

Inheritance

A-Level Biology ■ Topic 16

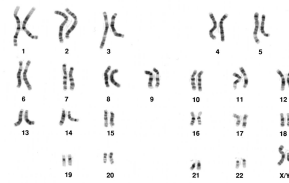
A-Level Biology

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Inheritance

What we will cover

- 1 Meiosis & variation
- 2 The language of genetics
- 3 Genetic crosses
- 4 Sex linkage
- 5 Genes to phenotype
- 6 Gene control



Normal Karyotype

23 homologous pairs

1 Meiosis

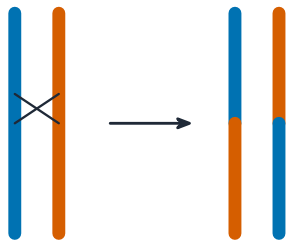
Meiosis

Two divisions of a diploid cell give four haploid, genetically different gametes. Meiosis I separates homologous pairs (halves the number). Meiosis II separates sister chromatids.

Crossing over in prophase I and independent assortment in metaphase I are the two sources of variation.

Variation from meiosis

crossing over



paired (a chiasma) segments swapped
(new combinations)

Meiosis makes gametes genetically different:

- **crossing over** 交叉互换 – pairs swap segments
- **independent assortment** 自由组合 – pairs line up randomly

Then **fertilisation** 受精 fuses any two gametes at random.

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Genetics

The language of genetics

allele 等位基因 – one version of a gene

dominant 显性 vs **recessive** 隐性
– 1 copy shows vs needs 2

genotype 基因型 vs **phenotype** 表现型 – alleles vs features

homozygous 纯合 vs **heterozygous** 杂合 – same vs different

A **test cross** 测交 with the recessive homozygote reveals an unknown genotype.

Genetic crosses

parents: $Tt \times Tt$

	T	t	
T	TT	Tt	green = tall (has a T)
t	Tt	tt	orange = short (tt)

ratio 3 tall : 1 short

A **Punnett square** 庞纳特方格 shows how gametes combine – here $Tt \times Tt$ gives 3 tall : 1 short. A

monohybrid 单基因杂交 follows one gene; a **dihybrid** 双基因杂交 two. The **chi-squared test** 卡方检验 checks if results fit by chance.

Sex linkage

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 colour-blind son

In **sex linkage** 伴性遗传 the gene is on the X chromosome, so the result differs by sex.

A carrier mother's sons may be colour-blind, while her daughters are only carriers.

3 Genes and control

Inheritance
└ Genes and control

From genes to phenotype

faulty **tyrosinase** 酪氨酸酶 →
albinism 白化病

faulty factor VIII →
haemophilia 血友病

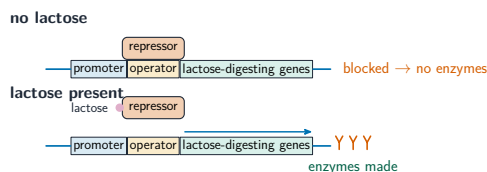
faulty **haemoglobin** 血红蛋白 →
sickle cell 镰状细胞贫血

faulty huntingtin → **Hunting-**
ton's 亨廷顿病

A gene codes for a protein, and the protein shapes the **phenotype** 表现型 – so a faulty allele gives a faulty protein.

Inheritance
└ Genes and control

Gene control: the lac operon



The **lac operon** 乳糖操纵子 controls lactose digestion:

- no lactose → a **repressor** 阻遏物 blocks the genes
- lactose pulls the repressor off → enzymes made (**inducible** 可诱导)

Eukaryotes use **transcription factors** 转录因子.

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Recap

Inheritance
└ Recap

Worked example – the chi-squared test

A $Tt \times Tt$ cross gives 160 offspring: 114 tall, 46 short. Does this fit 3 : 1?

- Expected: tall = $\frac{3}{4} \times 160 = 120$; short = $\frac{1}{4} \times 160 = 40$.
- $\chi^2 = \sum \frac{(O - E)^2}{E} = \frac{(114 - 120)^2}{120} + \frac{(46 - 40)^2}{40}$
= $0.30 + 0.90 = 1.20$
- Degrees of freedom = classes - 1 = 1; critical value at $p = 0.05$ is 3.84.
- $1.20 < 3.84 \Rightarrow$ difference is not significant; the data fit 3 : 1.

χ^2 below the critical value
 $\Rightarrow$ accept the null hypothesis (any difference is chance). Use raw counts, never percentages.

Inheritance
└ Recap

Topic 16 – key takeaways

1 Meiosis

halves chromosomes; makes variation

2 Terms

allele, dominant/recessive, genotype/phenotype

3 Crosses

Punnett squares; sex linkage differs by sex

4 Gene control

lac operon repressor; transcription factors

Check yourself

- 1 How many haploid gametes does meiosis make?
- 2 What does "heterozygous" mean?
- 3 $Tt \times Tt$ gives what phenotype ratio?
- 4 What pulls the repressor off the lac operon?

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Answers 1. four 2. the two alleles are different 3. 3 tall : 1 short 4. lactose