Reindeer Genetics: Punnett Squares

Grades 7–12

Name _____ Date _____

Background

Every reindeer gets two copies of each gene, one from each parent. Each version of a gene is called an **allele**. A **dominant** allele (capital letter) shows its trait even if only one copy is present. A **recessive** allele (lower-case letter) only shows when there are two copies.

A **Punnett square** shows every way the parents' alleles can combine. Each box is one possible calf, so a 2 × 2 square shows four equally likely outcomes, each with a 25% chance.

Note: the reindeer traits on this worksheet are made up for practice. Real reindeer inherit traits in more complicated ways, but the rules of inheritance you use here are the real ones.

Trait key

Trait	Dominant allele	Recessive allele
Nose colour	N = black nose (dominant)	n = red nose (recessive)
Antlers	A = branched (dominant)	a = straight (recessive)
Coat colour	B = brown coat (dominant)	b = white coat (recessive)
Hoof colour incomplete dominance	H^KH^K = black	H^KH^S = grey (a blend)	H^SH^S = silver

How to complete a Punnett square



1. Write one parent's two alleles across the top and the other parent's down the side.
2. Fill each box with the letter from its column and the letter from its row. Write the capital letter first.
3. Count the genotypes, then decide each box's phenotype using the trait key.
4. Write ratios in the order dominant : recessive, and probabilities as a fraction and a percentage.

Vocabulary check

Write the letter of the matching definition on each line.

____ **allele**

____ **genotype**

____ **phenotype**

____ **homozygous**

____ **heterozygous**

____ **dominant**

A having two identical alleles, such as NN or nn

B one version of a gene

C an allele that shows its trait even when only one copy is present

D the pair of alleles an organism has, such as Nn

E having two different alleles, such as Nn

F the trait you can see, such as a red nose

Monohybrid Crosses

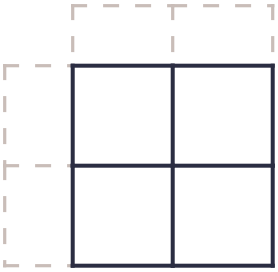
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Name _____ Date _____

Complete each Punnett square, then answer the questions. Use the trait key on page 1.

1 Dasher and Comet

Dasher is heterozygous for a black nose (**Nn**). Comet has a red nose (**nn**).



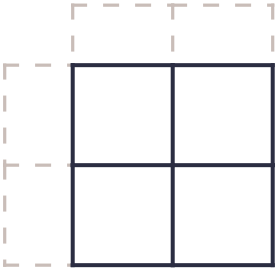
Genotype ratio: _____

Phenotype ratio: _____

Chance of a calf with red nose: _____

2 Blitzen and Prancer

Blitzen and Prancer are both heterozygous for branched antlers (**Aa**).



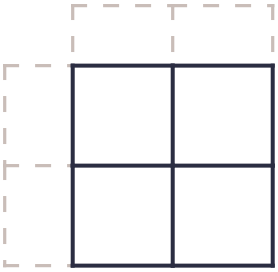
Genotype ratio: _____

Phenotype ratio: _____

Chance of a calf with straight antlers: _____

3 Vixen and Cupid

Vixen is homozygous for a brown coat (**BB**). Cupid has a white coat (**bb**).



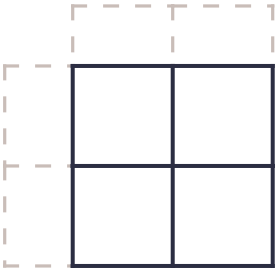
Genotype ratio: _____

Phenotype ratio: _____

Chance of a calf with white coat: _____

4 The surprise calf

Dancer and Donner both have black noses, but their calf has a red nose. Work out the parents' genotypes, then complete the square.



Parents' genotypes: _____

Genotype ratio: _____

Phenotype ratio: _____

Chance of a calf with red nose: _____

Incomplete Dominance and Test Crosses

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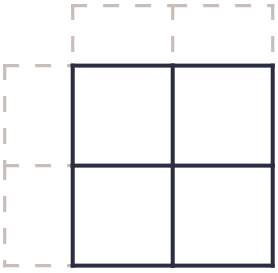
Name _____ Date _____

In hoof colour, neither allele is dominant. A reindeer with one of each allele has a **blend** of the two colours: grey hooves.

H^KH^K black H^KH^S grey H^SH^S silver

1 Two grey-hoofed parents

Two reindeer with grey hooves (H^KH^S) have calves.

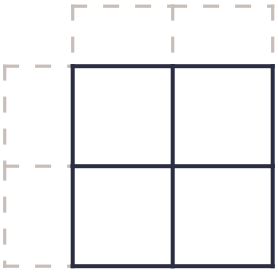


Genotype ratio: _____

Phenotype ratio: _____

2 Black × silver

A reindeer with black hooves (H^KH^K) and one with silver hooves (H^SH^S) have calves.



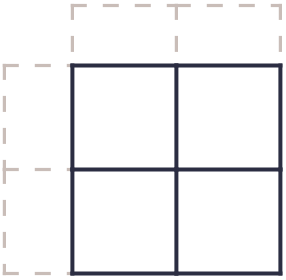
Genotype ratio: _____

Phenotype ratio: _____

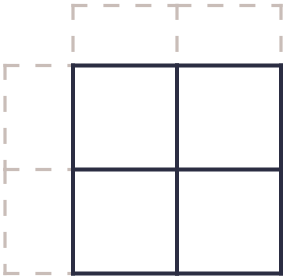
3 Test cross: is Donner AA or Aa?

Donner has branched antlers, so he could be **AA** or **Aa**. To find out, he is crossed with a reindeer with straight antlers (**aa**). Complete both squares.

If Donner is **AA**



If Donner is **Aa**



Which result would prove Donner is heterozygous? Explain.

_____

_____

Dihybrid Crosses: Two Traits at Once

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Now follow antlers **and** nose colour together. Each parent makes four kinds of gametes. For **AaNn**, pair each antler allele with each nose allele: **AN, An, aN, an**. Put one parent's gametes across the top and the other's down the side, then fill all 16 boxes.

1 Dancer × Dasher

Dancer and Dasher are both heterozygous for branched antlers and a black nose (**AaNn**).

Gametes from parent 1: _____

Phenotype ratio (branched-black : branched-red : straight-black : straight-red): _____

Fraction of calves with branched antlers AND a red nose: _____

2 Comet × Cupid

Comet is **AaNn**. Cupid has straight antlers and a red nose (**aann**).

Gametes from parent 1: _____

Phenotype ratio (branched-black : branched-red : straight-black : straight-red): _____

Fraction of calves with branched antlers AND a red nose: _____







Reindeer Genetics

Teacher Key



Page 1 – Vocabulary

allele: **B** genotype: **D** phenotype: **F** homozygous: **A** heterozygous: **E** dominant: **C**

Page 2 – Monohybrid crosses

1 Dasher and Comet

Dasher is heterozygous for a black nose (**Nn**). Comet has a red nose (**nn**).

	n	n
N	Nn	Nn
n	nn	nn

Genotype ratio: **2 Nn : 2 nn**

Phenotype ratio: **2 black nose : 2 red nose**

Chance of a calf with red nose: **2/4 = 50%**

2 Blitzen and Prancer

Blitzen and Prancer are both heterozygous for branched antlers (**Aa**).

	A	a
A	AA	Aa
a	Aa	aa

Genotype ratio: **1 AA : 2 Aa : 1 aa**

Phenotype ratio: **3 branched antlers : 1 straight antlers**

Chance of a calf with straight antlers: **1/4 = 25%**

3 Vixen and Cupid

Vixen is homozygous for a brown coat (**BB**). Cupid has a white coat (**bb**).

	b	b
B	Bb	Bb
B	Bb	Bb

Genotype ratio: **4 Bb**

Phenotype ratio: **4 brown coat : 0 white coat**

Chance of a calf with white coat: **0/4 = 0%**

4 The surprise calf

Dancer and Donner both have black noses, but their calf has a red nose. Work out the parents' genotypes, then complete the square.

	N	n
N	NN	Nn
n	Nn	nn

Parents' genotypes: **Nn × Nn (both carry the red-nose allele n)**

Genotype ratio: **1 NN : 2 Nn : 1 nn**

Phenotype ratio: **3 black nose : 1 red nose**

Chance of a calf with red nose: **1/4 = 25%**

Reindeer Genetics

Teacher Key

Page 3 – Incomplete dominance and test cross

1 Two grey-hoofed parents

Two reindeer with grey hooves (H^KH^S) have calves.

	H^K	H^S
H^K	H^KH^K	H^KH^S
H^S	H^KH^S	H^SH^S

Genotype ratio: **1 H^KH^K : 2 H^KH^S : 1 H^SH^S**

Phenotype ratio: **1 black : 2 grey : 1 silver**

2 Black × silver

A reindeer with black hooves (H^KH^K) and one with silver hooves (H^SH^S) have calves.

	H^S	H^S
H^K	H^KH^S	H^KH^S
H^K	H^KH^S	H^KH^S

Genotype ratio: **4 H^KH^S**

Phenotype ratio: **4 grey**

3 Test cross: is Donner AA or Aa?

Donner has branched antlers, so he could be **AA** or **Aa**. To find out, he is crossed with a reindeer with straight antlers (**aa**). Complete both squares.

If Donner is **AA**

	a	a
A	Aa	Aa
A	Aa	Aa

If Donner is **Aa**

	a	a
A	Aa	Aa
a	aa	aa

Which result would prove Donner is heterozygous? Explain.

If any calf has straight antlers (aa), Donner must be Aa. If AA, every calf has branched antlers; if Aa, about half have straight antlers.

Page 4 – Dihybrid crosses

1 Dancer × Dasher

Dancer and Dasher are both heterozygous for branched antlers and a black nose (**AaNn**).

	AN	An	aN	an
AN	AANN	AANn	AaNN	AaNn
An	AANn	AAnn	AaNn	Aann
aN	AaNN	AaNn	aaNN	aaNn
an	AaNn	Aann	aaNn	aann

Gametes from parent 1: **AN, An, aN, an**

Phenotype ratio (branched-black : branched-red : straight-black : straight-red): **9 : 3 : 3 : 1**

Fraction of calves with branched antlers AND a red nose: **3/16**

2 Comet × Cupid

Comet is **AaNn**. Cupid has straight antlers and a red nose (**aann**).

	an	an	an	an
AN	AaNn	AaNn	AaNn	AaNn
An	Aann	Aann	Aann	Aann
aN	aaNn	aaNn	aaNn	aaNn
an	aann	aann	aann	aann

Gametes from parent 1: **AN, An, aN, an**

Phenotype ratio (branched-black : branched-red : straight-black : straight-red): **4 : 4 : 4 : 4, which simplifies to 1 : 1 : 1 : 1**

Fraction of calves with branched antlers AND a red nose: **4/16 = 1/4**