

10.2 Inheritance

Dihybrid Crosses

Solve the following questions (HINT: use Punnett Squares)

1. Some dogs bark when trailing, others are silent. The barking trait (B) is dominant over the silent trait (b). Erect ears (E) are dominant over drooping ears (e). An erect-eared barker is crossed with a droopy-eared silent trailer. Litter after litter produces pups with erect ears, but some are barkers and some are silent. What are the probable genotypes of the parents?

$EEBb \times eebb$

(All offspring have erect ears, so trait is probably homozygous in erect-eared parent)

2. In Cocker Spaniels, black coat (B) is dominant over red coat (b), and solid colour (S) is dominant over spotted colour (s). A solid black male is mated with a solid red female. They produce a litter of six pups: 2 solid black pups; 2 solid red pups; 1 black spotted pup; 1 red spotted pup. Determine the genotype of the parents.

$BbSs \times Bbss$

(All four phenotype combinations are present, so dominant traits must be heterozygous)

3. In fruit flies, long wings (L) are dominant over vestigial wings (l). If a vestigial winged fly is crossed with a homozygous long winged fly, what genotype and phenotype possibilities are expected in the F1 generation? In the F2 generation?

F1: $Ll = 100\%$ long winged

F2: $1LL : 2Ll : 1ll = 75\%$ long winged ; 25% vestigial winged

4. In hogs, a white belt around the middle (M) is dominant over being beltless (m), and syndactyly, or fused hooves (F), are dominant over normal split hooves (f). A uniformly coloured hog that is homozygous for fused hooves is mated with a homozygous belted hog with split hooves. Determine the genotypes of the parents and the possible genotypes and phenotypes of offspring.

Parents: $mmFF \times MMff$

Offspring: $mM Ff = 100\%$ belted with fused hooves

5. In rabbits, short hair (K) is dominant over long hair (k), and brown hair (B) is dominant over black hair (b). A short black-haired rabbit was crossed with a long brown-haired rabbit. In four litters, 38 rabbits were produced, all with short brown hair. Determine the genotypes of the parents and the 38 offspring.

Parents: $KKbb \times kkBB$

Offspring: $Kk Bb$

(Because all offspring show the dominant traits, parents were likely homozygous for these)

Gene Linkage

Define linkage group

A linkage group is a group of genes whose loci are on the same chromosome

Linked genes function as a single inheritable unit and do not follow independent assortment

Identify the factor that determines the likelihood of recombination between two linked genes

Distance: The further apart two genes are on a chromosome, the more likely they are to recombine)

Outline how Morgan discovered non-Mendelian ratios via experimentation with *Drosophila*

He undertook breeding experiments with *Drosophila* (fruit flies) and found a clear sex bias in the inheritance of certain traits

Morgan determined that genes located on a shared chromosome would NOT assort independently

(+ have non-Mendelian ratios)

Identify the recombinants in the following cross: $\frac{AB}{ab} \times \frac{ab}{ab}$ $\frac{Ab}{ab}$ and $\frac{aB}{ab}$

Polygenic Inheritance

Define polygenic inheritance

Polygenic traits are characteristics that are controlled by more than two gene loci

Distinguish between discrete and continuous variation

Monogenic traits therefore have a finite pattern of expression (i.e. discrete variation)

Polygenic traits normally exhibit a bell-shaped distribution (i.e. continuous variation)

List two examples of polygenic inheritance

1. Human height
2. Skin colour / pigmentation

Chi-Squared Test

Complete the chi-squared test to determine whether two genes are linked

Two heterozygous long green plants (LlGg) are crossed, yielding the following F1 frequencies:

296 = long green 19 = long yellow 27 = short green 85 = short yellow

1. Identify Hypotheses

Null Hypothesis: *There is no difference between observed and expected frequencies (i.e. genes are unlinked)*

Alternative Hypothesis: *There is a difference between observed and expected frequencies (genes are linked)*

2. Calculate Frequencies

Dihybrid Ratios: **9 : 3 : 3 : 1**

Frequencies:

	LG	Lg	lG	lg
LG	LLGG	LLGg	LlGG	LlGg
Lg	LLGg	LLgg	LlGg	Llgg
lG	LlGG	LlGg	llGG	llGg
lg	LlGg	Llgg	llGg	llgg

Phenotype	Observed	Expected (Total × Ratio)
Long green	296	$427 \times 9/16 = 240$
Long yellow	19	$427 \times 3/16 = 80$
Short green	27	$427 \times 3/16 = 80$
Short yellow	85	$427 \times 1/16 = 27$

3. Calculate Chi-Squared Value

	Long green	Long yellow	Short green	Short yellow
$\frac{(O - E)^2}{E}$	13.067	46.513	35.113	124.593

χ^2 : **219.29**

4. Determine Statistical Significance

Degree of Freedom	Probability of Exceeding Critical Value						
	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.584	1.212	2.366	4.11	6.25	7.81	11.34

Conclusion: *There IS a significant difference between observed and expected data (genes may be LINKED)*