Worksheet 5: Inheritance of Eye Colour and Fur Colour

Name: **Student Number:**

Only Questions 1 and 2 will be reviewed for completion. Questions 3 and 4 are optional practice questions.

1 . As part of your grad studies, you are investigating the inheritance of fur colour (blue vs. golden) and eye colour (green, red or yellow) in a rare species of rat. The table below shows the results of several different genetic crosses between male and females . Assume that these traits are influenced by two different genes, and that for each gene there exist two alleles.

- note: genotypes in table below are only to assist in understanding. Students are not required to write anything in the table, and may have used different letters/symbols.

Table 1.

Cross #	Parents (P)	Offspring (F1)
1	Green eyes, golden fur x red eyes, blue fur E1/E1; F1/F1× E2/E2; F2/F2	34 yellow eyes, golden fur 100% E1/E2; F1/F2
2	Red eyes, golden fur x red eyes, blue fur E2/E2; F1/F2× E2/E2; F2/F2	15 red eyes, golden fur 16 red eyes, blue fur 50% E2/E2; F1/F2 50% E2/E2; F2/F2
3	Green eyes, golden fur x green eyes, golden fur E1/E1; F1/F2× E1/E1; F1/F2	28 green eyes, golden fur 9 green eyes, blue fur 25% E1/E1; F1/F1 50% E1/E1; F1/F2 25% E1/E1; F2/F2
4	Red eyes, blue fur x yellow eyes, blue fur E2/E2; F2/F2× E1/E2; F2/F2	18 yellow eyes, blue fur 16 red eyes, blue fur 50% E1/E2; F2/F2 50% E2/E2; F2/F2

a) Inheritance of eye colour.

Step 1. Review the data for eye colour. Look for patterns to come up with your (initial) hypothesis regarding the dominance relationship between the alleles involved in eye colour.

Step 2. State your hypothesis (e.g., 'allele 1 is dominant to allele 2').

Example: E1and E2 alleles have a non-dominant relationship

Step 3. Define your alleles for eye colour

Example: Green eyes allele: E1 Red eyes allele: E2

Step 4. Select one of the crosses from the table above and **assign genotypes** to the parents based on your stated hypothesis.

Example - cross #1

Green parent: E1/E1

Red parent: E2/E2

[Note: It's best to use a cross that involves all three genotypes – because you cannot properly demonstrate a dominant-recessive relationship between two alleles without seeing the phenotypes of the heterozygote as well as both homozygotes.]

Step 5. Based on the genotypes that you have assigned, **make a prediction** regarding the offspring genotypes and phenotypes resulting from that specific cross.

	E1
E2	E1E2

Predicted offspring genotypes = 100% E1/E2
Predicted offspring phenotypes = 100% yellow eyes
[Note: It would also be okay if you expressed the genotypic and phenotypic ratios as fractions.]

Step 6. Does your **prediction match the observations** from the table? If not, revisit your hypothesis. What conclusion can you make regarding the dominance relationship between the alleles of interest for eye colour? Back up your claim by referring to the data in the table.

The predicted offspring phenotypes (all yellow eyes) match the observed offspring phenotypes (34 yellow eyes) for cross #1. This supports the hypothesis that the alleles for eye colour have a non-dominant relationship. [Note: If you said the alleles have neither a dominant nor recessive relationship, that would also be acceptable].

b) Inheritance of fur colour.

Step 1. Review the data for fur colour. Look for patterns to come up with your (initial) hypothesis regarding the dominance relationships between the alleles involved in fur colour.

Step 2. State your hypothesis about the relationship between the alleles in this cross (e.g. "allele 1 is dominant to allele 2").

Hypothesis: F1 is dominant over F2. [You could also write this as F1 > F2.]

Step 3. Define your alleles for fur colour

Example - Golden fur = F1 Blue fur = F2

Step 4. Select one of the crosses above and **assign genotypes** to the parents based on yourstated hypothesis.

Example - Cross #3
Both golden parents: F1/F2

[Note: It's best to use a cross that involves all three genotypes – because you cannot properly demonstrate a dominant-recessive relationship between two alleles without seeing the phenotypes of the heterozygote as well as both homozygotes.]

Step 5. Based on the genotypes that you have assigned, **make a prediction** regarding the offspring genotypes and phenotypes resultingfrom that specific cross.

	F1	F2
F1	F1F1	F1F2
F2	F1F2	F2F2

Predicted offspring genotypes: 1:2:1 F1F1 : F1F2 : F2F2
Predicted offspring phenotypes: 3:1 golden: blue fur

[Note: It would also be okay if you expressed the genotypic and phenotypic ratios as percentages or fractions.]

Step 6. Does your **prediction match the observations** from the table? If not, revisit your hypothesis. What conclusion can you make regarding dominance relationships between the alleles in question for fur colour? Back up your claim by referring to the data.

The predicted offspring phenotypes under this hypothesis (a 3:1 phenotype ratio of golden to blue fur) match the observed F1 offspring phenotypes (28 golden fur, 9 blue fur). This supports the hypothesis that the allele associated with golden fur is dominant over the allele associated with blue fur.

2. Based on your answers to question 1, assign genotypes to the following individuals (individuals are from Table 1):

Table 2.

Cross #	Individuals)	Insert genotypes here
1	Green eyes, golden fur parent (P)	E1/E1;F1/F1
2	Red eyes, golden fur offspring (F1)	E2/E2;F1/F2
3	Green eyes, blue fur offspring (F1)	E1/E1;F2/F2
4	Yellow eyes, blue fur parent (P)	E1/E2;F2/F2

3) You take two F1 offspring (a male and female)from cross #1 (from Table 1) and cross them together to produce an F2 generation. Assuming the alleles from the two genes assort independently (i.e., they are not physically linked), what proportion of offspring would you expect to inherit each combination of traits? Show all of your work.

	E1; F1	*E1; F2*	*E2; F1*	*E2; F2*
E1; F1	*E1/E1; F1/F1*	*E1/E1; F1/F2*	*E1/E2; F1/F1*	*E1/E2; F1/F2*
E1; F2	*E1/E1; F1/F2*	*E1/E1; F2/F2*	*E1/E2; F1/F2*	*E1/E2; F2/F2*
E2; F1	*E1/E2; F1/F1*	*E1/E2; F1/F2*	*E2/E2; F1/F1*	*E2/E2; F1/F2*
E2; F2	*E1/E2; F1/F2*	*E1/E2; F2/F2*	*E2/E2; F1/F2*	*E2/E2; F2/F2*

Green-eyes, golden fur: 3/16
Green-eyes, blue-grey fur: 1/16
Yellow-eyes, golden fur: 6/16
Yellow-eyes, blue-grey fur: 2/16 = 1/8
Red-eyes, golden fur: 3/16
Red-eyes, blue-grey fur: 1/16

4) One day, you discover a new phenotype in one of your litters of baby rats: three baby rat siblings were born with purple eyes. You think that the baby rats may have been born with a mutant allele, and decide to investigate. You raise the three purple-eyed rats to maturity, and use them in the following crosses.

Table 3.

Cross #	Parents (P)	Offspring (F_1)
5	Purple eyes × yellow eyes	32 purple eyes
6	Purple eyes × red eyes	15 purple eyes, 16 yellow eyes
7	Purple eyes × yellow eyes	15 purple eyes, 7 yellow eyes, 8 red eyes

(Note: Each cross uses a different purple-eyed rat in the P generation.)

What is the dominance relationship between the purple allele and the eye-colour alleles you identified in question 1a? Formulate a hypothesis and support it by referring to the data in the table.

Example answer:
Hypothesis: Allele for purple eyes is dominant over the eyes for green eyes and red eyes.

Purple eyes allele: E3
Green eyes allele: E1
Red eyes allele: E2

Note: It is important that the symbols that you use to represent the alleles are consistent with the alleles you identified in part 1a.

Cross #5
Purple parent: E3/E3
Yellow parent: E1/E2

Prediction:

	E1	E2
E3	E1E1	E2E3

Predicted offspring genotypes: 50% E1/E3 and 50% E2/E3
Predicted offspring phenotypes: 100% purple

The predicted offspring phenotypes under this hypothesis (all purple eyes) match the observed F1 offspring phenotypes (all 32 F1 offspring have purple eyes). This supports the hypothesis that the allele associated with purple eyes (E3) is dominant over both the green eyes (E1) allele and the red eyes allele (E2).