Inheritance

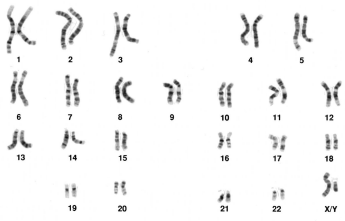
A-Level Biology ▪ Topic 16

A-Level Biology

TT	Tt
Tt	tt

What we will cover

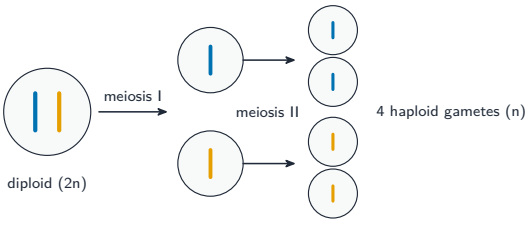
1. Meiosis & variation
2. The language of genetics
3. Genetic crosses
4. Sex linkage
5. Genes to phenotype
6. Gene control

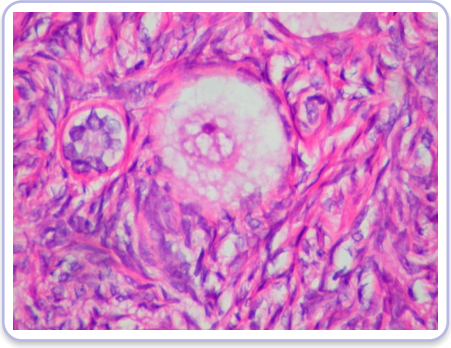


Normal Karyotype

23 homologous pairs

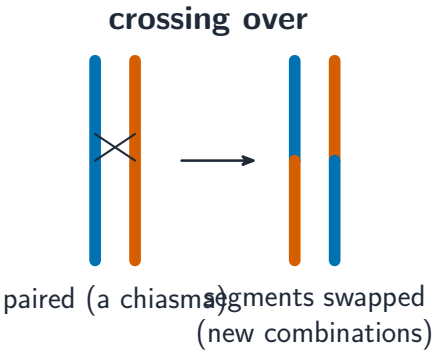
Meiosis





egg

Variation from meiosis



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.

The language of genetics

allele 等位基因 – one version of a gene

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

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

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 × Tt

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

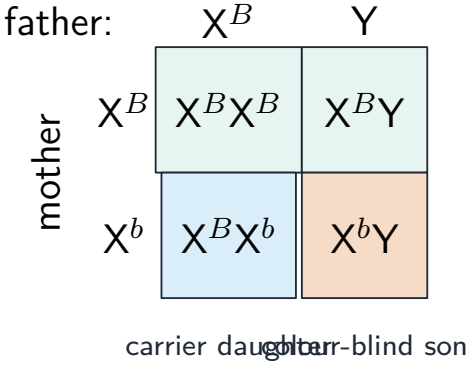
green = tall (has a T)

orange = short (tt)

ratio 3 tall : 1 short

A **Punnett square** 庞纳特方格 shows how gametes combine – here Tt × 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



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.

From genes to phenotype

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

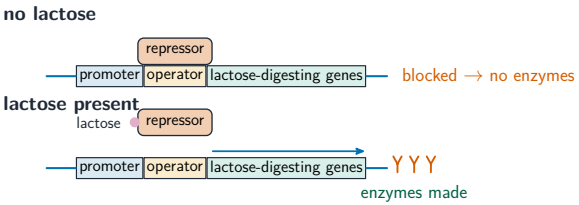
faulty **haemoglobin** 血红蛋白 → **sickle cell** 镰状细胞贫血

faulty factor VIII → **haemophilia** 血友病

faulty huntingtin → **Huntington'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.

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.

Worked example – the chi-squared test

A Tt × 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.

Topic 16 – key takeaways

1 Meiosis

halves chromosomes; makes variation

2 Terms

allele, dominant/recessive, genotype/phenotype

3 Crosses

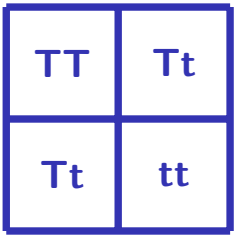
Punnett squares; sex linkage differs by sex

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 × Tt gives what phenotype ratio?
4. What pulls the repressor off the lac operon?



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