2

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91157

911570

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
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Level 2 Biology, 2015

91157 Demonstrate understanding of genetic variation and change

9.30 a.m. Monday 16 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of genetic variation and change.	Demonstrate in-depth understanding of genetic variation and change.	Demonstrate comprehensive understanding of genetic variation and change.

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 space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

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

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Low Achievement

TOTAL 11

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QUESTION ONE: BLACK ROBINS

http://nzbirdsonline.org.nz/species/black-robin

Introduced species such as cats and rats caused the Chatham Island black robin (*Petroica traversi*) population to plummet to five individuals in 1980. Due to intensive conservation efforts, the species now has over 250 individuals in the gene pool.

(a) Describe the term gene pool.

Gene pool is a term that refers to the alleles that are established and present within a population.

(b) Explain how genetic drift affects the black robin's gene pool.

Genetic drift is the random loss of alleles through chance rather than migration and environmental disasters. Because the black robins gene pool is small the alleles within the gene pool are not very stable and can easily be affected through mating and death of a few of the birds causing genetic drift.

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(c) Female black robins usually lay eggs inside their nests. However, conservationists found some birds laid eggs on the rims of nests, where the eggs could not survive. So, they pushed the eggs back into the nests where they could be incubated and hatch successfully. However, this selection pressure from humans caused the rim laying allele to increase to 50% in the black robin population. They decided to stop pushing eggs back into the nests to prevent the behaviour from spreading throughout the population. In 2011 only 9% of the population laid eggs on the rims of nests.

Nest showing egg laid on rim.
www.math.canterbury.ac.nz/~r.sainudiin/preprints/plos_br_preprint.pdf

Discuss why some female black robins lay eggs on the rims of nests, while most lay eggs inside the nests, and how humans affected this behaviour.

artificial

In your answer include:

- a description of what allele and allele frequency mean
- an explanation of what selection pressures are, and how they affect natural selection
- a discussion of natural selection using the black robin egg laying example
- a discussion of why the rim laying behaviour increased with human intervention, then decreased once the intervention stopped.

Due to human action some robins lay eggs on the rim of their nest while most lay in the nest. Allele is an alternate form of gene and allele frequency is the amount of times a specific allele occurs in a gene pool. Selection pressures ~~are things~~ when refers to favourable phenotypes are selected for or when certain environmental factors change / alter requiring the organism to adapt to meet the requirements of the selection pressure. Selection pressures of an environment affect natural selection as they decide what phenotypes are better suited for the environment and therefore ~~[illegible]~~ naturally selected for. Natural selection is the process by where favourable phenotypes are selected

There is more space for your answer to this question on the following page.

for and the unfavourable phenotypes eventually die out. The rimlaying phenotype was an unfavourable phenotype as it caused eggs to ~~[illegible]~~ die. Eventually this phenotype for rimlaying was selected against and the black robins that layed eggs ~~on~~ within the nest was selected for. ~~Thus~~ Due to natural selection of this phenotype + therefore allele, the rimlaying trait has since plummeted with very few black robins sho[wing] in ~~the~~ this particular phenotype. Because the humans intervened to conserve the black robin population the rimlaying phenotype was not recognised as unfavourable ~~to~~ by the population. Thus ~~resu~~ naturally resulting in an increase of this trait. However when humans realised that their artificial selection pressures and conservation efforts were not beneficial to the species ~~and~~ they stopped. The rimlaying behaviour continued to expressed but it meant the species was able to ~~nog~~ recognise it as unfavourable due to the eggs not surviving and then selected against this trait. This is why the traid decreased ~~[illegible]~~ when human ~~se~~ selection pressures stopped as the environment and species were able to naturally select against it.

~~Which carried [illegible] meant that subsequent generations~~

QUESTION TWO: BLOOD TYPE

There are multiple alleles that determine a human's blood type. These are known as I^A, I^B and i^O. Alleles I^A and I^B are dominant over i^O. However, when I^A and I^B are inherited together, they show co-dominance.

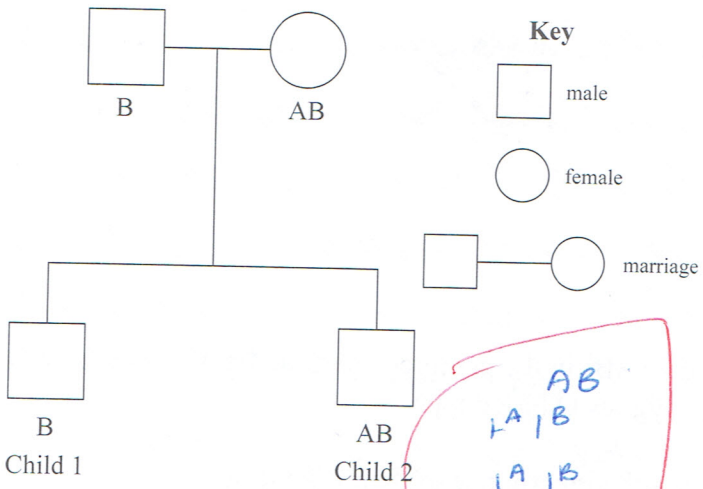
(a) Describe what multiple alleles are.

Multiple alleles is when there is more than two alleles for one one gene

(b) The pedigree chart below shows the two children and their phenotypes that result from a male with phenotype B and a female with phenotype AB.

Blood Types

Phenotype	Genotype
A	I^AI^A, I^Ai^O
B	I^BI^B, I^Bi^O
AB	I^AI^B
O	i^Oi^O



B = I^BI^B, I^Bi^O
I^BI^B I^Bi^O

AB
I^AI^B
I^AI^B

Explain why Child 1 has two possible genotypes while Child 2 has only one possible genotype.

You may use diagrams in your answer.

Child 1 has two possible genotypes because as there are two allele combinations that code for that specific blood group. B = I^BI^B, I^Bi^O when you cross these alleles ~~I^BI^B~~ you end up with the same two genotypes. Where as blood group AB has only one possible genotype as there

There is more space for your answer to this question on the following page.

only one allele combination that codes for that specific blood group (not multiple alleles for group AB)

(c) Child 2 (AB) in the pedigree chart on the previous page has children with a female having homozygous O blood type.

Discuss the inheritance of their offspring.

In your answer include:

- the possible phenotypes AND genotypes of the offspring
- an explanation of the difference between dominance and co-dominance
- a discussion of why none of their children will have the blood type O or AB.

You may use diagrams in your answer.

$I^A I^B \times i^O i^O$

$i^O I^A$

$i^O I^B$

If child AB were to mate with a homozygous dominant O blood type individual they would have two possible ~~gene~~ genotypes and phenotypes. Being, $I^A i^O$ which codes for the

phenotype blood group A and I^Bi^o which codes for the phenotype blood group B. Co-dominance and dominance occur in the presence of homozygous dominant alleles. Dominance is when one dominant allele completely masks the recessive allele and is fully expressed. however when you have 2 dominant alleles. co-dominance can occur. co-dominance is when both of the genotypes are fully expressed when creates a 3rd phenotype none of their children will have the blood type O or AB as these genotypes cannot possibly make the genotype for those blood groups. Due to the presence of both the i^o and I^AI^B alleles within their genotype the possible combinations for their children will never fit the requirements for O or AB as they only have I^AI^B for AB and i^oi^o for blood group O making it impossible for the offspring to naturally produce children with these genotypes.

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QUESTION THREE: COAT COLOUR

In 1905, Lucien Cuénot observed unusual ratios when studying inheritance of coat colour in mice. After mating two heterozygous yellow mice (Yy), he observed that the offspring never showed a normal 3:1 phenotypic ratio. Instead, he always observed a 2:1 ratio, with two yellow mice for every grey mouse. He concluded that yellow coat colour (Y) was dominant over grey coat colour (y), and by using test crosses he showed that all his yellow mice were heterozygotes. However, from his many crosses, Cuénot never produced a single homozygous dominant yellow mouse.

www.themouseconnection.org/t955-what-are-these-sooty-colors

Subsequently, it was confirmed that no homozygous dominant yellow mice were present because of a lethal allele.

(a) Describe a lethal allele(s).

A lethal allele is an allele that if expre will cause the death of an organism due to its inability to form a functiona protein

(b) Discuss how Cuénot used test crosses to determine that all the live yellow mice were heterozygous.

In your answer include:

- a description of homozygous AND heterozygous
- an explanation of what a test cross is
- a discussion of how Cuénot used the test crosses to observe a 2:1 ratio (two yellow mice for every grey mouse), and determine that all live yellow mice were heterozygous.

You may use diagrams in your answer.

Homozygous shows two of the same allele in the genotype ie ~~aaaaaa~~ yy or YY. Hetero zygous is a genotype that has one of each allele represented. ie: Yy. a test cross is a way of predicting offspring when your know the genotype of a single org anism ie: ~~when Cuenot crossed the~~ or both of the mating partners phenotype

for example:

	X	y
X	XX	Xy
y	Xy	yy

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(c) The genetic disease cystic fibrosis is caused by lethal alleles. An affected individual is homozygous recessive, however heterozygous individuals are carriers of the lethal allele. Lethal alleles are caused by mutations. The mutation for cystic fibrosis occurs in the gametes.

Discuss how mutations cause lethal alleles, AND why cystic fibrosis alleles remain in the population.

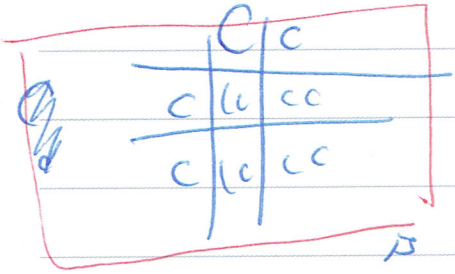
In your answer include:

- a description of what a mutation is
- an explanation of the difference between a gametic mutation and a somatic mutation
- a discussion of why the cystic fibrosis lethal allele remains in the human population.

A mutation is a random permanent change to the base sequence of ~~and~~ an individuals DNA. A gametic mutation is a mutation that occurs in the gametes ie: sperm and egg, and can be inherited by subsequent generations and become established in a gene pool. Somatic mutations can occur in all body cells except the gametes. It is not inheritable as it doesn't enter the gene pool and only affects

There is more space for your answer to this question on the following page.

the individual at which the mutation is in. The cystic fibrosis allele still remains in the human population due to carriers of the lethal allele. Carriers are individuals who carry the allele and have the ability to pass it on to their ~~offspring~~ offspring but does not express it due to having a different genotype. Due to the fact that carriers of the lethal allele have the ~~genotype~~ have the heterozygous genotype they would have to mate (for CF) with a homozygous recessive partner in order for the gene to have a possibility of be expressed. even then the ratio of and chance for the ~~gene~~ lethal allele to be expressed is 1:1 or 50%. This is why it still remains present in the population as it is carried by individuals who have the heterozygous phenotype and have the ability to produce homozygous recessive offspring.



Annotated Exemplar Template

Achieved exemplar for 91157 - 2015		Total score	11
Q	**Grade score**	**Annotation**	
1	4	Provides 4 definitions correctly in (a) (b) and (c). Has basic description of Natural selection. Explanation lacks any evidence linking ideas as to why the "phenotypes" of Rim Laying are selected against or Nest laying is selected for through natural selection in terms of genes /alleles in their response.	
2	2	Provides correct definition for Multiple alleles and dominance. Answer to part (b) just repeats information from table given instead of linking to the pedigree chart and gametes of parents. Part (c) also lacks link to gametes inherited from parents.	
3	5	Provides 3 of the definitions in each of (a) (b) and (c). Explains the difference between gametic and somatic mutations correctly. Punnet square indicates a cross between a heterozygous individual and a homozygous individual rather than 2 heterozygous individuals.	

91157

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2

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High Achievement

TOTAL 12

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QUESTION ONE: BLACK ROBINS

http://nzbirdsonline.org.nz/species/black-robin

Introduced species such as cats and rats caused the Chatham Island black robin (*Petroica traversi*) population to plummet to five individuals in 1980. Due to intensive conservation efforts, the species now has over 250 individuals in the gene pool.

(a) Describe the term gene pool.

A gene pool is the total set of alleles in organes in a ~~population~~ species population

(b) Explain how genetic drift affects the black robin's gene pool.

Genetic drift occurs when a group of individuals emigrate or are isolated or are dramatically decreased. This affects the black robin's genepool as when genetic drift occurs genes are lost therefore meaning less genetic variation in their species.

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(c) Female black robins usually lay eggs inside their nests. However, conservationists found some birds laid eggs on the rims of nests, where the eggs could not survive. So, they pushed the eggs back into the nests where they could be incubated and hatch successfully. However, this selection pressure from humans caused the rim laying allele to increase to 50% in the black robin population. They decided to stop pushing eggs back into the nests to prevent the behaviour from spreading throughout the population. In 2011 only 9% of the population laid eggs on the rims of nests.

Nest showing egg laid on rim.
www.math.canterbury.ac.nz/~r.sainudiin/preprints/plos_br_preprint.pdf

Discuss why some female black robins lay eggs on the rims of nests, while most lay eggs inside the nests, and how humans affected this behaviour.

In your answer include:

- a description of what allele and allele frequency mean
- an explanation of what selection pressures are, and how they affect natural selection
- a discussion of natural selection using the black robin egg laying example
- a discussion of why the rim laying behaviour increased with human intervention, then decreased once the intervention stopped.

An allele is the expressive form of a gene and allele frequency is how often that gene occurs in the gene pool. Selection pressures are things that influence natural selection. For example a selection pressure that occured with the Chatham Island Black Robin would be the ~~humans~~ conservationists pushing the eggs back into the nest and then deciding later on that they should leave the eggs on the rim of the nest. Natural selection is the process whereby a favourable phenotype and genotype is selected and suited to the environment so it is able to reproduce the

There is more space for your answer to this question on the following page.

more favourible phenotype of a species. For example natural selection occurs in the Chatham Island Black Robins when they lay an eggs. As the more favourible phenotype that was better suited to the environment was the birds gene to lay eggs in the centre of the nest instead of the rim, natural selection occured to keep the gene for laying eggs in the centre whilst removing the gene for laying on the rim.

The selection pressure of humans caused the allele for laying eggs on the rim of the nest to increase by 50%. ~~they~~ This is because they interfered with natural selection easily the gene for rim lay is to stay present in the gene pool instead of letting it be removed so that the centre laying was able to be more present and more available for the survival of the birds. As the conservationists relalised this they stopped interfering and in 2011 only 9% of the population laid Eggs on the rim of the nest.

QUESTION TWO: BLOOD TYPE

There are multiple alleles that determine a human's blood type. These are known as I^A, I^B and i^O. Alleles I^A and I^B are dominant over i^O. However, when I^A and I^B are inherited together, they show co-dominance.

(a) Describe what multiple alleles are.

(b) The pedigree chart below shows the two children and their phenotypes that result from a male with phenotype B and a female with phenotype AB.

Blood Types

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A	I^AI^A, I^Ai^O
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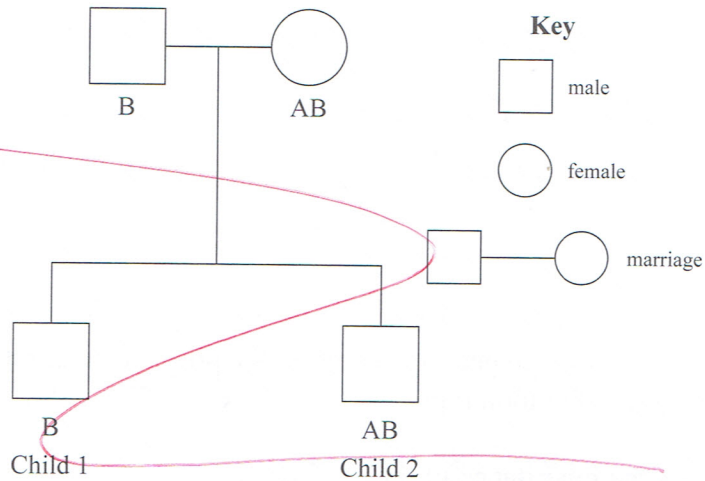
O	i^Oi^O



Explain why Child 1 has two possible genotypes while Child 2 has only one possible genotype.

You may use diagrams in your answer.

Child 1 is able to have 2 possible genotypes as here has the phenotype B. ~~As we are unable to know if~~ By having the phenotype B you can have 2 ~~different~~ possible genotypes (I^BI^B, I^Bi^O). Child 1 can either be a homozygous dominant or heterozygous for blood typeB. Child 2 on the

There is more space for your answer to this question on the following page.

other hand has the phenotype AB. There is only 1 possible ~~phen~~ genotype for this phenotype (I^AI^B). That is why child 2 can only have 1 possible genotype. ~~because there is heterozygous~~

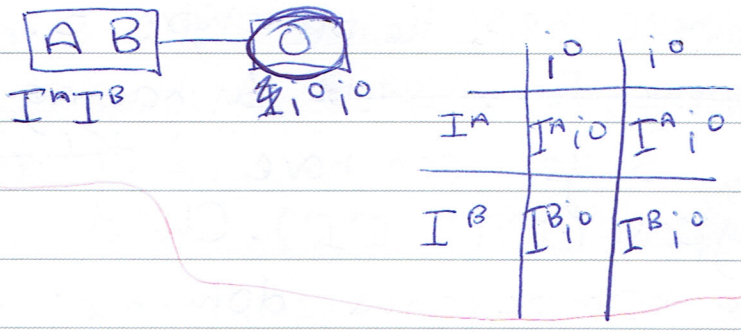
(c) Child 2 (AB) in the pedigree chart on the previous page has children with a female having homozygous O blood type.

Discuss the inheritance of their offspring.

In your answer include:

- the possible phenotypes AND genotypes of the offspring
- an explanation of the difference between dominance and co-dominance
- a discussion of why none of their children will have the blood type O or AB.

You may use diagrams in your answer.



The possible phenotypes of the offspring are 2 blood type A and

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2 blood type B. There genotypes are heterozygous for blood types A & B ($I^A i^o$ and $I^B i^o$).
The difference between dominence and codominence is that dominence is where one allele is dominant over the rest and that one allele if present with a recessive allele will overpower that allele and display the phenotype of the dominant.
Codominance is where 2 different alleles are able to overpower the recessive gene and if shown together can make an entirely new phenotype for example AB blood type.
None of the offspring will have the blood type O becase the 2 dominant alleles overpower the recessive i^o and there will be no blood type AB because the parent with blood type O has no dominant A or B allele meaning no offspring would be able to have the phenotype AB.

	i^o	i^o	
I^A	$I^A i^o$	$I^A i^o$	– Bloodtype A
I^B	$I^B i^o$	$I^B i^o$	– Bloodtype B

recessive genotype

N2

QUESTION THREE: COAT COLOUR

In 1905, Lucien Cuénot observed unusual ratios when studying inheritance of coat colour in mice. After mating two heterozygous yellow mice (Yy), he observed that the offspring never showed a normal 3:1 phenotypic ratio. Instead, he always observed a 2:1 ratio, with two yellow mice for every grey mouse. He concluded that yellow coat colour (Y) was dominant over grey coat colour (y), and by using test crosses he showed that all his yellow mice were heterozygotes. However, from his many crosses, Cuénot never produced a single homozygous dominant yellow mouse.

www.themouseconnection.org/t955-what-are-these-sooty-colors

Subsequently, it was confirmed that no homozygous dominant yellow mice were present because of a lethal allele.

(a) Describe a lethal allele(s).

Lethal alleles are deadly alleles. If lethal alleles appear together in an individual that individual will not survive. For example if (YY) were to be a genotype for an individual that individual would not survive.

(b) Discuss how Cuénot used test crosses to determine that all the live yellow mice were heterozygous.

In your answer include:

- a description of homozygous AND heterozygous
- an explanation of what a test cross is
- a discussion of how Cuénot used the test crosses to observe a 2:1 ratio (two yellow mice for every grey mouse), and determine that all live yellow mice were heterozygous.

You may use diagrams in your answer.

Homozygous and heterozygous are they way alleles are seen and shown through the phenotype of an offspring. For example 2 of the same alleles (YY or yy) are considered homozygous dominant (YY) and homozygous recessive (yy). While (Yy) is heterozygous and carries both the dominant trait and the recessive trait. A test cross is

Where you cross your unknown dominant with recessive so you ~~can~~ can determine whether the unknown is homozygous dominant or heterozygous. Cuenot used a test cross to observe a 2:1 ratio because if he were to get a 3:1 ratio the individual carrying the lethal allele would have to survive and that is not possible. He could determine that all live yellow mice were heterozygous as when they were crossed with a homozygous recessive at least one offspring was a grey recessive mouse

	Y	y
y	Yy	yy
y	Yy	yy

> grey recessive mouse

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(c) The genetic disease cystic fibrosis is caused by lethal alleles. An affected individual is homozygous recessive, however heterozygous individuals are carriers of the lethal allele. Lethal alleles are caused by mutations. The mutation for cystic fibrosis occurs in the gametes.

Discuss how mutations cause lethal alleles, AND why cystic fibrosis alleles remain in the population.

In your answer include:

- a description of what a mutation is
- an explanation of the difference between a gametic mutation and a somatic mutation
- a discussion of why the cystic fibrosis lethal allele remains in the human population.

A mutation is a change in genetic code in your DNA.

~~Here~~ A somatic mutation is caused in ~~cells~~ your body cells while a gametic mutation is caused in your sex cells (sperm for males, ova for females). Somatic mutations can not be inherited and will therefore not be present in the gene pool. Gametic mutations will however be inherited and the alleles will be present in the gene pool. Cystic fibrosis

There is more space for your answer to this question on the following page.

lethal alleles still remains in the human population because heterozygous individuals can still carry the lethal allele and reproduce with another individual who carries the lethal allele because even though they show the dominant trait of not having Cystic Fibrosis, they still carry it in their genotype so the lethal allele remains in the population because their offspring will also carry the lethal allele and it will stay in the ~~gene~~ gene pool.

Annotated Exemplar Template

Achieved exemplar for 91157 - 2015		Total score	12
Q	**Grade score**	**Annotation**	
1	4	Provides 2 correct definitions (a) and (c). Has some concept of Natural selection. Learner makes attempt to include an explanation of Natural Selection with links to alleles but does not provide sufficient evidence towards a discussion as to how future generations inherit favourable alleles required for survival.	
2	2	Answer to part (b) just repeats information from table given instead of linking to the pedigree chart and gametes of parents. Part (c) also lacks direct link to gametes inherited from parents. Response mentions dominance and Co dominance without explaining the link to parental gametes.	
3	6	Provides 4 of the definitions in each of (a) (b) and (c). Explains the difference between gametic and somatic mutations correctly. Has recognised the reason as to why carriers are able to produce offspring with Cystic Fibrosis, but fails to explain that it is caused by a recessive allele.	