

22 Heredity

NOTE: Alleles are alternative forms of a gene which occupies a particular position in a chromosome. Alleles affect the same characteristic (e.g. blood group) but not necessarily in the same way. I^A , I^B and i are alleles of a gene which controls the ABO blood groups.

1 A plant with red flowers is crossed with a white-flowered plant of the same species. All the seeds, when grown, produce plants with red flowers. Assuming that the flower colour is controlled by a single pair of alleles, which allele is dominant and which is recessive?

2 If a dominant allele for tall plants is represented by the letter D, what letter should represent the corresponding recessive allele?

3 In cats, the allele (**S**) for short fur is dominant to the allele (**s**) for long fur.

- What is the genotype of a true-breeding, long-furred cat?
- What is the phenotype of a cat with the genotype **Ss**?
- In an **Ss** genotype, which allele is expressed in the phenotype?
- Which of the following genotypes is (i) heterozygous (ii) homozygous dominant?
SS, Ss, ss

4 In rabbits, assume that the dominant allele (**B**) produces black fur. The allele (**b**) for white fur is recessive to **B**.

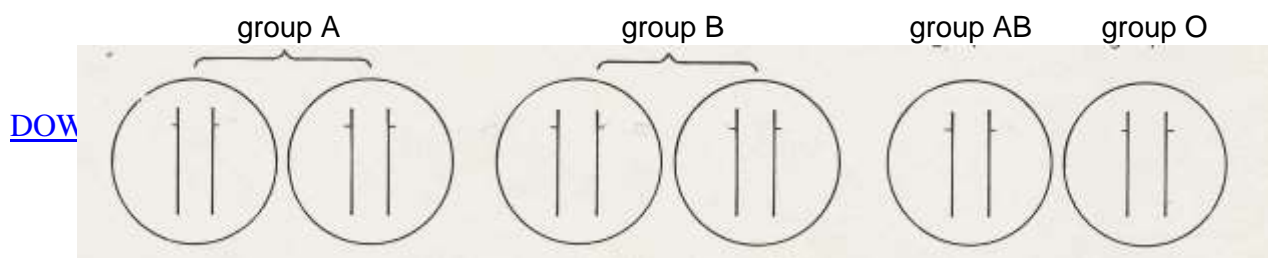
(a) What colour fur will each of the following rabbits have?

	<i>Rabbit 1</i>	<i>Rabbit 2</i>	<i>Rabbit 3</i>	<i>Rabbit 4</i>
genotype	BB	Bb	bB	bb

- Which of them will breed true?
- Which rabbits are homozygous for coat colour?
- If rabbits 1 and 4 were mated together and had 12 babies, how many of these would you expect to be black?
- If rabbits 2 and 3 are interbred and produce several litters, totalling 48 babies, how many white babies would be predicted by the laws of genetics?
- If rabbits 3 and 4 are mated together on several occasions and have 50 babies altogether, how many of their babies would you 'expect' to be black?

NOTE: In this context, 'expect' implies the perfect Mendelian ratio. In practice you would not expect to achieve this ratio with as few as 50 offspring.

5 The alleles controlling the ABO blood groups are given the letters I^A (group A), I^B (group B) and i (group O). On the drawings below, write in the alleles on the chromosomes for each of the blood groups. (The first one has been done for you)



$I^A \quad I^A$

or

or

Heredity (continued)

Self-assessment questions

22.02

6 In shorthorn cattle, the coat colours red or white are controlled by a single pair of alleles. A calf which receives the allele for red coat from its mother and the allele for white coat from its father is called a 'roan'. It has an equal number of red and white hairs in its coat.

- (a) Is this an example of codominance or of incomplete dominance?
- (b) Give a reason for your answer.
- (c) Give one example in each case of (i) codominance, (ii) incomplete dominance, in humans.

7 Give three examples of human disorders which are caused by the action of a single pair of alleles. In each case say whether the harmful allele is dominant or recessive to the non-harmful allele.

8 In humans, maleness or femaleness is determined by a pair of sex chromosomes called X and Y.

- (a) What is the genotype for males?
- (b) What is the genotype for females?

9 (a) In humans, is it the sperm or the ovum which determines the sex of the offspring?
(b) Give a reason for your answer.

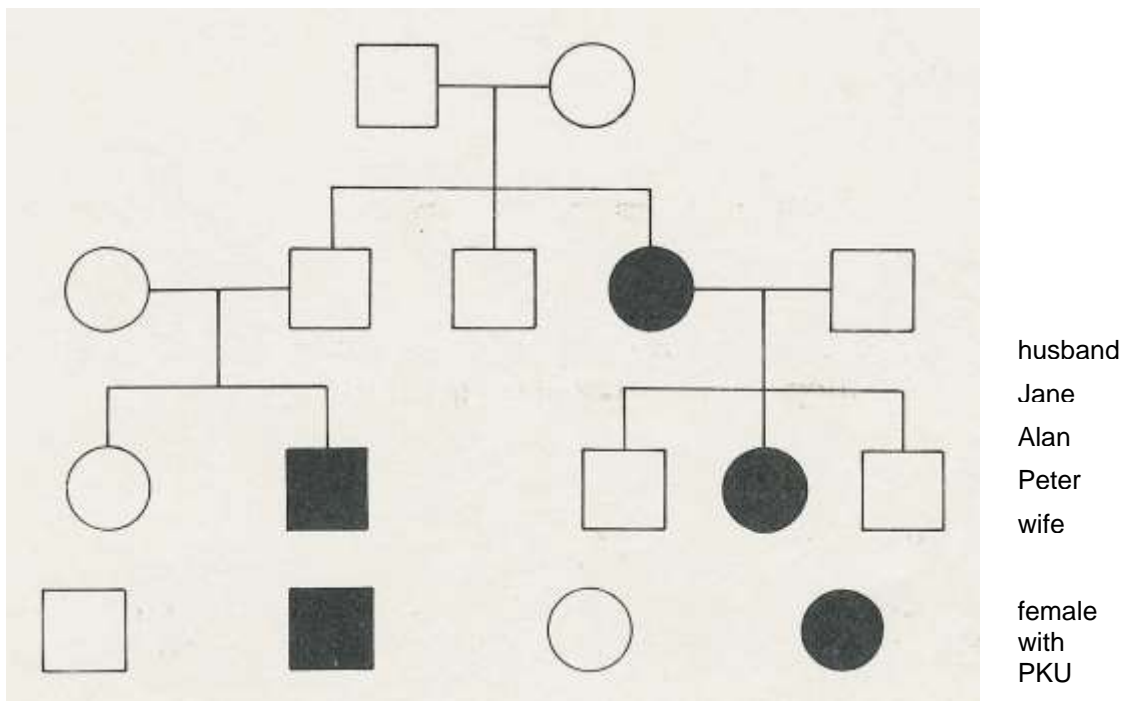
10 In fruit flies, the allele (**n**) for ebony (black) body is recessive to the allele (**N**) for normal (grey) body.

- (a) Complete the Punnett square, for a cross between normal (grey-bodied) flies which are heterozygous for this allele (i.e. Nn genotypes).
- (b) State the expected proportion of normal and ebony-bodied flies in a large sample of the offspring.
- (c) State the proportion of the normal phenotypes which would be true breeding.

11 When a particular gene is said to be 'sex-linked', on which chromosome is that gene usually present?

Heredity (continued)

12 The genetic disorder phenylketonuria (PKU) is caused by a recessive allele (**n**). The family tree below shows the incidence of the disease over three generations.



- KEY**
- | | | | |
|-------------------------------------------------------------------------------------------------------------------|---------------|---------------|---------------------|
| normal male | male with PKU | normal female | grandparents |
| (a) What can you deduce about the genotypes of the grandparents? | | | |
| (b) Explain your reasoning. | | | parents |
| (c) What is the genotype of Jane's husband? | | | |
| (d) Explain your reasoning. | | | children |
| (e) What are the chances that Peter is the carrier of the PKU allele that resulted in his having an affected son? | | | |
| (f) If Jane had been normal, what are the possible genotypes of the grandparents? | | | |
| (g) Is it possible that the allele for PKU is sex-linked? | | | |

13 One form of colour-blindness is a sex-linked inherited condition controlled by a recessive allele. Use the symbols **X** and **Y** for the sex chromosomes and **N** and **n** for the alleles for normal or defective colour vision to show the genotypes of

- (a) a normal male
- (b) a colour-blind male
- (c) a normal (non-carrier) female
- (d) a colour-blind female
- (e) a normal (carrier) female.

14 Use the genotypes you have written for your answer to question 13 to show the chances of

- (a) a son being colour blind,
- (b) a daughter being a carrier, resulting from a marriage between a normal man and a carrier woman.