

Inheritance

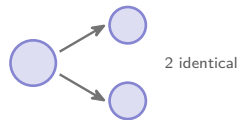
IGCSE Biology ■ Topic 17

IGCSE Biology



What we will cover

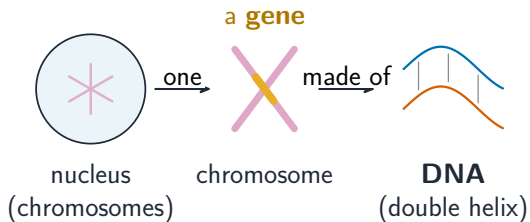
- 1 Chromosomes, genes & DNA
- 2 Sex determination
- 3 Making a protein
- 4 Mitosis vs meiosis
- 5 Inheritance key words
- 6 Monohybrid crosses



mitosis vs meiosis



Chromosomes, genes and DNA



- A **gene** is a length of DNA that **codes** for one **protein** .
- An **allele** 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
	X	XX	XY

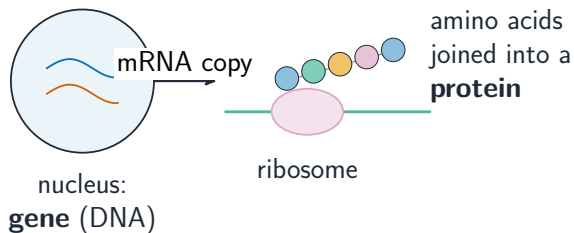
1 : 1

girls (XX, purple)

boys (XY, blue)

- The 23rd pair are the **sex chromosomes** : **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** sets the amino-acid order. But the gene stays in the **nucleus** and proteins are made in the **cytoplasm**, so **messenger RNA** carries the message out.

- **mRNA** carries the message
- a **ribosome** 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** three at a time and joins amino acids in the matching order.

Which proteins

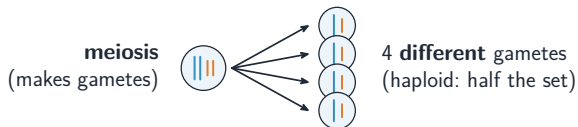
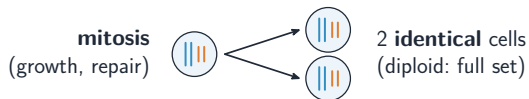
Enzymes, membrane carriers, and **receptor proteins** for **neuro-transmitters** – so controlling proteins controls the whole cell.

Same genes, different job

Nearly every body cell holds the **same** genes, but each one only **expresses** (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** – 2 **identical** **diploid** cells; growth & repair
- **meiosis** – 4 **different** **haploid** gametes



Inheritance key words

BB → brown eyes

Bb → brown eyes

bb → blue eyes

B (brown) is dominant

b (blue) is recessive

- **genotype** – the alleles;
phenotype – what you see
- **dominant** (B) shows with one copy
- **recessive** (b) needs two
- **homozygous** BB/bb;
heterozygous Bb

Two more words, and a family tree

Pure-breeding

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

Pedigree diagram

A **pedigree diagram** 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** – so each **daughter cell** 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** predicts the offspring.

■ $Bb \times Bb \rightarrow 3:1$

■ $Bb \times bb \rightarrow 1:1$

A **test cross** (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

both alleles show: $I^A I^B \rightarrow$
blood group AB

sex linkage

a gene on the X; **colour blindness** is commoner in boys

Sex chromosomes, sex linkage and blood groups

Sex chromosomes

The 23rd pair are the **sex chromosomes** : XX in a female, XY in a male, so the father's gamete decides the sex.

Sex-linked

A **sex-linked** characteristic is controlled by a gene on a sex chromosome, usually the X.

Red-green colour blindness

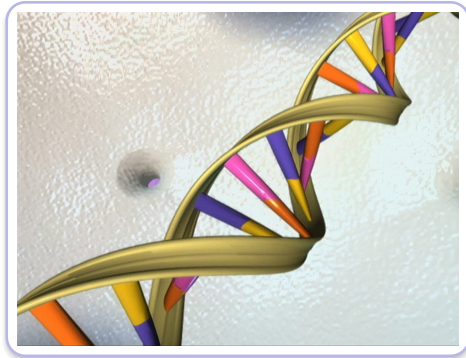
Red-green colour blindness is the standard example: the recessive allele sits on the X, so it is far more common in boys – they have no second X to mask it.

Blood groups

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

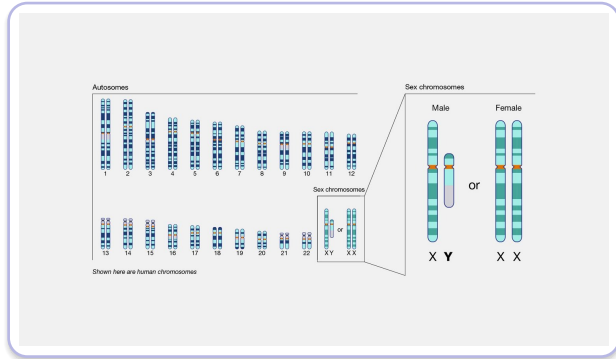
Write a sex-linked genotype on the chromosome: $X^B X^b$, not Bb . Half the marks are in the notation.

Chromosomes, genes and DNA, continued



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**

stem cells

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

the alleles an organism has – its genetic make-up

phenotype

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).



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