

MARKER CODE				



STUDENT ENROLMENT NUMBER (SEN)									

TONGA NATIONAL FORM SEVEN CERTIFICATE

2024

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	26
B	GENE EXPRESSION	23
C	BIOTECHNOLOGY APPLICATIONS	6
D	PATTERNS OF EVOLUTION	15
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: ECOLOGICAL NICHE

Octopus vulgaris are found in tropical, subtropical and temperate waters between the surface and a depth of 100 – 150m. They are active **nocturnal** predators that feed primarily on fish, crabs, gastropods and bivalves. Their size can reach 1-3 feet in length including the arms that can immobilised their prey. The mouth has a very strong beak and poisonous saliva which paralyzes the prey. Octopus live alone and spend much of their time in dens—small holes and crevices in rocks and coral. Their skin contains cells called chromatophores that allows the octopus to change colour and pattern.

Figure 1: Octopus



Source: Common Octopus - Octopus Vulgaris Facts & Images WeHeartDiving.com

- a. Define **nocturnal** activity pattern.

Skill level 1	
1	
0	
NR	

- b. Define 'adaptation'.

Skill level 1	
1	
0	
NR	

- c. Describe the features of the octopus' ecological niche.

Skill level 2	
2	
1	
0	
NR	

- d. Explain how the octopus **adaptations** assist in its survival.

Skill level 3	
3	
2	
1	
0	
NR	

- e. In species like the Giant Pacific Octopus, the male may mate with multiple females during their lifetime. This behaviour is more opportunistic rather than forming a structured **polygynous** system. It changes the texture and color of its skin during **courtship** to warn off the competitors. If this does not work, it will fight to win the female octopus for mating. After mating, the male octopus dies while the female lay eggs. When these are fertilized, the female guards them until they hatch. The female often does not eat at this time and hardly goes out of her den. She ensures the cleanliness of her eggs by aerating them well, as most of them may not hatch if proper care is not taken.

- i. Define '**courtship**'.

Skill level 1	
1	
0	
NR	

- ii. Even though the male octopus mates with many female octopus, it is not polygamous. Define '**polygamous**'.

Skill level 1	
1	
0	
NR	

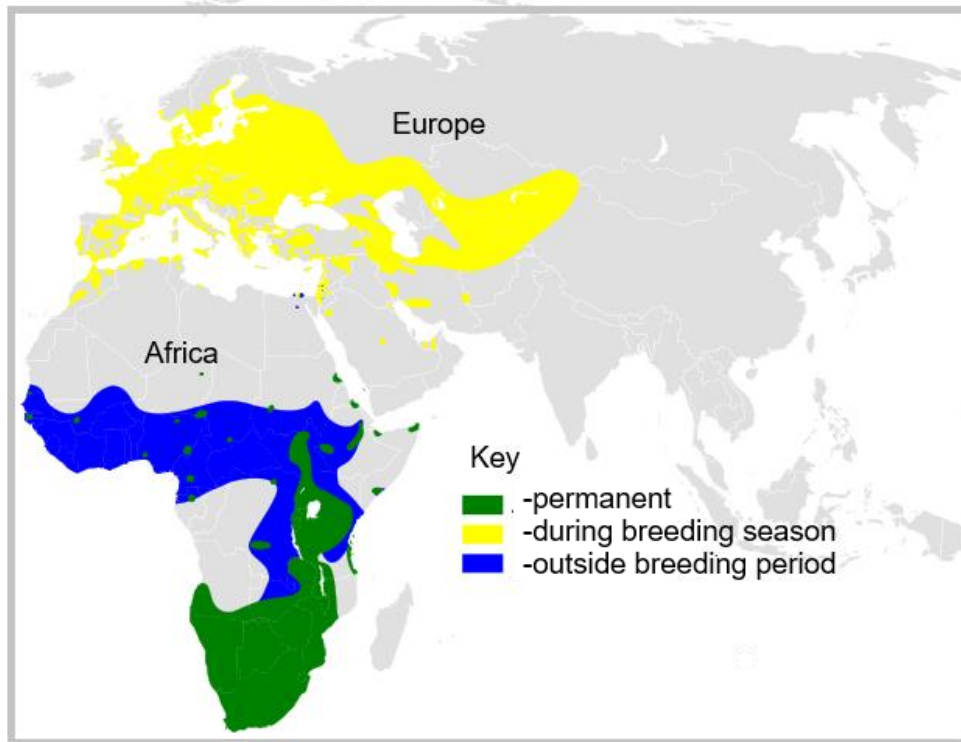
- iii. Describe the reproductive behaviors of the octopus as given above.

Skill level 2	
2	
1	
0	
NR	

QUESTION TWO: ORIENTATION AND NAVIGATION

The Eurasian Reed Warbler (*Acrocephalus scirpaceus*) undertakes an impressive migratory journey each year. These birds breed in their reedbeds habitat during breeding season across Europe and western Asia in summer. They migrate outside their breeding period to their wintering grounds in sub-Saharan Africa.

Figure 2: Map showing countries where warblers breed (yellow) and countries migrate to in winter (blue)



Source: Eurasian Reed Warbler - *Acrocephalus scirpaceus* - Carnivora

- a. Define 'migration'.

Skill level 1	
1	
0	
NR	

- b. Describe the timing responses and activity patterns of a reed warbler as determined by seasonal rhythm.

Skill level 2	
2	
1	
0	
NR	

- c. Describe the navigation features of reed warblers that use magnetic field lines.

Skill level 2	
2	
1	
0	
NR	

- d. During the breeding season, male reed warblers establish and defend territories within their reed beds. Outside the breeding season, reed warblers are less territorial, and their home range can expand to Sub-Saharan Africa.

Explain the advantages of territory and home range to male reed warblers.

Skill level 3	
3	
2	
1	
0	
NR	

- e. Reed warblers, like many other bird species, compete for resources such as food, nesting sites, and mates. This competition can influence their breeding success and overall population dynamics.

Discuss how intra-specific interactions in reed warblers' impact on the behavior and overall survival of its populations.

SECTION B:

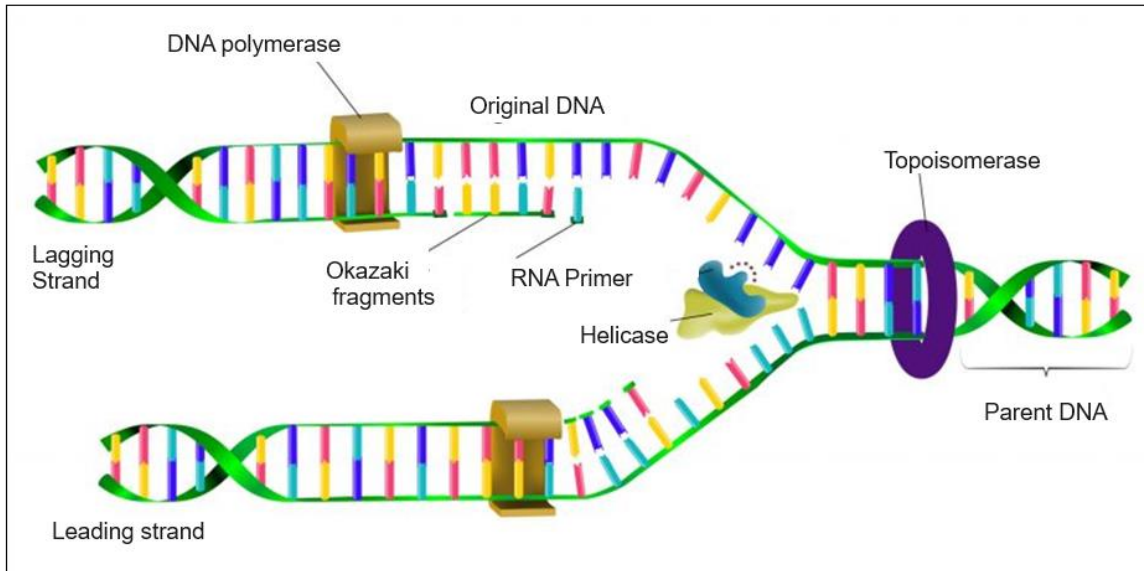
GENE EXPRESSION

QUESTION ONE:

DNA STRUCTURE AND REPLICATION

The diagram below illustrates DNA replication. Use it to answer the questions that follow:

Figure 3 : DNA replication



Source: <https://www.biologyonline.com/tutorials/dna-structure-dna-replication>

- a. Outline the process of DNA replication as illustrated above.

Skill level 3	
3	
2	
1	
0	
NR	

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

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION TWO: MUTATIONS

The redundancy of the genetic code is shown in the table of mRNA below.

Figure 4: mRNA table showing corresponding amino acids

		Second nucleotide					
		U	C	A	G		
First nucleotide	U	UUU Phe UUC UUA Leu UUG	UCU UCC Ser UCA UCG	UAU Tyr UAC UAA STOP UAG STOP	UGU Cys UGC UGA STOP UGG Trp	U	
	C	CUU CUC Leu CUA CUG	CCU CCC Pro CCA CCG	CAU His CAC CAA Gln CAG	CGU CGC Arg CGA CGG	C	
	A	AUU AUC Ile AUA AUG Met	ACU ACC Thr ACA ACG	AAU Asn AAC AAA Lys AAG	AGU Ser AGC AGA AGG Arg	A	
	G	GUU GUC Val GUA GUG	GCU GCC Ala GCA GCG	GAU Asp GAC GAA Glu GAG	GGU GGC Gly GGA GGG	G	

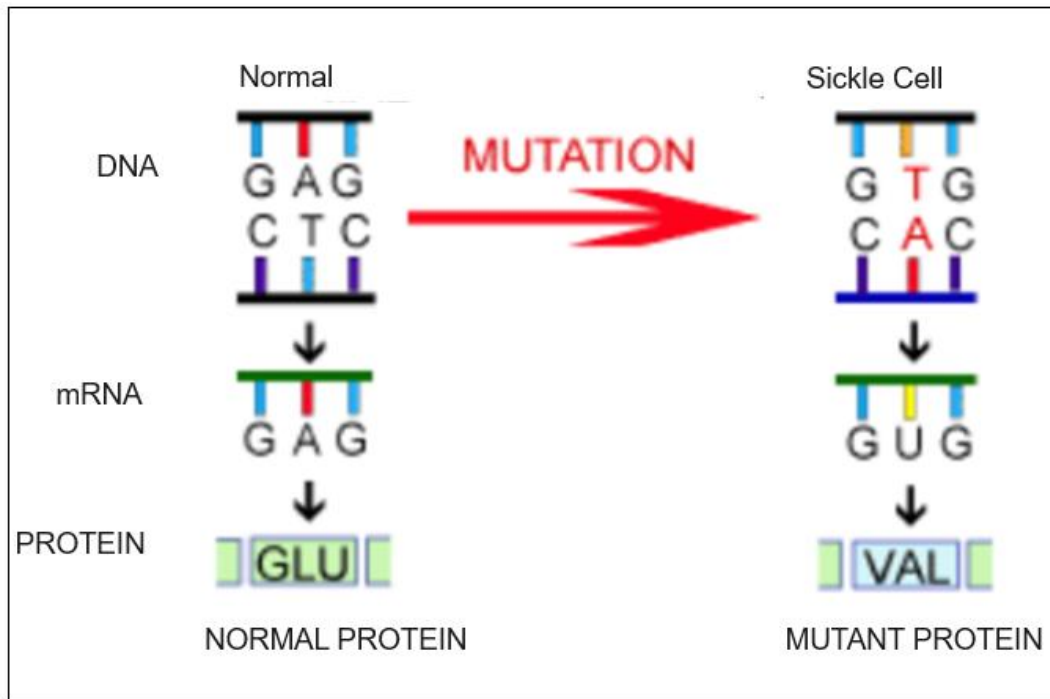
Source: <https://www.nature.com/scitable/topicpage/the-information-in-dna-determines-cellular-function6523228/#:~:text=Redundancy%20in%20the%20genetic%20code,CUC%2C%20CUA%2C%20and%20CUG.>

a. Explain how redundancy of the genetic code buffers gene mutation.

Skill level 3	
3	
2	
1	
0	
NR	

The diagram below shows a gene mutation that occurred where the normal gene that formed the normal protein was changed and formed a mutant protein.

Figure 5: Illustration of how gene mutation occurs



Source: Solved Sickle-cell anemia is caused by a point mutation in | Chegg.com

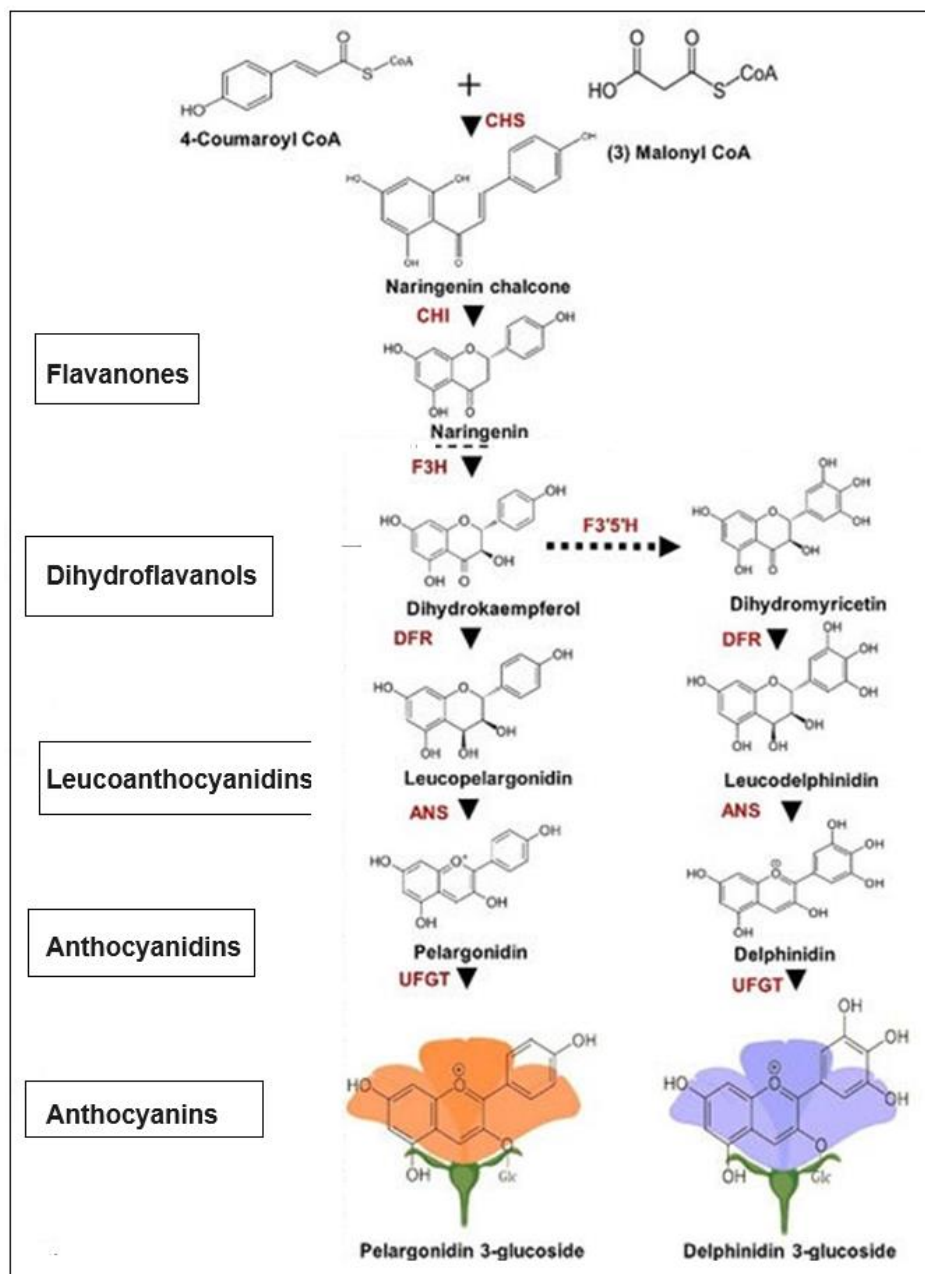
b. Explain how this gene mutation can be considered harmful.

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION THREE: GENE – GENE INTERACTION

In *Hydrangea macrophylla*, the color of the flowers is primarily influenced by the **anthocyanin biosynthesis pathway** illustrated below. This pathway is responsible for the production of anthocyanins, which are pigments that make the flowers to appear red, purple, or blue colour.

Figure 6: Anthocyanidins biosynthesis pathway



Source: [Schematic representation of the anthocyanin biosynthesis pathway... | Download Scientific Diagram \(researchgate.net\)](#)

Enzymes are regulatory genes involved in the biosynthesis pathway and are shown in red writings in the diagram, namely:

- CHS-chalcone synthase;
- CHI-chalcone isomerase;
- F3H-flavanone 3-hydroxylase;
- F3 H-flavonoid 3 -hydroxylase;
- F3 5 H-flavonoid 3 5 -hydroxylase;

-
- 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.

The colors of the Hydrangea flowers can change based on the pH of the soil and the presence of aluminum ions. Acidic soils with available aluminum results in blue flowers while alkaline soils lead to pink flowers.

Figure 7: Varieties of hydrangea flowers



Source: Blue Hydrangea - Image Abyss (alphacoders.com)

Source: Flower, Pink Hydrangea Free Stock Photo - Public Domain Pictures

b. Explain the effects of the environment on the flower colors of the hydrangea.

Skill level 3	
3	
2	
1	
0	
NR	

QUESTION FOUR: MENDELIAN INHERITANCE

a. Differentiate between incomplete dominance and co dominance.

Skill level 3	
3	
2	
1	
0	
NR	

b. Researchers can use linkage to find the location of a gene on a chromosome by looking at how often different genes are inherited together, researchers can create maps of the relative distances between them.

Define **'linked genes'**.

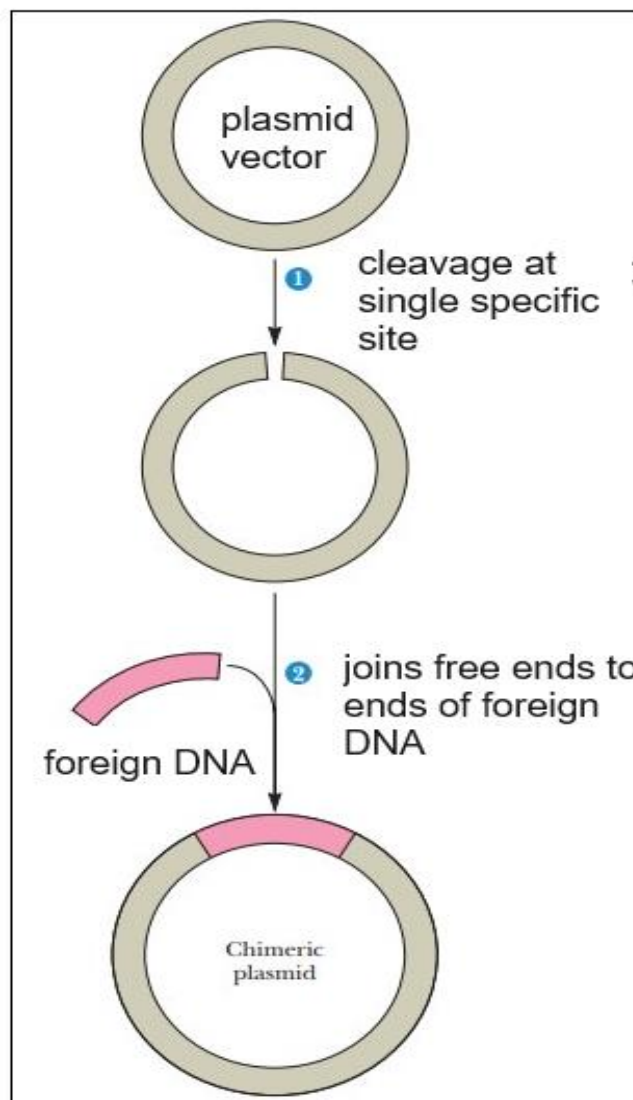
Skill level 1	
1	
0	
NR	

SECTION C: BIOTECHNOLOGY APPLICATIONS

QUESTION ONE:

The production of recombinant DNA to clone is illustrated below:

Figure 8 : Illustration of how Recombinant DNA is formed



Source: https://www.brainkart.com/article/Cloning_27581/

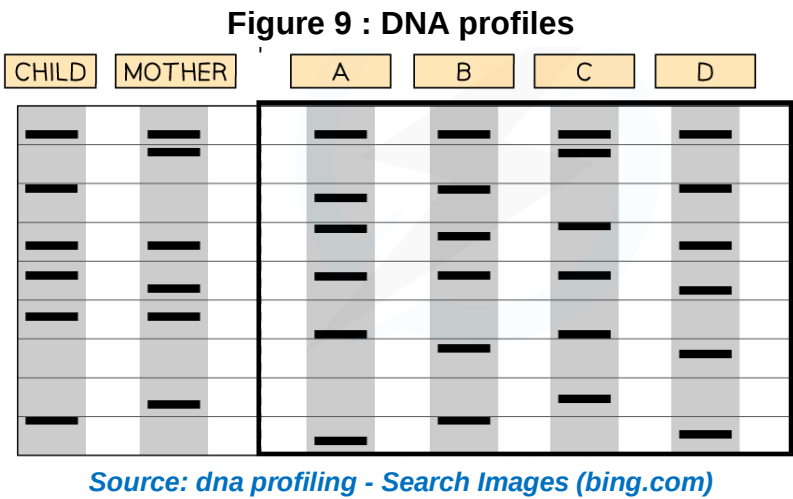
- a. Describe how recombinant DNA is formed using techniques of restriction enzymes and ligation.

Skill level 2	
2	
1	
0	
NR	

- b. Define 'gene cloning'.

Skill level 1	
1	
0	
NR	

c. The diagram below illustrates profiles of DNA from four different suspects in a paternity test:



Explain the positive and negative impacts of DNA profiling.

Skill level 3	
3	
2	
1	
0	
NR	

SECTION D:

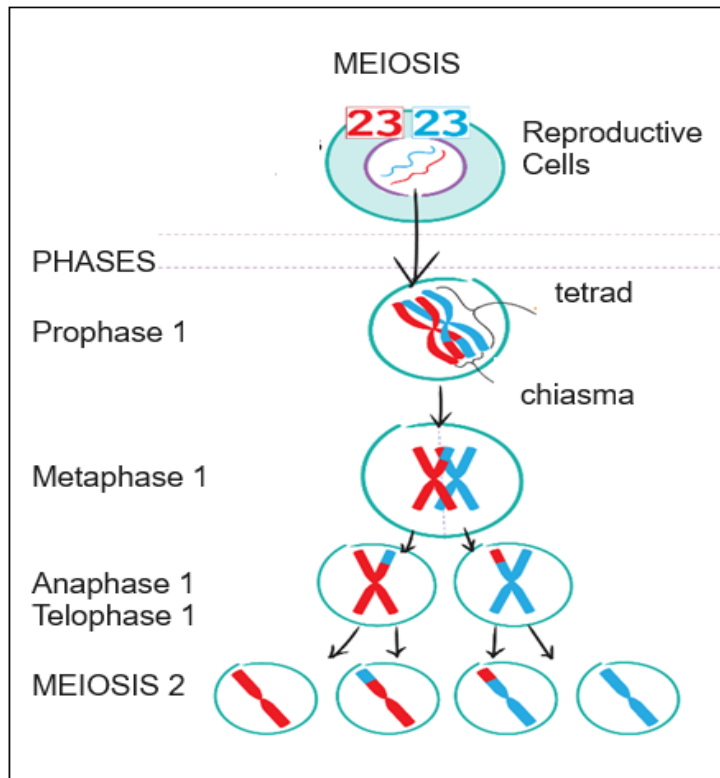
PATTERNS OF EVOLUTION

QUESTION ONE:

VARIATION AND NATURAL SELECTION

The diagram below illustrates the type of cell division, meiosis. Use it to answer the questions that follow:

Figure 10 : Illustration of process of meiosis



Source: Meiosis Diagram A Level Biology (windows.net)

- a. Describe the role of meiosis in producing variation as shown in the diagram above.

Skill level 2	
2	
1	
0	
NR	

- b. State the role of mutation in producing variation.

Skill level 1	
1	
0	
NR	

- c. Describe the main ideas in the theory of natural selection as proposed by Darwin.

Skill level 2	
2	
1	
0	
NR	

QUESTION TWO: GENE POOL AND ALLELE FREQUENCY

a. List the factors that affect allele frequency.

Skill level 2	
2	
1	
0	
NR	

b. Describe the features of founder effect.

Skill level 2	
2	
1	
0	
NR	

QUESTION THREE: SPECIATION

Birds of Paradise found in New Guinea have some of the most extravagant courtship displays. Each species has its own unique combination of dances, poses and feather displays.

Figure 11: Birds of Paradise

	
The Vogelkop superb bird of paradise, a distinct species prepares to begin his mating dance by shuffling its feet in quick little motions, gliding from side to side.	The superb bird of paradise flips the feathers on their back—called their cape—and dance in semi-circles. It deeply bends its knees and bounces.

Source: *Superb Bird of Paradise – Facts, Size, Sounds, Habitat, Pictures (animalspot.net)*

- a. Describe the feature of pre-zygotic isolating mechanism displayed by the two species of the birds of paradise.

Skill level 2	
2	
1	
0	
NR	

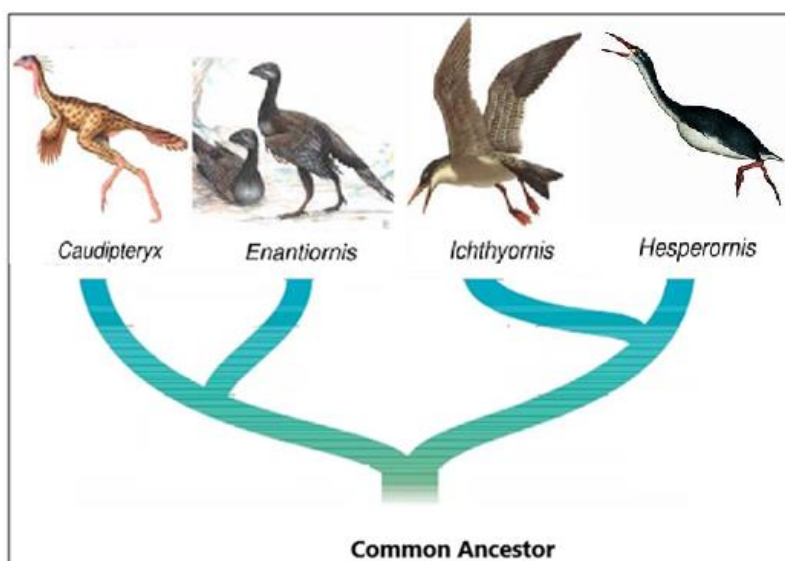
- b. Describe the features of hybrid sterile.

Skill level 2	
2	
1	
0	
NR	

QUESTION FOUR: PATTERNS OF EVOLUTION

Study the pattern of evolution shown in the pictures below and use it to answer the question that follow:

Figure 12: Evolution of birds



Source: PPT - The Evolution of Birds & the Origin of Flight PowerPoint Presentation - ID:4743914 (slideserve.com)

Describe the features of the evolution pattern illustrated in the diagram above.

Skill level 2	
2	
1	
0	
NR	