

Inheritance

IGCSE Biology ■ Topic 17

IGCSE Biology



Inheritance

What we will cover

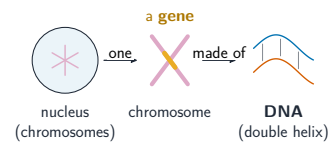
- 1 Chromosomes, genes & DNA
- 2 Sex determination
- 3 Making a protein
- 4 Mitosis vs meiosis
- 5 Inheritance key words
- 6 Monohybrid crosses



1 Genes

Inheritance

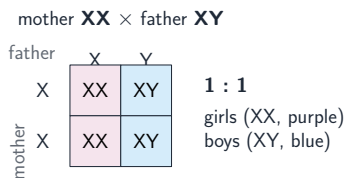
Chromosomes, genes and DNA



- A **gene** is a length of DNA that **codes** 编码 for one **protein** 蛋白质.
- An **allele** 等位基因 is an alternative form of a gene. For example, a gene for eye colour may have a brown allele and a blue allele.

Inheritance

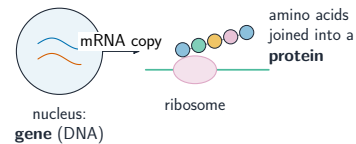
Sex determination



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Inheritance

Making a protein



A gene's **base sequence** 碱基序列 sets the amino-acid order. But the gene stays in the **nucleus** 细胞核 and proteins are made in the **cytoplasm** 细胞质, so **messenger RNA** 信使 RNA carries the message out.

- **mRNA** 信使 RNA copies the gene
- a **ribosome** 核糖体 reads it
- amino acids join into the protein

Inheritance

Genes

What the gene actually controls

The bases carry the order

The ribosome reads the mRNA's bases 碱基 three at a time and joins amino acids in the matching order.

Which proteins

Enzymes 酶, membrane carriers, and receptor proteins 受体蛋白 for neurotransmitters 神经递质 – so controlling proteins controls the whole cell.

Same genes, different job

Nearly every body cell holds the same genes, but each one only expresses 表达 (switches on) the genes it needs.

A gene is an instruction for one protein. Everything a cell can do, it does because of a protein it made.

Inheritance

Genes

Mitosis vs meiosis

mitosis

(growth, repair)



2 identical cells (diploid: full set)

meiosis

(makes gametes)



4 different gametes (haploid: half the set)

■ mitosis 有丝分裂 – 2 identical diploid 二倍体 cells; growth & repair

■ meiosis 减数分裂 – 4 different haploid 单倍体 gametes 配子

2

Crosses

Inheritance

Crosses

Inheritance key words

BB → brown eyes

Bb → brown eyes

bb → blue eyes

B (brown) is dominant

b (blue) is recessive

■ genotype 基因型 – the alleles; phenotype 表现型 – what you see

■ dominant 显性 (B) shows with one copy

■ recessive 隐性 (b) needs two

■ homozygous 纯合子 BB/bb; heterozygous 杂合子 Bb

Inheritance

Crosses

Two more words, and a family tree

Pure-breeding

A homozygous 纯合 organism (BB or bb) carries two identical alleles, so it breeds true – it is pure-breeding 纯种.

Pedigree diagram

A pedigree diagram 系谱图 is a family tree of one feature. Work backwards from an affected child to fix the parents' genotypes.

Replication first

Before any division the chromosomes are copied exactly – replication 复制 – so each daughter cell 子细胞 can keep the full number.

On a pedigree, two unaffected parents with an affected child prove the allele is recessive, and that both parents are carriers.

Inheritance

Crosses

Monohybrid crosses

A Punnett square 庞纳特方格 predicts the offspring.

■ $Bb \times Bb \rightarrow 3:1$

■ $Bb \times bb \rightarrow 1:1$

A test cross 测交 (against bb) reveals an unknown genotype.

$Bb \times Bb$ (both parents)

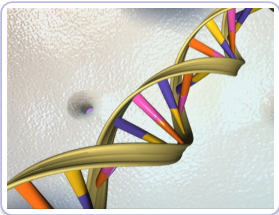
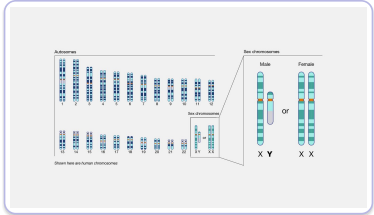
gametes

	B	b
B	BB	Bb
b	Bb	bb

3 : 1

3 dominant (blue)

1 recessive (orange)

Inheritance └ Crosses Codominance and sex linkage codominance 共显性 both alleles show: $I^A I^B \rightarrow$ blood group 血型 AB sex linkage 伴性遗传 a gene on the X; colour blindness 色盲 is commoner in boys	Inheritance └ Crosses Sex chromosomes, sex linkage and blood groups Sex chromosomes The 23rd pair are the sex chromosomes 性染色体: XX in a female, XY in a male, so the father's gamete decides the sex. Sex-linked A sex-linked 伴性 characteristic is controlled by a gene on a sex chromosome, usually the X. Red-green colour blindness Red-green colour blindness 红绿色盲 is the standard example: the recessive allele sits on the X, so it is far more common in boys – they have no second X to mask it. Blood groups The ABO blood groups 血型 show codominance: I^A and I^B are both expressed in group AB. Write a sex-linked genotype on the chromosome: $X^B X^b$, not Bb. Half the marks are in the notation.
Inheritance └ Crosses Chromosomes, genes and DNA, continued  DNA carries inherited information in its double-helix structure.	Inheritance └ Crosses Cell division (Supplement)  A karyotype shows the full set of chromosomes in a human cell.
Inheritance └ Crosses Mitosis, stem cells, and the inheritance words mitosis is used for growth, repair of tissues, replacing old cells, and asexual reproduction 无性生殖 stem cells 干细胞 unspecialised cells that divide by mitosis; their daughter cells can then become specialised where they are in plant meristems, and in animal bone marrow and embryos genotype 基因型 the alleles an organism has – its genetic make-up phenotype 表现型 the features you can observe the link phenotype comes from genotype and environment together Two organisms with the same genotype can differ in phenotype. That is why identical twins are the standard evidence in this topic.	Inheritance └ Crosses Exam tips ■ Gene = a length of DNA coding for a protein. Allele = one form of a gene. ■ Genotype = the alleles present; phenotype = what you see. Homozygous = two same; heterozygous = two different. ■ Dominant shows with one copy; recessive needs two copies. ■ Learn to draw a Punnett square. $Bb \times Bb \rightarrow 3:1$; $Bb \times bb \rightarrow 1:1$. ■ (Supplement) Codominance: both alleles show (blood group AB). Sex linkage: a gene on the X, more common in boys (colour blindness).

3 Recap

Inheritance
↳ Recap

Worked example – a monohybrid cross

In peas, T (tall) is dominant to t (dwarf). Two heterozygous tall plants are crossed. Give the offspring ratio.

- Heterozygous tall $\Rightarrow$ both parents are Tt.
- Each parent makes two kinds of gamete: T and t.
- Fill in every combination (the square, right).
- Genotypes: 1 TT : 2 Tt : 1 tt.
- TT and Tt both look tall, so phenotypes are 3 tall : 1 dwarf.

	T	t
T	TT	Tt
t	Tt	tt

Only tt is dwarf: 1 in 4.

Show the parent genotypes, the gametes, then the square. A recessive phenotype needs both recessive alleles.

Inheritance
↳ Recap

Topic 17 – key takeaways

1 Genes

a gene codes for a protein; alleles are forms

2 Division

mitosis identical; meiosis halves & varies

3 Dominant

shows with one copy; recessive needs two

4 Crosses

Bb $\times$ Bb $\rightarrow$ 3:1; Bb $\times$ bb $\rightarrow$ 1:1

Inheritance
↳ Recap

Check yourself

- 1 What does a gene code for?
- 2 Which gamete decides a baby's sex?
- 3 What does meiosis make?
- 4 What ratio does Bb $\times$ Bb give?



Answers 1. one protein 2. the sperm 3. four different haploid gametes 4. 3:1