Exercise walk-through

The roles of genes in determining the phenotype ▪ 16.2

eXercise

You must be able to

- use the genetic terms exactly and construct Punnett squares for crosses
- predict ratios for monohybrid, codominance and sex-linked crosses
- relate genes to proteins and phenotype (e.g. albinism, sickle cell)

Method — The language of genetics

A **gene** is a length of DNA coding for a protein; its position is its **locus** 基因座. An **allele** 等位基因 is a version of a gene. **Dominant** shows with one copy; **recessive** needs two. **Homozygous** = same alleles; **heterozygous** = different. **Genotype** = the alleles; **phenotype** = the visible features.

Method — A monohybrid cross

For Tt × Tt: gametes T and t; offspring TT, Tt, Tt, tt → **3 dominant : 1 recessive**.

parents: Tt × Tt

	T	t
T	**TT**	**Tt**
t	**Tt**	**tt**

green = tall (has a T)

orange = short (tt)

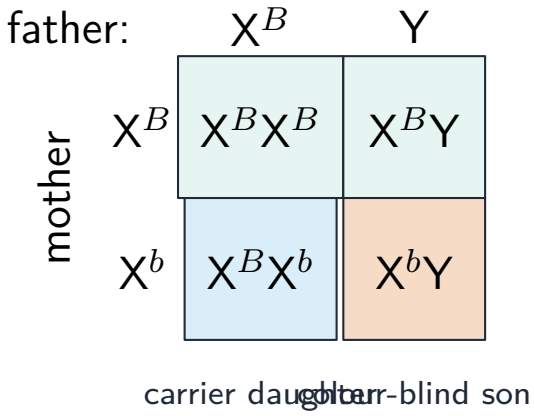
ratio 3 tall : 1 short

A Punnett square for Tt x Tt giving TT, Tt, Tt, tt — 3 tall : 1 short

Method — Codominance and sex linkage

In **codominance 共显性** both alleles show (e.g. red $\times$ white flowers $\rightarrow$ pink). In **sex linkage 伴性遗传** the gene is on the X chromosome, so results differ by sex.

Method — Codominance and sex linkage



Method — Genes, proteins and phenotype

A faulty allele → a faulty protein → a changed phenotype: e.g. the *TYR* gene → tyrosinase → **albinism 白化病** if non-functional; *HBB* → haemoglobin → **sickle cell anaemia**.

Practice 2.1 ▪ 2 marks

Define **homozygous** and **heterozygous**.

Solution 2.1

Method: The language of genetics

Worked steps

homozygous — the two alleles of a gene are the same B1; heterozygous — the two alleles are different B1.

Practice 2.2 ▪ 1 mark

A test cross is used to find an unknown genotype. State the genotype the organism is crossed with.

Solution 2.2

Worked steps

the homozygous recessive B1.

Exam-style 3.1 ▪ 1 mark

In a cross Tt $\times$ tt, what proportion of the offspring are expected to show the recessive phenotype?

A 0

B 1/4

C 1/2

D 3/4

Solution 3.1

Method: A monohybrid cross

A 0

B 1/4

C 1/2 ✓

D 3/4

Worked steps

C. Tt × tt → Tt, Tt, tt, tt → half show the recessive phenotype.

Exam-style 3.2 ▪ 1 mark

Two pink flowers (codominant red R and white W, genotype RW) are crossed. The expected ratio of red : pink : white is:

A 3 : 0 : 1

B 1 : 2 : 1

C 1 : 1 : 0

D 9 : 3 : 4

Solution 3.2

Method: Codominance and sex linkage

A 3 : 0 : 1

B 1 : 2 : 1 ✓

C 1 : 1 : 0

D 9 : 3 : 4

Worked steps

B. RW $\times$ RW $\rightarrow$ RR (red) : RW (pink) : RW (pink) : WW (white) $= 1 : 2 : 1$.

Exam-style 3.3 ▪ 3 marks

Red-green colour blindness is X-linked recessive. A carrier mother (X^BX^b) has children with a normal father (X^BY).

(a) Draw a genetic diagram (Punnett square) for this cross.

(b) State the probability that a son is colour-blind.

Solution 3.3

Method: Codominance and sex linkage

Worked steps

(a) parents $X^BX^b \times X^BY$; gametes X^B, X^b and X^B, Y **M1**; offspring $X^BX^B, X^BX^b, X^BY, X^bY$ **M1** — normal daughter, carrier daughter, normal son, colour-blind son **A1**.
(b) 1/2 (of the sons) **B1**.

Exam-style 3.4 ▪ 2 marks

Explain how a faulty *TYR* allele leads to albinism.

Solution 3.4

Method: Genes, proteins and phenotype

Worked steps

the faulty *TYR* allele codes for a non-functional tyrosinase enzyme M1; so no melanin pigment is made, giving albinism A1.