

Inheritance

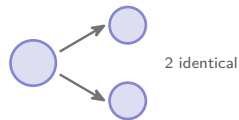
IGCSE Biology ■ Topic 17

IGCSE Biology



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

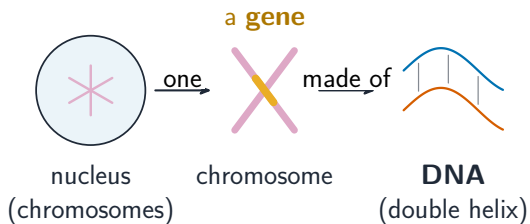


mitosis vs meiosis

1

Genes

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.

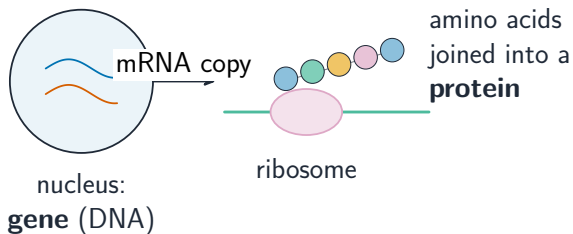
Sex determination

mother **XX** × father **XY**

father		X	Y	
mother	X	XX	XY	1 : 1 girls (XX, purple) boys (XY, blue)
	X	XX	XY	

- The 23rd pair are the **sex chromosomes** 性染色体: **XX** in a female, **XY** in a male.
- An egg always carries an X. A sperm carries **either** an X or a Y, so the **father's gamete decides the sex**.
- The cross **XX × XY** gives XX, XY, XX, XY – a **50%** chance either way, for every pregnancy.

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

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

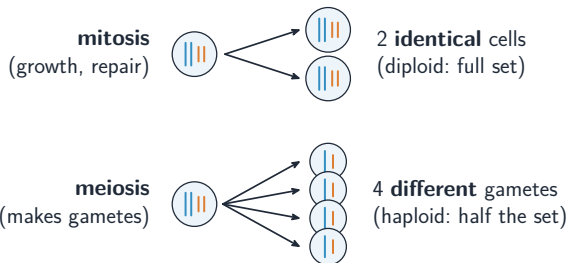
Enzymes 酶, membrane carriers, and **receptor proteins** 受体蛋白 for **neurotransmitters** 神经递质 – so controlling proteins controls the whole cell.

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.

Mitosis vs meiosis



- **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 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

Two more words, and a family tree

Pure-breeding

A **homozygous** 纯合子 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.

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)

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

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** 伴性遗传 characteristic is controlled by a gene on a sex chromosome, usually the X.

Red-green colour blindness

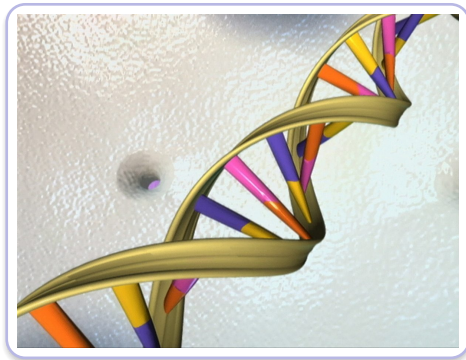
Red-green colour blindness 红绿色盲 is the standard example: the recessive allele sits on the X, so it is far more common in boys – they have no second X to mask it.

Blood groups

The ABO **blood groups** 血型 show codominance: I^A and I^B are both expressed in group AB.

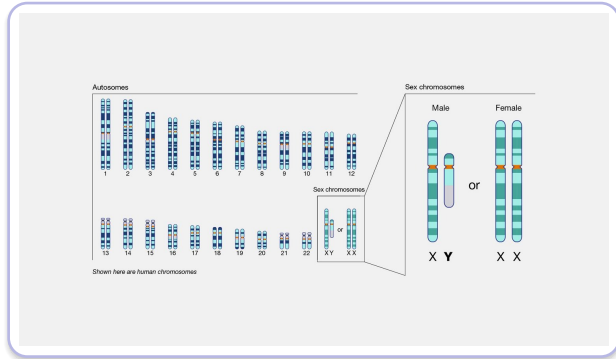
Write a sex-linked genotype on the chromosome: $X^B X^b$, not Bb . Half the marks are in the notation.

The DNA double helix



DNA carries inherited information in its double-helix structure.

Cell division (Supplement)



A karyotype shows the full set of chromosomes in a human cell.

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.

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

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.

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

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

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