

Exercise walk-through

5.4

Non-Mendelian Genetics

AP Biology

Non-Mendelian patterns

Many traits break Mendel's simple dominant/recessive rule:

Incomplete dominance

: red + white → pink

Codominance

: AB

blood (both show)

Multiple alleles

:

I^A, I^B, i

Sex-linked

: colour

blindness

**Polygenic
tasis**

& epis-

: a smooth range

Non-Mendelian patterns, continued

father:		X^B	Y
mother	X^B	$X^B X^B$	$X^B Y$
	X^b	$X^B X^b$	$X^b Y$
		carrier daughter	color-blind son

- **Incomplete dominance** : heterozygotes are a blend (red $\times$ white $\rightarrow$ pink).
- **Codominance** : both alleles show fully (AB blood type).
- **Multiple alleles, polygenic** traits (many genes, like height), **pleiotropy** (one gene, many effects), and **sex-linked** genes (on the X chromosome) all give more complex ratios.

Worked example – the chi-square test

A monohybrid cross predicts 3 : 1. Of 80 offspring, 55 show the dominant trait and 25 the recessive. Do the data fit?

- expected: 60 and 20
- $\chi^2 = \sum \frac{(o - e)^2}{e} = \frac{25}{60} + \frac{25}{20} = 0.42 + 1.25 = 1.67$
- $df = 2 - 1 = 1$; the critical value at $p = 0.05$ is 3.84
- $1.67 < 3.84$, so **do not reject** the null hypothesis – the data fit

The null hypothesis is that any difference is **chance alone**. Failing to reject it is not proof the ratio is right, only that the deviation is unremarkable.

Exercises 2.1-2.3

2.1 In incomplete dominance, what is the heterozygote's phenotype? [1]

2.2 What blood type is genotype $I^A I^B$, and why? [2]

2.3 Why are males more often affected by X-linked recessive traits? [1]

Exercises 2.1-2.3

2.1 In incomplete dominance, what is the heterozygote's phenotype? [1]

2.1

- A blend of the two (e.g. pink)
-

2.2 What blood type is genotype $I^A I^B$, and why? [2]

2.2

- Type AB – both the I^A and I^B alleles are fully expressed (codominance)
-

2.3 Why are males more often affected by X-linked recessive traits? [1]

2.3

- Males have only one X chromosome, so a single recessive allele is expressed (no second X to mask it)

Exercise 3.1

3.1 When both alleles are fully expressed in the heterozygote, the pattern is [1]

☐

A complete dominance

B incomplete dominance

C codominance

D recessive

Exercise 3.1

3.1 When both alleles are fully expressed in the heterozygote, the pattern is [1]

☐

- A** complete dominance
- B** incomplete dominance
- C** codominance
- D** recessive

3.1 C

- codominance

Exercise 3.2 (a)

3.2 Red (RR) and white (WW) flowers show incomplete dominance (pink RW).

(a) Cross two pink flowers ($RW \times RW$) and give the phenotype ratio. [3]

Exercise 3.2 (a)

3.2 Red (RR) and white (WW) flowers show incomplete dominance (pink RW).

(a) Cross two pink flowers ($RW \times RW$) and give the phenotype ratio. [3]

(a)

- $RW \times RW$ gives $1 RR : 2 RW : 1 WW = 1 \text{ red} : 2 \text{ pink} : 1 \text{ white}$

Exercise 3.2 (b)

3.2 Red (RR) and white (WW) flowers show incomplete dominance (pink RW).

(b) State how this differs from a normal Mendelian 3 : 1 ratio.

[1]

Exercise 3.2 (b)

3.2 Red (RR) and white (WW) flowers show incomplete dominance (pink RW).

(b) State how this differs from a normal Mendelian 3 : 1 ratio. [1]

(b)

- The heterozygote (pink) is a distinct phenotype, so there are three phenotypes (1 : 2 : 1) instead of two (3 : 1)

Exercise 3.3

3.3 A color-blind allele is X-linked recessive. Explain why a son can inherit color blindness from a carrier mother. [2]

Exercise 3.3

3.3 A color-blind allele is X-linked recessive. Explain why a son can inherit color blindness from a carrier mother. [2]

3.3

- The mother carries one color-blind X allele; she can pass that X to her son, and since he has only one X (from her), he will be color-blind