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Activity

Canine inbreeding

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Introduction

Use information from Olivia Murray's article, *Canine inbreeding*, and your own knowledge to answer the following questions.

Questions

- 1 The article refers *in vivo* research. What does this term mean? [1 mark]
- 2 The article also refers to fixed alleles of genes.
 - a What is meant by a 'fixed allele' of a gene? [1 mark]
 - b Give **one** advantage and **one** disadvantage of a fixed allele in the context of dog breeding. [2 marks]
- 3 Figure 1 of the article shows how crossing over of homologous chromosomes leads to genetic variation. Give **two** other ways in which genetic variation can arise within a species. [2 marks]
- 4 Dogs and humans can suffer from von Willebrand disease (vWD) and haemophilia A (HA).

HA results from a mutation in the gene encoding coagulation factor VIII (F8), which is essential for the conversion of prothrombin to thrombin. F8 is normally carried in the blood stream bound to von Willebrand factor (vWF). In the absence of vWF, F8 remains inactive and degrades.

 - a Use the above information to explain the effect of low vWF concentrations on blood clotting, other than its effect on platelets. [3 marks]
 - b While vWD is equally common in male and female humans, HA is much more common in males. Use information from the article and your own knowledge to explain why. [3 marks]
- 5 This question relates to two of the genes that control the length and texture of a dog's coat.

The gene controlling coat length (the fibroblast growth factor-5 gene or *FGF5*) has two alleles. The genotypes LL and Lℓ result in short hair, while the genotype ℓℓ results in long hair.

The gene controlling coat curl (the keratin-71 gene or *KRT71*) also has two alleles. The RR genotype results in straight hair, the Rr genotype results in wavy hair and the rr genotype results in curly hair.

 - a Which allele of these genes, if any, is dominant? Justify your answer. [2 marks]
 - b What is the phenotype of a dog with the genotype LℓRr? [1 mark]
 - c A heterozygous female, LℓRr, was repeatedly crossed with a heterozygous male, LℓRr.

Complete a genetics diagram to show the expected ratio of phenotypes among their offspring.
[5 marks]

d The cocker spaniel is a breed of dog originally used when hunting woodcock birds. It has long, straight fur.

Assuming no mutation occurred, would a cross between a female and male cocker spaniel always result in puppies with long, straight fur? Justify your answer [2 marks]

Model answers

- 1** (Research) involves the use of living organisms.
- 2** **a** One allele of a gene becomes the only allele of that gene within a population.
b The allele for the desired trait becomes purebred.
The allele for the undesired/potentially harmful allele produces health/behavioural problems.

- 3** Any two of:
- gene mutation
 - independent segregation of homologous chromosomes during meiosis I
 - chromosome non-disjunction

- 4** **a** (No/little prothrombin to thrombin so) no/little fibrinogen converted into fibrin.
(So) no/little fibrin polymer formed.
(So) the blood clot is not bound together.
b The gene for vWD is on a somatic chromosome/chromosome 12 in humans.
The gene for haemophilia is on the X chromosome (in humans).
Males with the mutant allele on their X chromosome would show haemophilia but females would have to have both X chromosomes with the mutant allele.

- 5** **a** (Only the L allele is dominant).
The genotype Ll shows the dominant phenotype/shows the same phenotype as LL .
The Rr genotype does not have the same phenotype as the RR genotype.
b Short, wavy coat/hair/fur
c 5 marks for the following ratio of coats:
6 short, wavy : 3 short, straight : 3 short, curly : 2 long, wavy : 1 long, straight : 1 long, curly
With the contents of the genetics diagram as shown below:

	LR	Lr	ℓR	ℓr
LR	LL RR	LL Rr	$L\ell$ RR	$L\ell$ Rr
Lr	LL Rr	LL rr	$L\ell$ Rr	$L\ell$ rr
ℓR	$L\ell$ RR	$L\ell$ Rr	$\ell\ell$ RR	$\ell\ell$ Rr
ℓr	$L\ell$ Rr	$L\ell$ rr	$\ell\ell$ Rr	$\ell\ell$ rr

If 5 marks cannot be awarded, to avoid loss of marks for consequential errors, allow 1 mark for each of:

- Headings of each row and column show each one of LR, Lr, ℓR and ℓr (in any order).
- Each box in the table shows the correct diploid genotype from the two haploid gametes.
- The given ratio accurately represents the ratio of phenotypes from the given table.

- d** (Yes, no mark)

The genotype for long, straight fur is $\ell\ell$ RR.

So (assuming no mutation) the parents could only produce gametes with the ℓR genotype.