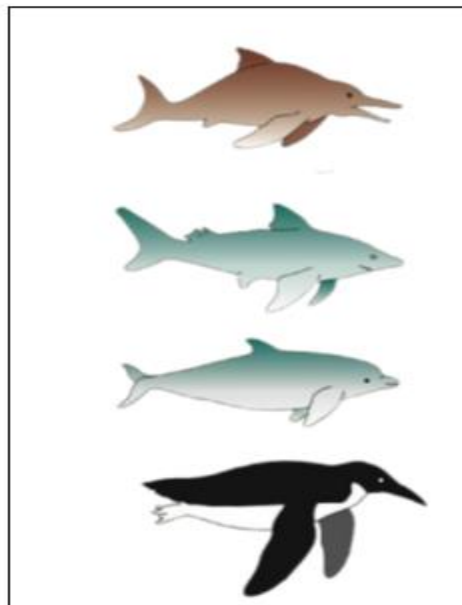
Figure 16 illustrates an ancestral fish population that was split into two by the formation of the Isthmus of Panama about 3.5 million years ago. This caused the formation of the **Porkfish** (*Anisotremus virginicus*) in the Caribbean Sea and the **Panamic porkfish** (*Anisotremus taeniatus*) in the Pacific Ocean.

Figure 16: Speciation in Porkfish



Source: https://biology-forums.com/gallery/33_14_07_11_6_00_25.jpeg

Figure 17: Evolution in marine species



Source: <https://player.slideplayer.com.jpg>

- a. Define **Allopatric speciation**.

Skill level 1	
1	
0	
NR	

- b. Describe the features of divergent evolution as shown in **Figure 16**.

Skill level 2	
2	
1	
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NR	

- c. Explain how **Convergent evolution** occurs in the marine species shown in **Figure 17**.

Skill level 3	
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NR	

Question Six: Reproductive isolation

Describe the features of **EITHER** hybrid sterile or hybrid breakdown.

Skill level 2	
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