Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Chemistry and Biology RAS 2023

92022 Demonstrate understanding of genetic variation in relation to an identified characteristic

EXEMPLAR

Merit

TOTAL 06

Part A:

Sexual reproduction is when a female gamete (egg) is fertilized by a male gamete (sperm) and become a zygote, this process combines genetic material from two different individuals (23 chromosomes form father and 23 from mother), leading to siblings with a unique combination of alleles. Mutation is when the DNA sequence is changed, it can happen by errors in DNA replication, viral infection and chemical or radioactive substances or other things and they are the source of new genetic information.

Mutation introduces new genetic variations through changes in DNA sequence, such as point mutations, insertions, deletions, and gene duplications. Sexual reproduction combines genetic material from two parents through processes like cell division, and random fertilization, resulting in unique combinations of alleles in offspring. Both mutation and sexual reproduction contribute to genetic diversity within populations, contributing to evolution and adaptation.

The genotype in humans refers to the genetic information an individual inherits from their parents. It consists of the specific alleles (versions of genes) present in an individual's DNA. These alleles determine the potential traits an individual can express, genotype is not directly observable. The phenotype in humans is the observable physical and functional traits of an individual, resulting from the interaction between their genotype and environmental factors, in the genotype we can have dominant genes or recessive genes, when you have recessive gene and one dominant your phenotype will be of this dominant gene, you only would have a recessive gene in your phenotype if your genotype genes were two recessives. Phenotypes can include traits such as hair colour, height, and susceptibility to certain diseases. An example of this variation is my father because his mother has green eyes (represented as “bb”), but his father has brown eyes (could be represented as “Bb” or “BB”, but in his case my grand grandparents’ had brown eyes, so it is “BB”), as the genes of brown are dominant and the genes of green eyes are recessive his phenotype is for brown eyes, but in his genotype we will find the genes of green eyes (represented as “Bb”), so if his father had green eyes too, he would have green eyes because would be two recessive genes.

Genetic variation helps populations survive and flourish. When environments change, some individuals with certain traits can have better chances of surviving and reproducing. This ensures that the population can adapt over time. Additionally, genetic diversity helps in the fight against diseases. If everyone had the same genetic makeup, a single disease could affect everyone the same way. But with variation, some individuals might be naturally resistant, which helps prevent widespread outbreaks. This could be seen in the Pandemic of Coronavirus where some people were asymptomatic, and others died or had severe health problems.

Part B:

The genetic information obtained from the kakapo population is highly significant for several critical reasons. By studying their genetic makeup, scientists can gain a deep understanding of the extent of genetic diversity within the population. This knowledge is essential for designing effective conservation strategies that aim to prevent inbreeding and ensure the long-term survival of a healthy population. Understanding the genetic composition not only helps to prevent inbreeding, which occurs when closely related individuals reproduce, but also reduces the risk of decreased genetic diversity and the resulting emergence of genetic disorders. This data is crucial for developing breeding programs that often play a key role in boosting the populations of endangered species. These programs are guided by genetic information, assisting in the selection of suitable breeding

pairs to maximize genetic diversity while avoiding the mating of closely related individuals. Moreover, by examining the DNA of kakapos, it becomes possible to identify increased vulnerability to specific pathogens, empowering conservationists to take proactive measures against disease threats.

The genetic relationships highlighted by this data are pivotal in shaping the breeding program. By assessing the level of inherent genetic diversity within the species, steps can be taken to prevent health problems and diminished fitness resulting from inbreeding. This involves purposeful breeding of kakapos like Richard Henry, who exhibited genetic variations distinct from other individuals. This approach ensures reduced relatedness and enhances genetic diversity, which are critical for maintaining the species' resilience. Additionally, individuals well-suited for breeding may possess genetic markers associated with disease resistance and other favourable traits. This guides the selection of mating pairs, strengthening the overall health of the population while avoiding the transmission of harmful genetic traits.

For the next steps of kakapo conservation, I would recommend regularly monitoring the species' genetic diversity and overall health remains crucial. This enables conservationists to make informed decisions based on updated genetic insights. The ongoing execution of the breeding program, utilizing the wealth of genetic data, should consistently prioritize breeding pairs that optimize genetic diversity and minimize the risks of inbreeding. Public awareness initiatives are pivotal, emphasizing the importance of kakapo conservation in broader communities. Furthermore, conservation strategies should remain adaptable, evolving alongside emerging genetic information. It's important to recognize that the genetic diversity fostered through the breeding program enhances the species' ability to adapt, helping against extinction. The most important goal is to reintroduce the species to its natural habitat for sustained and self-sufficient survival.

Merit

Subject: Chemistry and Biology

Standard: 92022

Total score: 06

Q	Grade score	Marker commentary
(a)	M6	This response sits at Merit level because the candidate accurately defines key ideas (e.g. sexual reproduction, mutation, genotype / phenotype), and has explained how genetic variation occurs and the implications of this.
(b)		The candidate has explained how information from genetic relationships can inform the breeding programme. They explain that information about relatedness can inform the breeding of individuals that are less closely related, with the intention of reducing in-breeding in this small population.