SUPERVISOR'S USE ONLY

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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 1 Chemistry and Biology 2025

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

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of genetic variation in relation to an identified characteristic.	Explain genetic variation in relation to an identified characteristic.	Evaluate genetic variation in relation to an identified characteristic.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

QUESTION ONE: Chromosomes, genes, alleles, and DNA

The cystic fibrosis transmembrane conductance regulator (CFTR) gene in humans is responsible for mucus production in the human body.

The normal allele (F) is dominant over the mutant allele (f) in humans. Individuals who are homozygous recessive will develop cystic fibrosis, a condition where too much mucus is produced, which can cause difficulty breathing.

Figure 1: Location of the CFTR gene on a pair of chromosomes

(a) Explain the relationship between chromosomes, genes, alleles, and DNA. Include examples in your answer.

(b) (i) Define the term **mutation**.

(ii) Discuss how genetic variation has occurred in the CFTR gene.

In your answer, include:

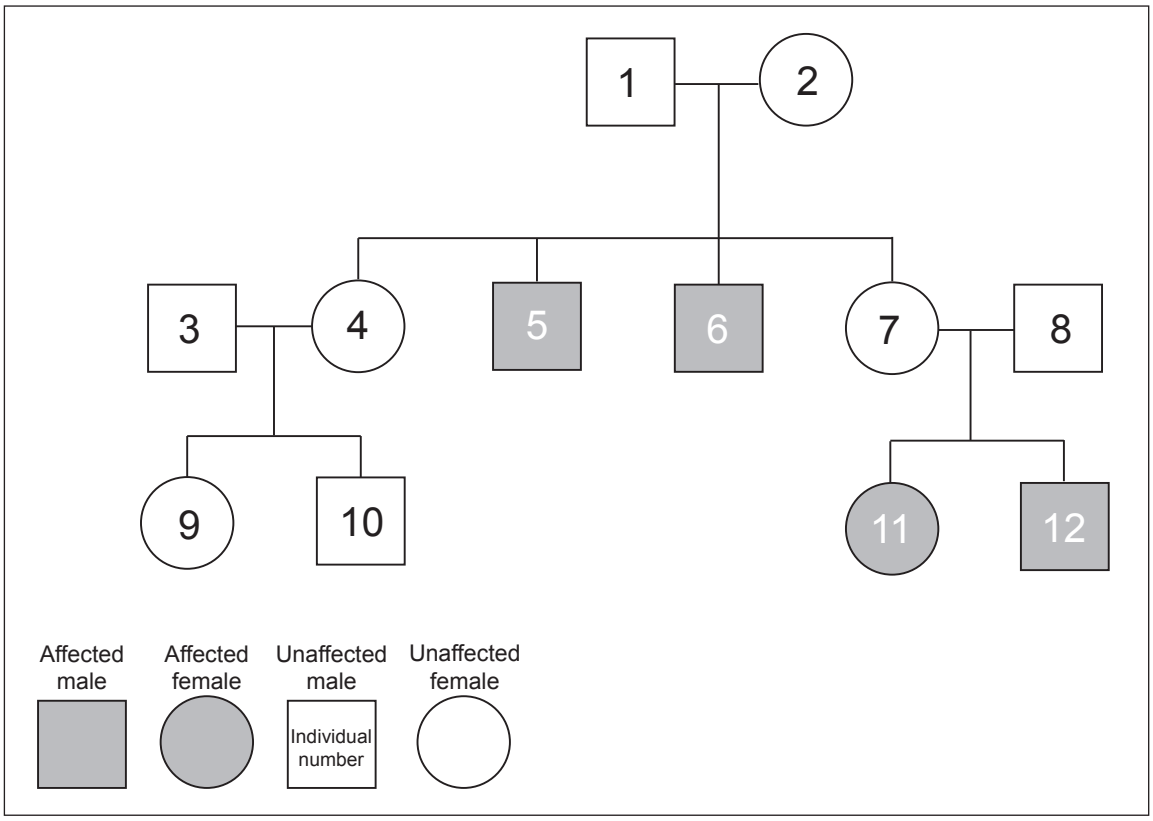
- the difference between phenotype and genotype
- the difference between heritable and non-heritable variation.

QUESTION TWO: Tracking the cystic fibrosis allele

Cystic fibrosis is a heritable genetic disease in humans. It is caused by a recessive allele (f). The normal allele (F) is dominant over the mutant allele (f).

Figure 2 is a pedigree chart tracking the inheritance of cystic fibrosis in a family.

Figure 2: Inheritance of cystic fibrosis



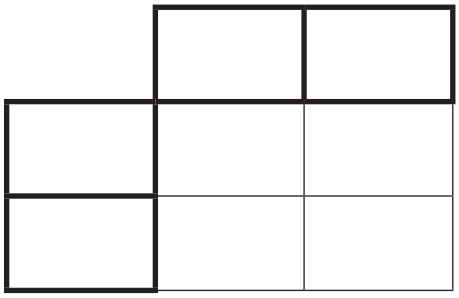
(a) (i) What are the possible genotypes of an individual who **does not** have cystic fibrosis?

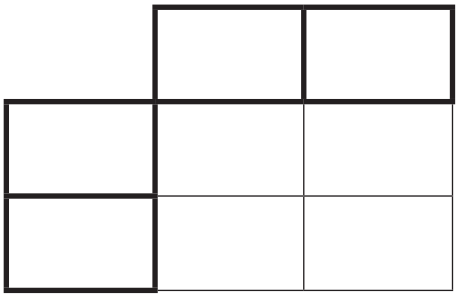
(ii) Fill in the table below with the genotype(s) of the numbered individuals from Figure 2.

	Genotype		
Individual 4		*or*	
Individual 5			
Individual 7			

(b) How are scientists able to confirm the genotype of individual 7 from Figure 2?
Support your answer using evidence from both the parents of individual 7 **and** the children of individuals 7 and 8.

Use Punnett squares to support your answer.





(c) Discuss the purpose of identifying the genetic relationship for the genotype(s) of individual 4 from Figure 2.

In your answer, consider:

- the possible genotype(s) of individual 4 by referring to individual 10
- the purpose for tracking the cystic fibrosis allele in this family in relation to individual 4.

Answer space continues on the next page ➤

QUESTION THREE: Continuation in the population

The normal cystic fibrosis transmembrane conductance regulator (CFTR) allele (F) is dominant over the mutant allele (f). Homozygous recessive individuals will develop cystic fibrosis. Homozygous dominant and heterozygous individuals will not be affected.

(a) Explain how meiosis, sexual reproduction, and non-random mating can contribute to the continuation of the recessive allele (f) in the population.

Question Three continues on the next page ➤

(b) Discuss how the CFTR mutant allele (f) remains in the population.

In your answer, consider:

- if the occurrence of the recessive allele (f) will increase, decrease, or stay the same over time
- why an increase in the frequency of recessive alleles (f) in a population does not always lead to an increase in the frequency of the cystic fibrosis phenotype.

Acknowledgements
Material from the following source has been adapted for use in this assessment:

Figure 1 https://stock.adobe.com/335315205, https://stock.adobe.com/763873950

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