Inheritance and probability

Worked solutions

GCSE science calculations

This topic online

1 In mice, the allele for black fur (**B**) is dominant to the allele for brown fur (**b**).

The Punnett square shows a cross between two mice.

	B	**b**
b	Bb	bb
b	Bb	bb

What is the probability that an offspring has brown fur? (1 mark)

Golden fur = bb

2 out of 4 boxes are bb

probability = 2 ÷ 4

0.5

2 In tomato plants, the allele for a tall stem (**T**) is dominant to the allele for a dwarf stem (**t**).

The Punnett square shows a cross between two tomato plants.

	T	**t**
T	TT	Tt
t	Tt	tt

Give the expected ratio of tall plants to dwarf plants. (2 marks)

Any box with a T is tall

tall: TT, Tt, Tt = 3

dwarf: tt = 1

3:1

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3 The Punnett square shows how sex is inherited in humans.

	X	**X**
X	XX	XX
Y	XY	XY

What percentage of children are expected to be male? (2 marks)

Male = XY

2 out of 4 boxes are XY

$\text{percentage} = \frac{2}{4} \times 100$

50%

4 In cats, the allele for short hair (**L**) is dominant to the allele for long hair (**l**).
Two short-haired cats are both heterozygous for this gene. They have kittens.
Calculate the probability that a kitten has long hair. Give your answer as a decimal. (3 marks)

Heterozygous parents: Ll x Ll

gametes L, l and L, l

offspring: LL, Ll, Ll, ll

Long hair = ll

probability = 1 ÷ 4

0.25

5 In fruit flies, the allele for normal wings (**N**) is dominant to the allele for short, crumpled wings (**n**).
Leila crosses a fly that is homozygous for normal wings with a fly that is heterozygous.
Give the expected ratio of offspring with genotype NN to offspring with genotype Nn. (3 marks)

Parents: NN x Nn

gametes N, N and N, n

offspring: NN, NN, Nn, Nn

NN : Nn = 2 : 2

Simplify the ratio

1:1

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6 In guinea pigs, the allele for a rough coat (**R**) is dominant to the allele for a smooth coat (**r**).

Two guinea pigs with genotype Rr are crossed.

Give the expected ratio of the genotypes RR : Rr : rr in the offspring. (3 marks)

Parents: Rr x Rr

offspring: RR, Rr, Rr, rr

The question asks for genotypes, not phenotypes

RR = 1, Rr = 2, rr = 1

1:2:1

7 In maize, the allele for purple kernels (**P**) is dominant to the allele for yellow kernels (**p**).

A cob from a cross between two Pp plants has 240 kernels.

Calculate the expected number of yellow kernels on the cob. (2 marks)

Pp x Pp gives PP, Pp, Pp, pp

Yellow = pp

probability = 1 ÷ 4 = 0.25

Expected number = probability x total

number = 0.25 x 240

60

8 A plant breeder sows seeds from a cross between two barley plants. Some seedlings are green and some are white, because they cannot make chlorophyll.

- 312 seedlings are green.
- 104 seedlings are white.

Calculate the ratio of green seedlings to white seedlings in its simplest form. (2 marks)

green : white = 312 : 104

Divide both sides by 104

312 ÷ 104 = 3

104 ÷ 104 = 1

3:1

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9 A dog breeder has two dogs that are both carriers of a recessive allele that causes an eye condition. Neither dog has the condition.

Their first litter of 5 puppies included 2 puppies with the eye condition.

The dogs have another litter. Calculate the probability that the first puppy born in the new litter has the eye condition.

(2 marks)

Ignore the first litter: each puppy is a new cross

Ee x Ee gives EE, Ee, Ee, ee

Eye condition = ee

probability = 1 ÷ 4

0.25

10 Cystic fibrosis is caused by a recessive allele (**f**). The dominant allele is **F**.

Hamid and Zara are both carriers of cystic fibrosis. They are planning to have a child.

a. Calculate the probability that their child will have cystic fibrosis.

b. Calculate the percentage chance that their child will be a carrier.

c. Their child is born without cystic fibrosis. Calculate the probability that this child is a carrier. Give your answer as a fraction.

Show your working.

(4 marks)

Ff x Ff gives FF, Ff, Ff, ff

a)

Cystic fibrosis = ff

probability = 1 ÷ 4

0.25

b)

Carrier = Ff

percentage = $\frac{2}{4}$ x 100

50%

c)

No cystic fibroses, so cross out ff

Left: FF, Ff, Ff (3 outcomes)

probability = $\frac{2}{3}$

2/3

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11 In rabbits, the allele for black fur (**B**) is dominant to the allele for white fur (**b**).

Oliver does not know the genotype of his black rabbit. He crosses it with a white rabbit. Over two litters there are 14 offspring:

- 8 are female and 6 are male
- 7 have black fur and 7 have white fur

a. Calculate the ratio of black offspring to white offspring in its simplest form.

b. Give the genotype of the black parent.

Show your working.

(3 marks)

Only fur colour is needed, not male and female

a)

black : white = 7 : 7

Divide both sides by 7

1:1

b)

white parent = bb

Bb x bb gives Bb, Bb, bb, bb = 1 : 1

Bb

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12 In pea plants, the allele for purple flowers (**R**) is dominant to the allele for white flowers (**r**).

Priya crosses a plant with genotype Rr with a plant with genotype rr. She grows 180 seedlings from the seeds.

a. Calculate the expected number of seedlings with purple flowers.

b. When the plants flower, 84 have purple flowers. Calculate the percentage of the 180 plants that have purple flowers. Give your answer to 3 significant figures.

Show your working.

(4 marks)

a)

Rr x rr gives Rr, Rr, rr, rr

Red = Rr

probability = 2 ÷ 4 = 0.5

Expected number = probability x total

number = 0.5 x 180

90

b)

Percentage = part ÷ total x 100

$$\text{percentage} = \frac{84}{180} \times 100$$

percentage = 46.666...%

46.7%

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