

Inheritance

IGCSE Biology 0610 · Topic 17 revision notes

Everything from the 5 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Chromosomes, genes and proteins

2. Mitosis

3. Meiosis

4. Monohybrid crosses

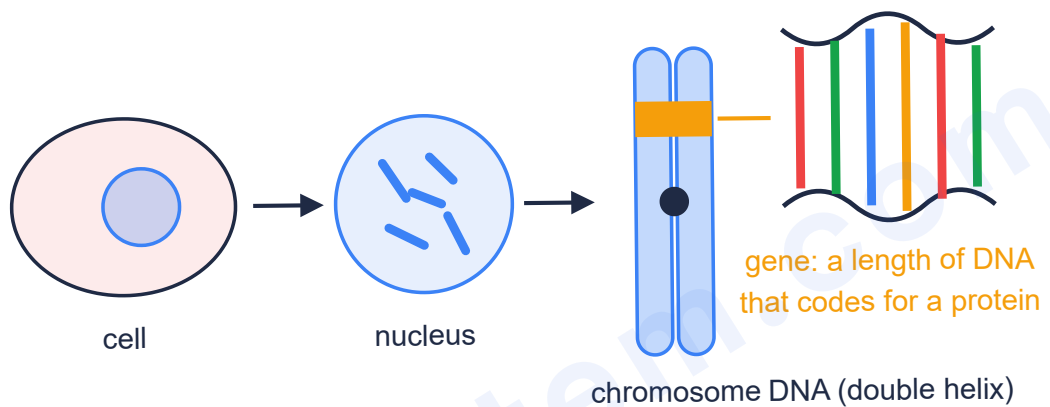
5. Pedigrees, codominance and sex linkage

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1 Chromosomes, genes and proteins

Syllabus 17.1

Chromosomes are made of **DNA**, which contains genetic information in the form of **genes**. A **gene** is a length of DNA that codes for a protein, and an **allele** is an alternative form of a gene. Females are **XX** and males are **XY**. Extended: the sequence of bases in a gene sets the sequence of amino acids in a protein, and that sequence sets the protein's shape.



human body cell: 46 chromosomes = 23 pairs

Fig. 1: zooming in from a cell to its nucleus, a chromosome and the DNA of one gene

Chromosome, gene, allele, protein.

- ✓ **Chromosome** = DNA; **gene** = length of DNA coding for a protein; **allele** = alternative form of a gene.
- ✓ **Sex:** XX female, XY male; eggs all X, sperm half X and half Y, so 1 : 1.
- ✓ **Extended:** gene stays in nucleus → mRNA copy → cytoplasm → ribosome joins amino acids in the order set by the bases.
- ✓ **Extended:** diploid = two sets (23 pairs in humans); haploid = one set (23).

Watch out!

Do not mix up gene and allele. The gene is the instruction for a feature such as flower colour; the alleles are the different versions of that instruction, such as purple and white.

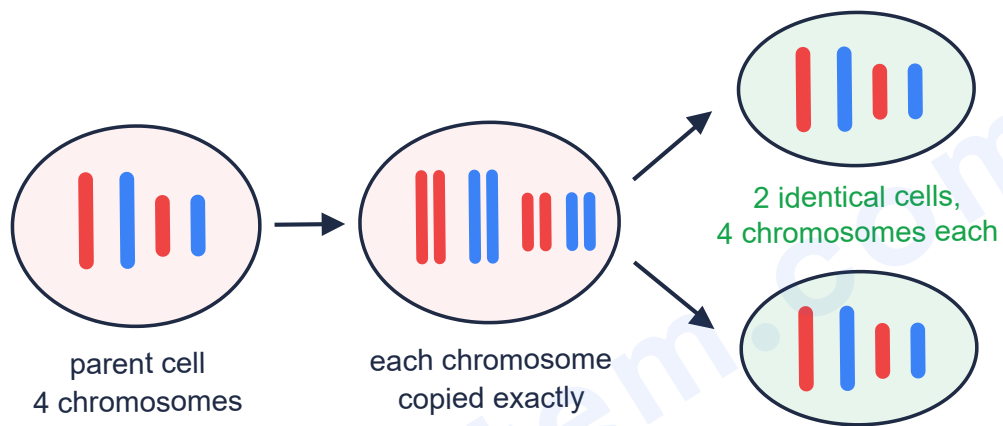
The mother cannot decide the sex of a child: all her eggs carry an X. Whether the child is XX or XY depends on which sperm fertilises the egg.

The DNA itself never leaves the nucleus. It is the mRNA copy that travels to the ribosome.

2 Mitosis

Syllabus 17.2

Mitosis is nuclear division giving rise to **genetically identical cells**. It is used for **growth**, **repair** of damaged tissues, **replacement** of cells and **asexual reproduction**. Extended: the chromosomes are replicated exactly before mitosis, and during mitosis the copies separate, so each daughter cell keeps the same chromosome number.



mitosis: growth, repair, replacement, asexual reproduction

Fig. 1: mitosis in a cell with two pairs of chromosomes gives two genetically identical cells

Identical cells, same number.

- ✓ **Mitosis** = nuclear division giving genetically identical cells.
- ✓ **Roles**: growth, repair of damaged tissues, replacement of cells, asexual reproduction.
- ✓ **Extended**: exact replication first, then the copies separate, so the chromosome number is kept.
- ✓ **Extended**: stem cells are unspecialised and divide by mitosis to give cells that can specialise.

Watch out!

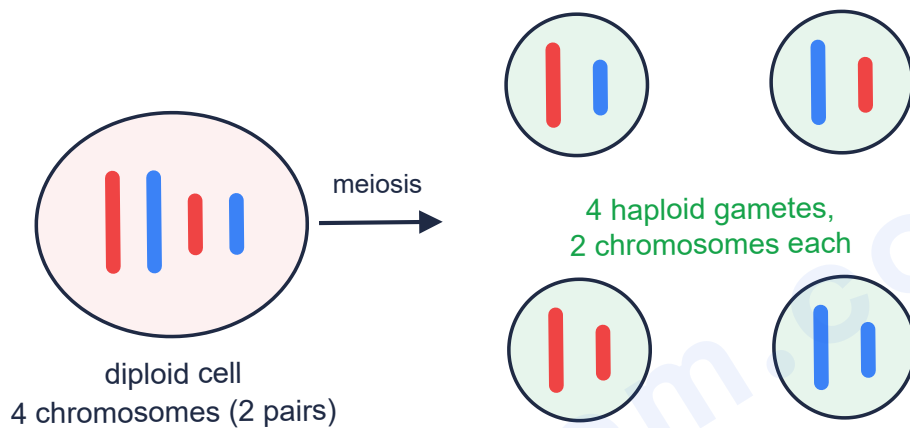
Mitosis does not halve the chromosome number. A human body cell with 46 chromosomes gives two cells that each have 46, with exactly the same alleles.

Stem cells are not already specialised. They become specialised only after dividing, when a daughter cell develops a particular structure and job.

3 Meiosis

Syllabus 17.3

Meiosis is involved in the production of **gametes**. Extended: it is a **reduction division** in which the chromosome number is halved from **diploid** to **haploid**, resulting in **genetically different** cells.



reduction division: diploid $\rightarrow$ haploid, genetically different

Fig. 1: meiosis turns one diploid cell into four haploid gametes, each with one chromosome from each pair

Gametes come from meiosis.

- ✓ **Meiosis** is involved in producing gametes (sperm, eggs, pollen nuclei).
- ✓ **Extended:** reduction division, diploid $\rightarrow$ haploid (46 $\rightarrow$ 23 in humans).
- ✓ **Extended:** the gametes are genetically different; mitosis gives identical cells.
- ✓ **Fertilisation** restores the diploid number: haploid + haploid = diploid zygote.

Watch out!

Haploid does not mean half a chromosome or half of each chromosome. It means a single set: one whole chromosome of each type.

The zygote divides by mitosis, not meiosis. Meiosis happens only when gametes are being made.

4 Monohybrid crosses

Syllabus 17.4

Genotype is the genetic make-up of an organism in terms of its alleles; **phenotype** is its observable features. A **dominant** allele is expressed if it is present; a **recessive** allele only when no dominant allele is present. Crossing two heterozygotes gives a **3 : 1** ratio; crossing a heterozygote with a homozygous recessive gives **1 : 1**.

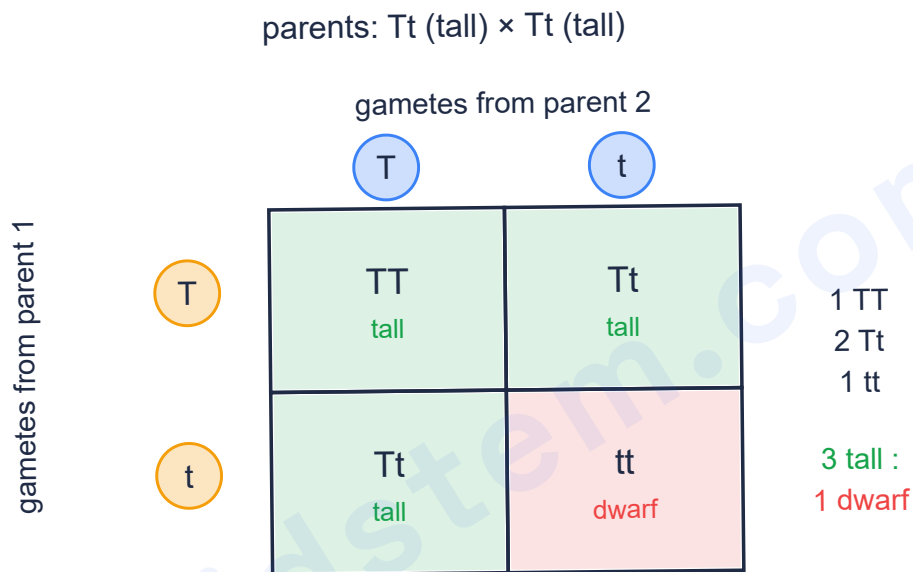


Fig. 1: a Punnett square for two heterozygous tall pea plants, Tt × Tt, giving 3 tall : 1 dwarf

Five lines, every time.

- ✓ **Parents:** phenotype and genotype of each (choose a letter, capital for dominant).
- ✓ **Gametes:** one allele per gamete, circled.
- ✓ **Punnett square:** every combination of the gametes gives the offspring genotypes.
- ✓ **Offspring:** phenotypes and the ratio (3 : 1 from Aa × Aa; 1 : 1 from Aa × aa).
Extended: a test cross uses aa.

Watch out!

Each gamete carries only ONE allele of the gene. Write the gametes as T and t, never as Tt, and circle each one.

All-black offspring do not prove the parent is BB: a Bb parent could, by chance, give only black pups. A large number of offspring makes the conclusion much more reliable.

5 Pedigrees, codominance and sex linkage

Syllabus 17.4

In a **pedigree diagram**, two unaffected parents with an affected child show that the allele is **recessive** and both parents are carriers. Extended: in **codominance** both alleles in a heterozygote contribute to the phenotype ($I^A I^B$ is blood group AB). A **sex-linked** gene is on a sex chromosome, so the feature is more common in one sex, as with red-green colour blindness.

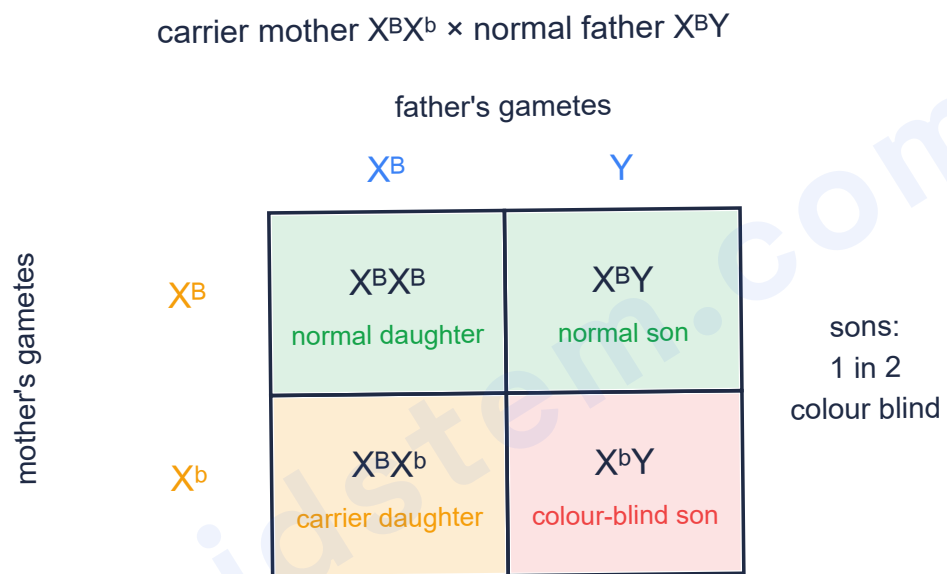


Fig. 1: a genetic diagram for red-green colour blindness: a carrier mother and a father with normal vision

Pedigrees, codominance, sex linkage.

- ✓ **Pedigree:** affected people first (aa for a recessive feature), then their parents and children.
- ✓ **Extended codominance:** both alleles contribute to the phenotype; $I^A I^B$ = group AB, I^o is recessive.
- ✓ **Extended sex linkage:** write alleles on the X: X^B , X^b ; the Y carries none.
- ✓ **Extended:** sons get their X from their mother; colour blindness is more common in males.

Watch out!

An unaffected person is not automatically AA. Look at their parents and children: an aa child or an aa parent proves they carry a.

A person can only have TWO of the three alleles. Group A is not always $I^A I^A$: it can be $I^A I^o$, which is how two group A parents can have a group O child.

A son can never inherit colour blindness from his father: a father passes his Y, not his X, to every son.