**Model Answers: Easy**

1a

(a) The alleles in this example are...

- Codominant (alleles); [1 mark]
- (This is because) both alleles are expressed in the phenotype; [1 mark]

**[Total: 2 marks]**

1b

(b) It is usually not possible for a male cat to have tortoiseshell fur because...

- Males will only possess one of the alleles at a time / either **G** or **B OR** it is not possible for a male to be heterozygous for the gene (as the gene is found on the X chromosome); [1 mark]

**[Total: 1 mark]**

This is an example of a sex-linked gene, since it is only found on the X chromosome. The inheritance of such genes is dependent on the sex of the individual. Tortoiseshell fur is only possible in female cats because they have two copies of the X chromosome and can therefore carry both the **G** and **B** allele for fur colour.

1c

(c) A Punnett square of this cross would be as follows...

| | $X^G$ | $X^B$ |
|---|---|---|
| $X^B$ | $X^G X^B$ | $X^B X^B$ |
| Y | $X^G Y$ | $X^B Y$ |

- Correct gametes for each parent = $X^G X^B$ **and** $X^B Y$; [1 mark]
- Correct offspring genotypes = $X^G X^B$, $X^B X^B$, $X^G Y$ and $X^B Y$; [1 mark]
- 25% black male cats; [1 mark]

**[Total: 3 marks]**



1d

(d) This type of allele interaction is an example of...

- Epistasis; [1 mark]

**[Total: 1 mark]**

When epistasis is involved it is important to consider the entire combination of alleles from the different genes in order to determine the phenotype of an organism.

2a

(a) The genotypes of the two double homozygous guinea pigs is as follows...

- BBLL (long black hair); [1 mark]
- bbLL (long white hair); [1 mark]

**[Total: 2 marks]**

The term 'double homozygous' is used when an individual is homozygous for both of the traits being discussed.

2b

(b) The genetic cross that results from crossing the individuals in part (a) is as follows:

|  | BL |
|---|---|
| bL | BbLL |

- Correct gametes for each parent = BL **and** bL; [1 mark]
- Correct offspring genotypes = BbLL; [1 mark]
- The phenotype of all/100% of the offspring will be black **and** long haired; [1 mark]

**[Total: 3 marks]**

When drawing a Punnett square for a dihybrid cross it might be tempting to draw a full 5x5 grid every time, but it's also important to remember that you only have a limited amount of time in your exams and so saving time by drawing a smaller diagram in a case like this is a wise move. Only draw a new column or row for each unique parental gamete, not for repeats.
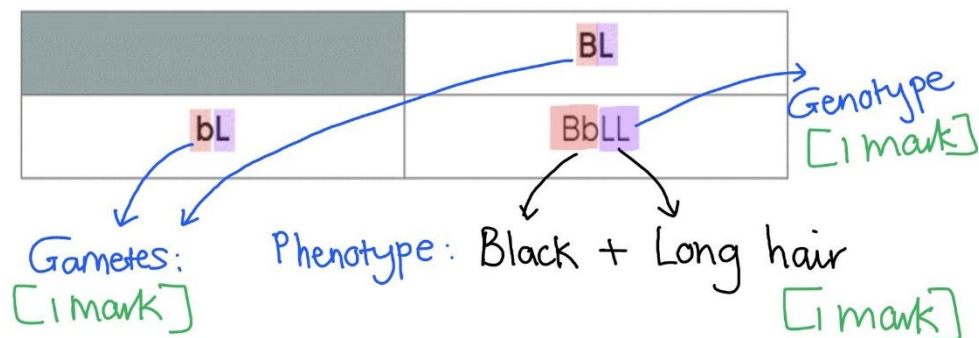


2c

(c) The actual ratios may not have matched up to the expected ratios because…

Any **two** of the following:

- The sample size was too small; [1 mark]
- Fertilisation/fusion of gametes is random; [1 mark]
- The genes may be linked / this may be an example of autosomal/sex linked genes; [1 mark]

**[Total: 2 marks]**

2d

(d) The scientists should carry out the following statistical test…

- Chi-squared / $\chi^2$; [1 mark]

**[Total: 1 mark]**

A chi-squared test is used to determine the significance of differences in categorical data

which is observed compared to the actual results collected. If there is a significant difference between the two sets of data, then it suggests that there is another influencing factor that hasn't been accounted for e.g. linkage between genes.

3a

(a) The phenotype of a plant that is heterozygous for the *Le* gene would be...

- Tall; [1 mark]

**[Total: 1 mark]**

In a heterozygous individual, the dominant allele (in this case **Le**, producing tall plants) will mask the presence of the recessive allele (**le**, producing short plants) so the plants will grow tall.

3b

(b) The reason why plants that are homozygous for the recessive allele *le* are dwarves includes...

Any **two** of the following:

- (It causes a) change in the primary structure / active site of the enzyme; [1 mark]
- (This change) makes the enzymes non-functional; [1 mark]
- (Without this enzyme) no active gibberellin is formed (and plants are unable to grow tall); [1 mark]

**[Total: 2 marks]**

By applying active gibberellin to these dwarf plants, they can be stimulated to grow tall despite their genetic makeup.

3c

(c) A gene, such as *HTT*, can affect the phenotype of an individual in the following ways...

Any **two** of the following:

- (Genes/*HTT*) code for mRNA / are transcribed into mRNA; [1 mark]
- (The mRNA) is translated into a polypeptide/protein/huntingtin; [1 mark]
- The protein affects the phenotype through a particular mechanism **OR** huntingtin protein is involved with neuronal development (which determines whether the individual develops Huntington's disease or not); [1 mark]

**[Total: 2 marks]**

You may have noticed that there are many examples of how genes affect the phenotype of an individual through the synthesis of certain proteins. Many of these proteins are enzymes which are involved in pathways that may lead to the production of other important molecules that affect the phenotype of an organism.

3d

(d) A person that is heterozygous for the abnormal *HTT* allele will most likely develop Huntington's disease because...

- The abnormal (*HTT*) allele is dominant; [1 mark]
- (This means that) only one copy of the abnormal allele needs to be inherited to develop the disease **OR** the presence of the abnormal allele will mask the presence of the (recessive) normal allele; [1 mark]

**[Total: 2 marks]**