A-LEVEL BIOLOGY • EXERCISE SHEET

16.2 The roles of genes in determining the phenotype

Name: _____ Class: _____ Date: _____ **Total: 11 marks**

Objective

Build the skills to answer exam questions on **the roles of genes in determining the phenotype** —genetic terms, **genetic diagrams** 遗传图解 (monohybrid, codominance, sex linkage), the **chi-squared test** 卡方检验, and gene→protein→phenotype.

You must be able to:

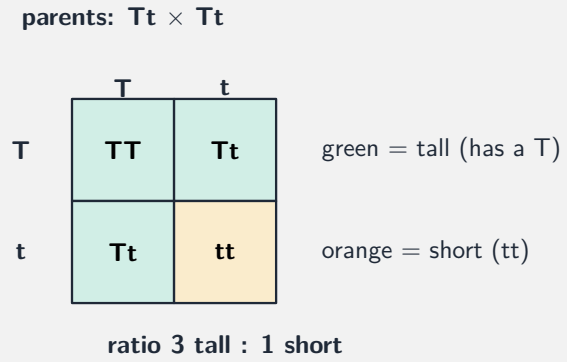
- use the genetic terms exactly and construct Punnett squares for crosses
- predict ratios for monohybrid, codominance and sex-linked crosses
- relate genes to proteins and phenotype (e.g. albinism, sickle cell)

1 Worked examples

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.

A monohybrid cross

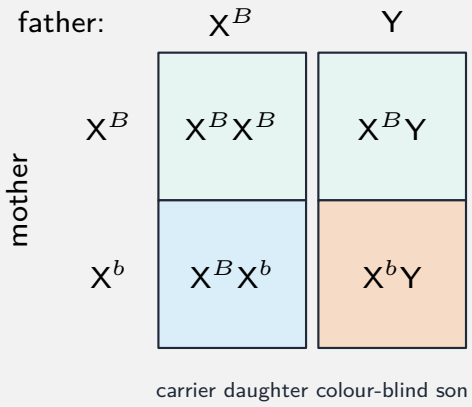


Tt × Tt → 3 tall : 1 short (T dominant)

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

■ Codominance and sex linkage

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



X-linked: a carrier mother's sons may be affected while daughters are carriers

■ 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**.

2 Practice

2.1 Define **homozygous** and **heterozygous**. [2]

2.2 A test cross is used to find an unknown genotype. State the genotype the organism is crossed with. [1]

3 Exam-style questions

3.1 In a cross Tt × tt, what proportion of the offspring are expected to show the recessive phenotype? [1]

- **A** 0
- **B** 1/4
- **C** 1/2

- **D** 3/4

3.2 Two pink flowers (codominant red R and white W, genotype RW) are crossed. The expected ratio of red : pink : white is: [1]

- **A** 3 : 0 : 1
- **B** 1 : 2 : 1
- **C** 1 : 1 : 0
- **D** 9 : 3 : 4

3.3 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. [3]

(b) State the probability that a son is colour-blind. [1]

3.4 Explain how a faulty *TYR* allele leads to albinism. [2]

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4 Go further

You are now ready for the real exam questions on this subtopic. Open the **16.2 The roles of genes in determining the phenotype** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/41 J25 —Q3 (genetics, calculation)

Genetics and chi-squared questions also appear across topic 16 structured questions.

Solutions

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

2.2 the homozygous recessive.

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

3.2 B. RW × RW → RR (red) : RW (pink) : RW (pink) : WW (white) = 1 : 2 : 1.

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

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