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MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
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Level 1 Science, 2015

90948 Demonstrate understanding of biological ideas relating to genetic variation

9.30 a.m. Tuesday 10 November 2015
Credits: Four

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of biological ideas relating to genetic variation.	Demonstrate in-depth understanding of biological ideas relating to genetic variation.	Demonstrate comprehensive understanding of biological ideas relating to genetic variation.

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.

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Excellence

TOTAL 23

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QUESTION ONE: FAMILY PEDIGREES

ASSESSOR'S USE ONLY

Albinism in rats results in white fur and pink eyes. Albinism is caused by a recessive allele **a**.

(a) Complete the following diagram:

albino rat heterozygous black rat

[redacted]

Genotype aa Aa

Gametes a a A a

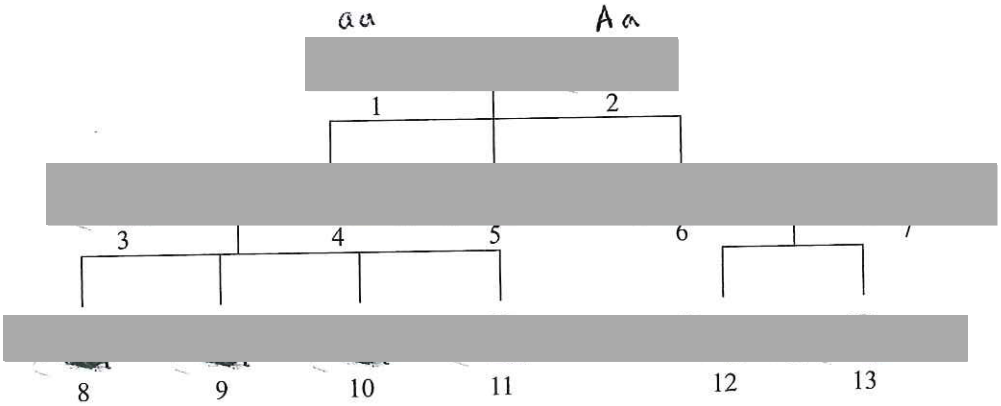
Genotype of offspring Aa aa Aa Aa

Aa
a | Aa aa
a | Aa aa

Correct Genotype Gametes + Genotype of offspring

Sources: www.janvier-labs.com/rodent-research-models-services/research-models/per-species/outbred-rats/product/sprague-dawley.html
www.nobuggy.com/pest-wiki/rats

(b) The albino rat and the heterozygous black rat produced the following two generations of offspring, as shown in the pedigree chart below.



What are the genotypes of the following rats?

Rat 4: aa //

Rat 6: Aa //

Rat 10: AA or Aa //

Incorrect as Rat 10 is offspring of homozygous recessive Rat 4.

(c) Rat 3 was **not** an offspring of Rat 1 and Rat 2 in the family tree.

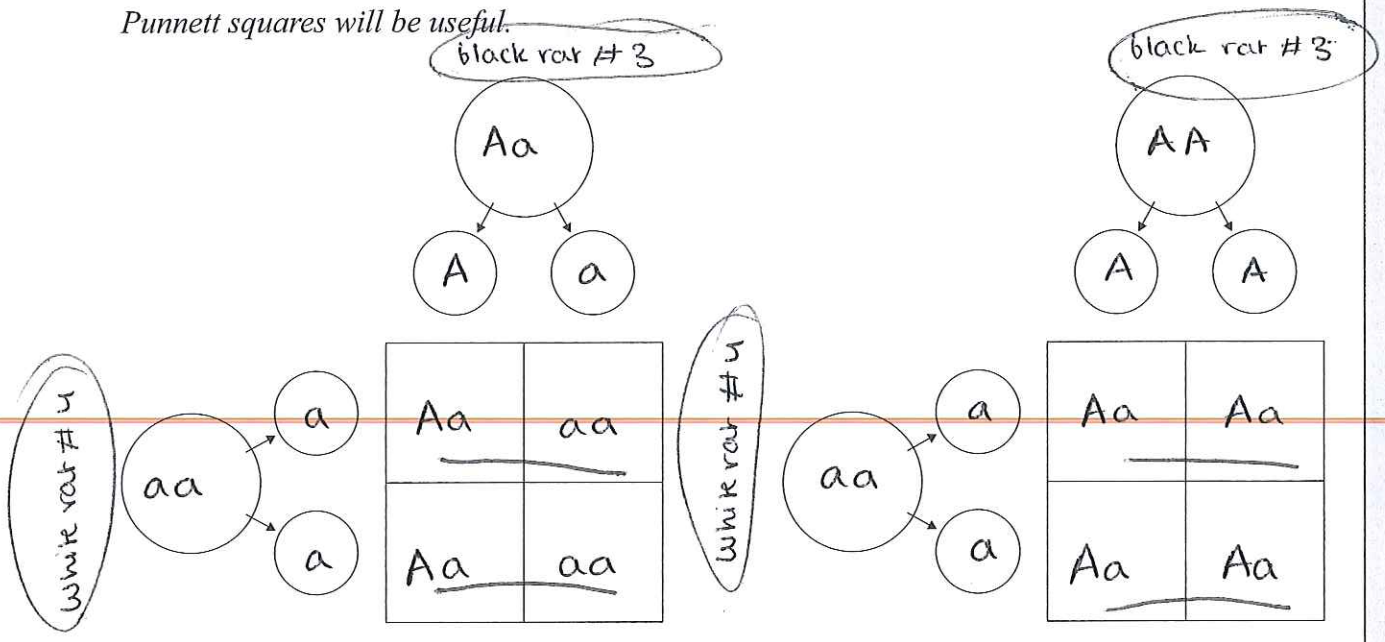
ASSESSOR'S USE ONLY

Give the possible genotypes for Rat 3 and explain which is the most likely genotype for Rat 3.

In your answer you should:

- state the possible genotypes for Rat 3
- explain why both genotypes are possible but one is more likely
- explain what you could do to be more certain about the genotype of Rat 3.

Punnett squares will be useful.



//Because Rat 3 has the phenotype of black fur, it either has the genotype Aa or AA. If Rat 3 is ~~homozo~~ heterozygous dominant, then according to the Punnett square on the left, there is a 50% chance of its offspring having black fur and a 50% chance of its offspring having white fur. However, if Rat 3 is homozygous dominant, then all of its offspring will have black fur. Looking at Rat 3 and 4's offspring (which all have black fur) it is highly likely Rat 3 is homozygous dominant because its 4 offspring are all black. But it is also possible that Rat 3 is heterozygous dominant and by chance, all its children have the dominant allele A for black fur. But it is very likely that Rat 3 is homozygous dominant because even though there's a 50% chance of offspring with the allele Aa if Rat 3 were heterozygous dominant, having 4 offspring in a row, all with black fur colour, is quite unlikely. Rat 3 being homozygous dominant is, therefore, a better fit. To find out the genotype of Rat 3, its genes could be taken a look at.//

Explains Rat 3 most likely AA

Explains possible Aa + how chance is, inherit of dominant allele

E1

QUESTION TWO: DNA, ALLELES, GENES, AND CHROMOSOMES

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A snail known as *Cepaea nemoralis* can have either a plain shell or a banded shell.

Plain shell

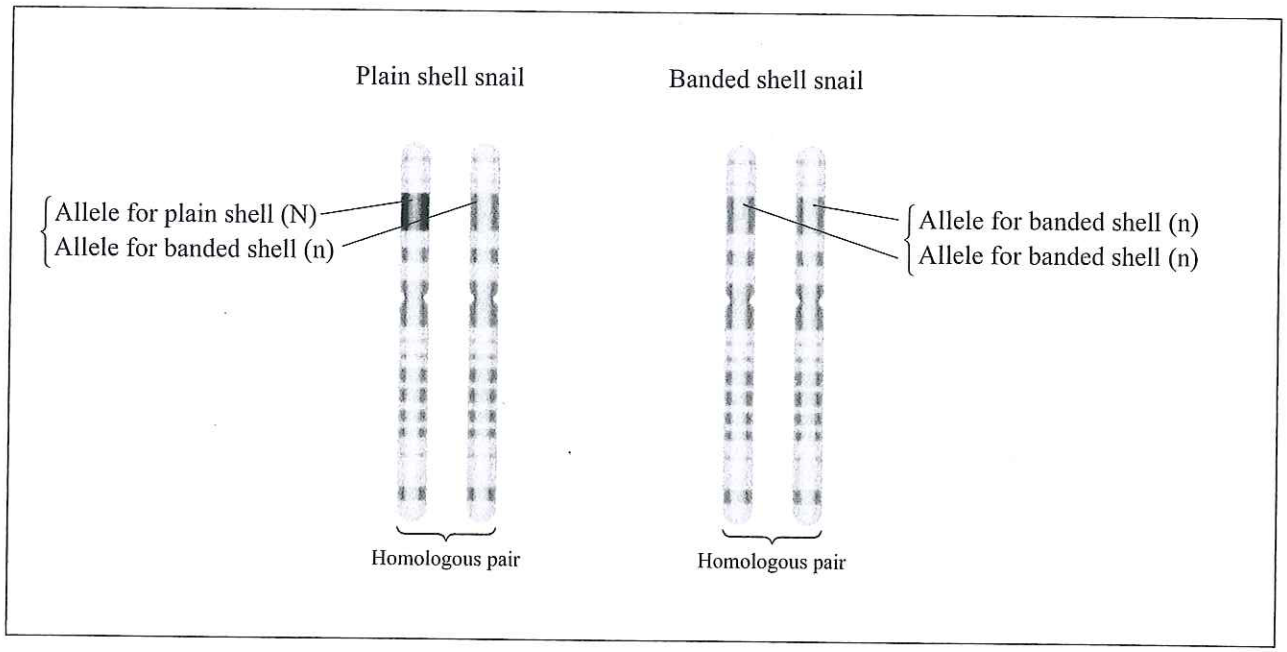
http://en.wikipedia.org/wiki/List_of_non-marine_molluscs_of_Ireland

Banded shell

http://de.wikipedia.org/wiki/Hain-B%C3%A4nderschnecke

The diagrams below show the homologous chromosomes that contain the gene for shell pattern for each of the snails in the photographs above.

Assume the allele for plain shell (N) is dominant over the allele for banded shell (n).



(a) In the diagram above, which snail is heterozygous for shell pattern?

The plain-shelled snail, because its genotype is Nn.

Explain why you chose this snail.

I chose the plain-shelled snail because it has a genotype Nn instead of NN or nn. Heterozygous means two different alleles. The banded-shelled snail is homozygous recessive because it has two of the same recessive alleles.

(b) Referring to the examples shown previously for shell pattern, explain the difference between an allele and a gene.

ASSESSOR'S USE ONLY

DNA (deoxyribonucleic acid) is made up of many thousands of base pairs. A group of base pairs is called a gene. A gene codes for a specific trait, for example shell type. An allele is a different version of a gene, which can give variation. For the gene of shell type, there are 2 different forms (alleles) – either plain-shelled or banded-shelled.

(c) These two snails were produced by sexual reproduction from the same male and female.

Discuss how they have inherited different alleles for shell pattern.

In your answer you should:

- explain where the homologous chromosomes have come from
- give the possible genotypes of both parents and explain how you determined these possible genotypes.

The homologous chromosomes in the offspring is inherited by the parents. When the offspring was conceived, its father gave one of the homologous chromosomes and its mother gave one of the chromosomes. This created the homologous chromosome pair in the offspring. The father and mother give half of the total chromosomes each (In the case of humans, we get 23 chromosomes each from our parents in order to have a total of 46 chromosomes) and the chromosomes are what contain DNA for the snails, which contain genes that code for the shell type. One "strand" each of the homologous chromosome was given by the male and female and these are the male's and females gametes, i.e. sex cells. These contain the parent's genes and alleles, which then combine randomly to form the snail's DNA.

Because the genotype for the banded shell snail is nn, and the genotype for the plain shell snail is Nn, it is for sure that one of their

There are more space and Punnett squares for your answer to this question on the following page.

(b) Referring to the examples shown previously for shell pattern, explain the difference between an allele and a gene.

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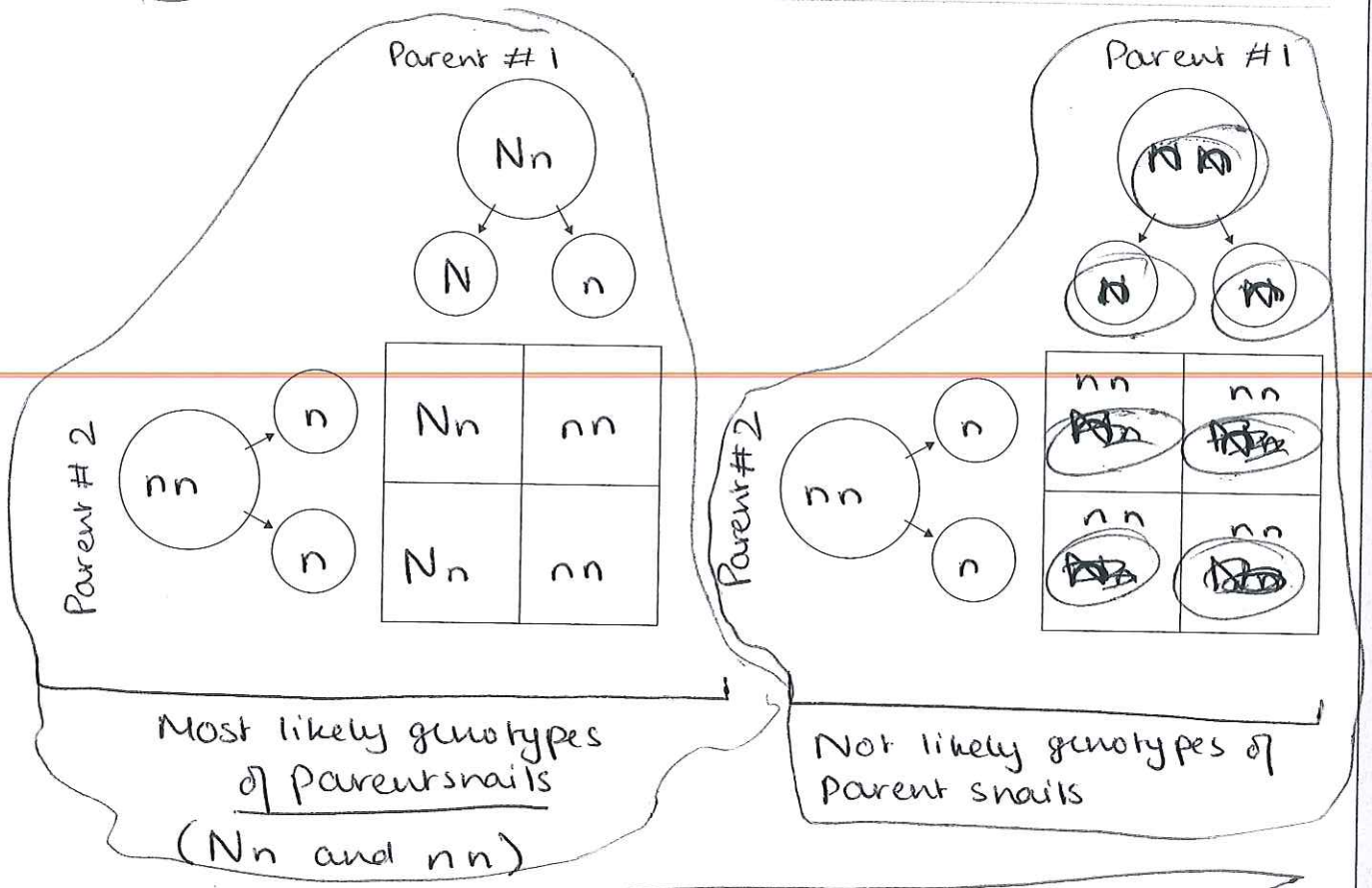
Because the genotype for the banded shell snail is nn, and the genotype for the plain shell snail is Nn, it is for sure that one of their

There are more space and Punnett squares for your answer to this question on the following page.

So the other parent must be heterozygous dominant.

//Parents is homozygous recessive. This is because in order to produce the banded-shell snail, it needed the recessive allele n from both parents, and I know that both parents can't be homozygous recessive, because then the plain-shelled snail needs atleast 1 dominant allele.//



Clear discussion of how plain (containing a dominant allele) + banded (homozygous recessive) offspring can be produced by two possible parent options.

E8

QUESTION THREE: VARIATION IN PLANTS

ASSESSOR'S USE ONLY

The photograph below shows a large number of plants that are all the same species.

http://blogs.ext.vt.edu/soybean-update/files/2013/08/Brown-Stem-Rot-IMAG0159.jpg

(a) The yellow-brown colour in some of the plants has been caused by a disease. The disease is present throughout the field, but affects only some plants. This is because of variation in the plants.

Explain why variation means not all the plants get the disease.

// Variation in this case can mean that the green plants are resistant to the disease, while the yellow ones got the disease. Variation means a difference in genes amongst a species and ensures that each individual plant has its own different traits and phenotypes, and ~~ats~~ can also provide resistance to a disease. If all plants' genotypes were the same, then possibly the entire population could be effected by the disease, but since there is variation, it has given a survival advantage to the green plants. //

(b) The plants in the photograph were grown from seeds. Seeds are the result of sexual reproduction.

(i) Name one process that occurs during sexual reproduction, and explain how it results in variation.

// Meiosis, the production of sex cells, is a ~~method~~ process which causes variation. There are sub-processes within Meiosis, like crossing over and independent assortment, which ensure variation. During crossing over, the chromosomes swap genes over, to create variation, and during independent assortment, these chromosomes line up randomly before becoming seperated, which ensures more variation //

(ii) Discuss the advantages of sexual reproduction for a species when the environment changes.

In your answer you should:

- give examples of a changing environment
- explain the impact of changing environments on a population
- consider the importance of variation in a population in a changing environment.

ASSESS USE O

// There could be a 'change in environment' anytime - like a fatal disease, climate change, a new predator, a change in the habitat, etc. Often, environmental changes can be negative for a species, which can potentially lead to the species dying out. However, through sexual reproduction, variation is ensured. Variation means every individual in a species is different ~~beta~~ by their genotypes. For example, the B example on the last page of the plants shows that although the plants look similar on the outside, their genes are actually different from each other. Through sexual reproduction, different genes and alleles were passed down to the offspring ~~(cuttings)~~ which caused variation. This variation can sometimes give a survival advantage to the species in case of any environmental change, for example, the plants who had resistance to the disease had a survival advantage over the plants who got the disease //

Demonstrates comprehensive understanding of how the processes involved in sexual reproduction results in genetic variation + long term survival of a species.

E8

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QUESTION ONE: FAMILY PEDIGREES

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Albinism in rats results in white fur and pink eyes. Albinism is caused by a recessive allele **a**.

(a) Complete the following diagram:

albino rat | heterozygous black rat

[redacted]

Genotype: a a | A a

Gametes: a | a | A | a

Genotype of offspring: A a | a a | A a | a a

Genotype
Gametes
+ Genotype of offspring
correct

Sources: www.janvier-labs.com/rodent-research-models-services/research-models/per-species/outbred-rats/product/sprague-dawley.html
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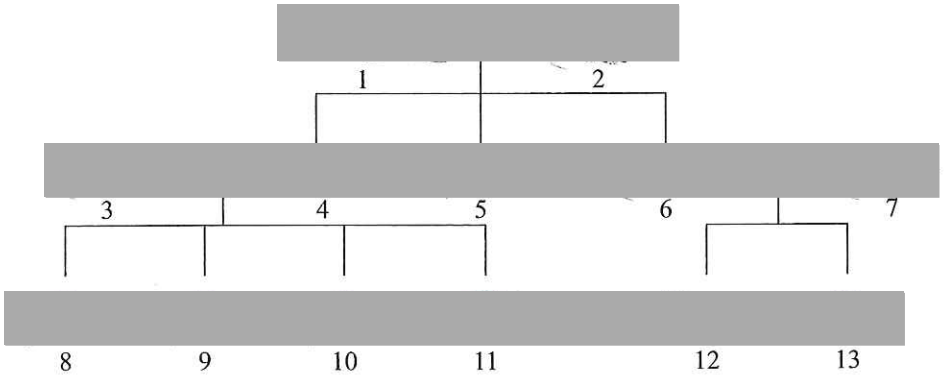
(b) The albino rat and the heterozygous black rat produced the following two generations of offspring, as shown in the pedigree chart below.



What are the genotypes of the following rats?

Rat 4: aa

Rat 6: Aa

Rat 10: Aa MM or AA ?

Incorrect as rat 10 is offspring of rat 4

(c) Rat 3 was **not** an offspring of Rat 1 and Rat 2 in the family tree.

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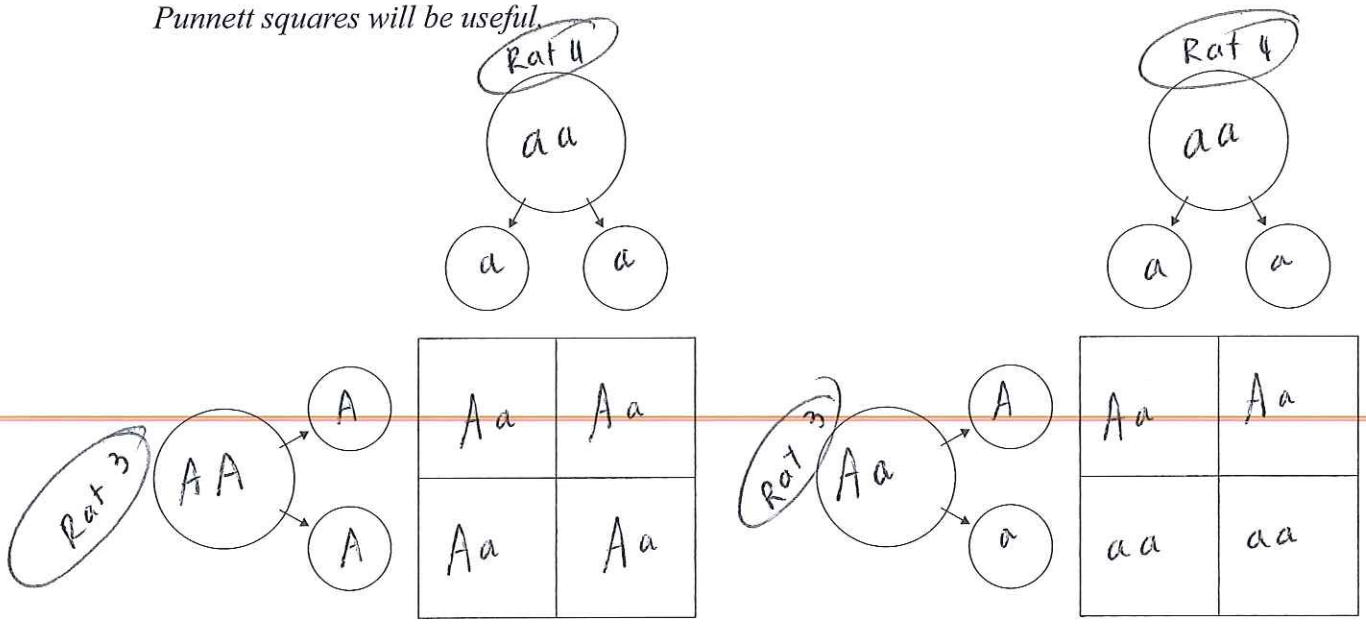

The possible ~~genotypes~~ genotypes for rat 3 are homozygous dominant - AA or heterozygous - Aa. Both of these genotypes (AA, Aa) are possible for rat 3 because the dominant allele for non-albinism (black) ~~is~~ is present in both genotypes and we know that Rat 3 must have a dominant allele because he does not have albinism. I think that the genotype which would be more certain for rat 3 would be homozygous dominant - AA because none of it's offsprings have albinism which most likely means he does not carry the recessive allele for albinism. What we could do to be more certain is mate the rat with many different homozygous recessive - aa (albino) rats and if no rats with albinism are produced then that must mean that rat 3 is homozygous dominant - AA

Clear explation why Rat 3 more likely AA

E7

Discussed evidence for Rat 3 being AA based on test crosses

QUESTION TWO: DNA, ALLELES, GENES, AND CHROMOSOMES

ASSESSOR USE ONL

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Plain shell

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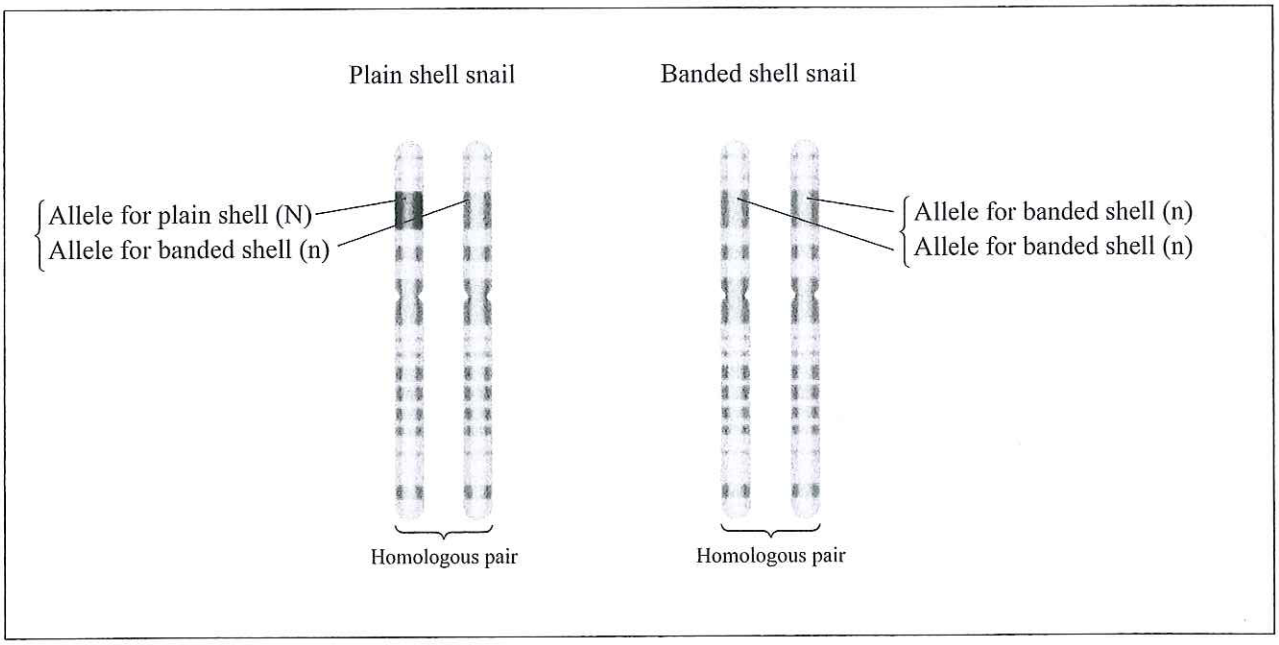


(a) In the diagram above, which snail is heterozygous for shell pattern?

The (Nn) plain shell snail//

Explain why you chose this snail.

because this snail has two different alleles for it's genotype which is plain shell (N) and banded shell (n)//

ASSESSOR'S USE ONLY

(b) Referring to the examples shown previously for shell pattern, explain the difference between an allele and a gene.

A gene is a section of DNA which codes for a specific trait e.g shell colour and alleles are alternate forms of a gene e.g plain shell colour or banded shell colour//

(c) These two snails were produced by sexual reproduction from the same male and female.

Discuss how they have inherited different alleles for shell pattern.

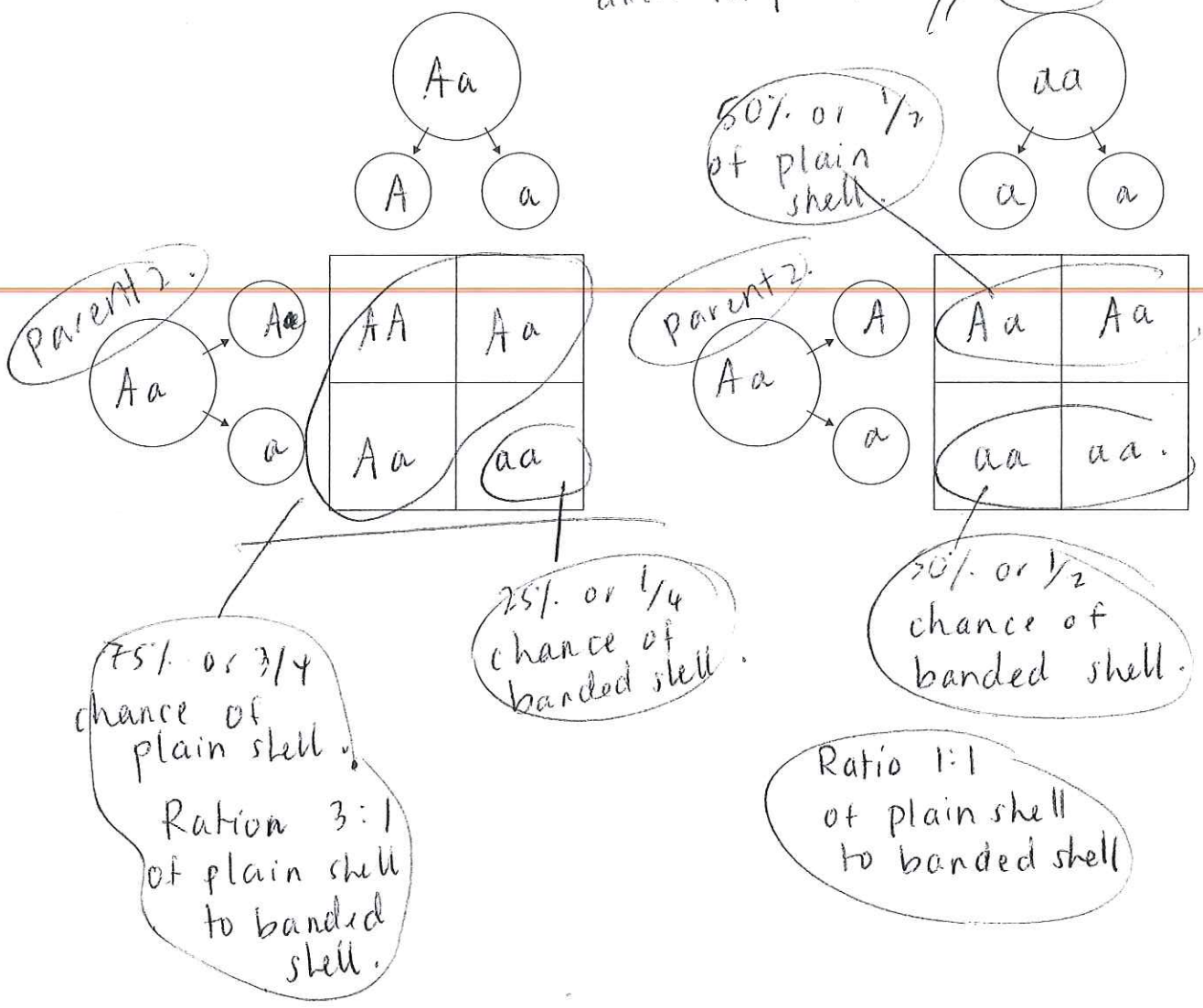
In your answer you should:

- explain where the homologous chromosomes have come from
- give the possible genotypes of both parents and explain how you determined these possible genotypes.

The homologous chromosomes ~~half~~ come half from each parent. For these pairs, ~~half the~~ one half of the chromosome comes from the mum and the other half comes from the dad. The possible genotypes for the parents are homozygous ~~dominant~~ recessive - Nn or heterozygous - Nn. I determined these possible genotypes for the parents by looking at the genotypes of their offsprings. The plain shell snail is heterozygous - Nn so one parent must have contributed the dominant allele and the other the recessive allele. The banded shell nail is homozygous recessive - nn so both parents must have contributed a recessive allele. None of the parents could be homozygous dominant because or else then no offspring could

There are more space and Punnett squares for your answer to this question on the following page.

be banded shell as one dominant allele in the genotype will be observed in the characteristic. Both parents must each carry a recessive allele(n) or else no banded shell offspring could be produced. Now 1 (must) or both parent~ can carry the dominant allele (N) because one Parent 1. offspring carries the dominant allele for plain shell // (Parent)



Clear discussion of two possibilities for parent snails + how this can result in both banded (homozygous recessive) + plain (containing dominant allele) snails.

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E8

QUESTION THREE: VARIATION IN PLANTS

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(a) The yellow-brown colour in some of the plants has been caused by a disease. The disease is present throughout the field, but affects only some plants. This is because of variation in the plants.

Explain why variation means not all the plants get the disease.

because the plants do not (all) have the identical genotype. Variation means (a specy) ~~spec~~ specie ~~are~~ is similar but not identical or else the whole population would be wiped out. The whole ~~spe~~ population has not (all) been affected by the disease because they may have an allele which help them to be immune to the disease//

(b) The plants in the photograph were grown from seeds. Seeds are the result of sexual reproduction.

(i) Name one process that occurs during sexual reproduction, and explain how it results in variation.

There is crossing over and independent assortment where alleles chosen for a gene are chosen at random as it is a random process so no one can be identical, only similar and there are many possible allele combinations. so no one is identical, only similar//

(ii) Discuss the advantages of sexual reproduction for a species when the environment changes.

ASSESSOR'S USE ONLY

In your answer you should:

- give examples of a changing environment
- explain the impact of changing environments on a population
- consider the importance of variation in a population in a changing environment.

An environment change could be new plants or water or temperature change. Those with favourable traits will not be affected. They will be able to reproduce and carry on the population and pass on their genes. Those with unfavourable traits will be affected and may die out. The importance of variation in a population is that everyone is similar but no one is identical. Variation will help a population survive to the future as everyone is different so not all will be affected by the same thing. Those with the favourable traits and live on will be able to carry on the population by passing their genes to their offspring and creating more variation and so on. The process will continue which will will continually let the population survive.

Clearly links species survival in a changing environment to processes of sexual reproduction that result in genetic variation.

E8