

The Mitotic Cell Cycle

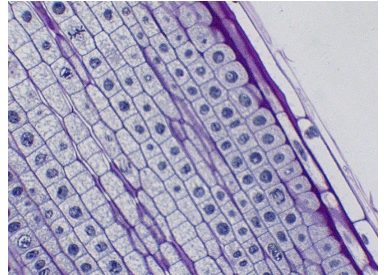
A-Level Biology ■ Topic 5

A-Level Biology



What we will cover

- 1 Chromosome structure
- 2 The cell cycle
- 3 The stages of mitosis
- 4 Telomeres
- 5 Stem cells
- 6 Tumours



cells caught dividing

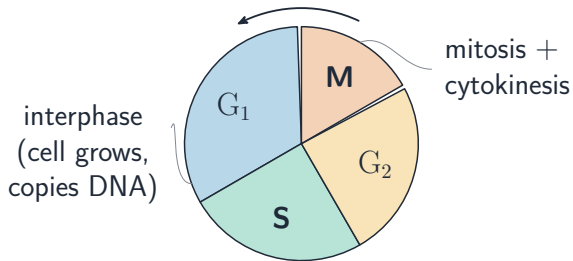


Chromosome structure

DNA wraps around **histone** proteins to make **chromatin** . Before mitosis it condenses into a visible chromosome of two **sister chromatids** joined at the **centromere** .

A chromatid is one copy of the replicated DNA. Once the centromere splits they are chromosomes.

The cell cycle



- **interphase** : grow (G₁), copy DNA (S), grow (G₂)

- **mitosis** : the nucleus divides

- **cytokinesis** : the cell splits

Mitosis makes **identical** cells – for growth, repair & **asexual reproduction** .

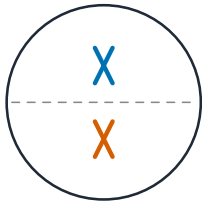


The four stages of mitosis

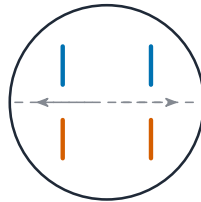
- **prophase** – chromosomes condense; **spindle** forms
- **metaphase** – line up at the **equator**
- **anaphase** – chromatids pulled apart
- **telophase** – two new nuclei form



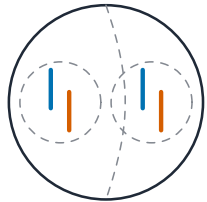
prophase



metaphase

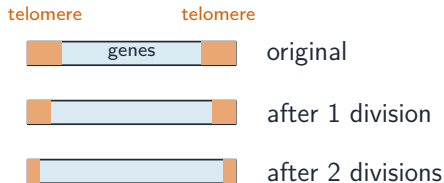


anaphase



telophase

Telomeres



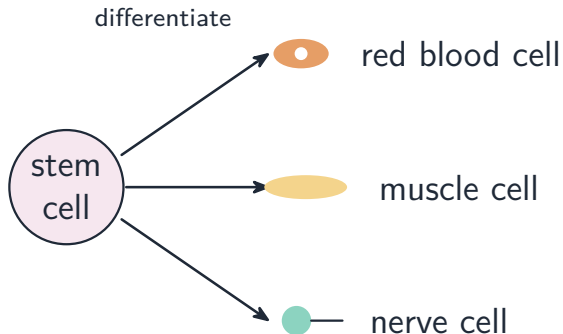
the telomeres shorten each time, but the genes are kept

Copying cannot reach the very end of the DNA, so a little is lost each division.

Telomeres carry **no genes**, so they shorten instead – protecting the genes in the middle.



Stem cells



A **stem cell** is unspecialised. It keeps dividing and can **differentiate** into many specialised cell types. They are the source of new cells for repair & replacement.

Uncontrolled division and tumours



controlled: cells stop dividing

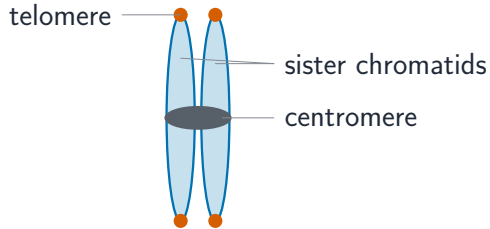


uncontrolled: a tumour grows

The cell cycle is normally tightly controlled, so cells divide only when needed.

If that control is lost, a cell divides again and again, forming a lump of cells – a **tumour**.

The structure of a chromosome



one chromosome = two identical copies after DNA replication

After replication a chromosome is two sister chromatids joined at the centromere, with telomeres at the tips

Chromosome structure, and why mitosis matters

a chromosome

one very long DNA molecule wound tightly around **histones**

why wound

so two metres of DNA fits inside a nucleus, and can be moved without tangling

the cell cycle

interphase (G1, S, G2), mitosis, then cytokinesis

growth

of **multicellular organisms** – more cells, genetically identical

repair and replacement

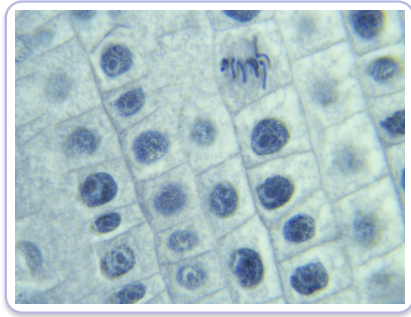
and asexual reproduction in many species

cytokinesis

in an animal cell the membrane **pinches inwards**; in a plant cell a **new wall forms** across the middle

Mitosis produces genetically identical **daughter cells** . Every use of it – growth, repair, asexual reproduction – depends on that identity.

Why mitosis matters



Onion root tip at metaphase: mitosis produces identical body cells for growth and repair

Exam tips

- Learn the stages **in order** (prophase, metaphase, anaphase, telophase) with one key event each; interphase (G1, S, G2) is **not** part of mitosis.
- Mitosis gives **two genetically identical diploid** cells – for growth, repair and asexual reproduction.
- **Mitotic index** = cells in mitosis $\div$ total cells; a high value means rapid division.
- Link **uncontrolled mitosis** to tumours and telomere shortening to the limit on the number of divisions.



Worked example – mitotic index

In a root-tip sample, 8 of the 50 cells seen are in mitosis. Find the mitotic index.

- Mitotic index = $\frac{\text{cells in mitosis}}{\text{total cells}}$
- $= \frac{8}{50} = 0.16$ (or 16%)
- It is a **proportion**, so it has no units.
- A high index means a lot of division – normal in a root tip, but a warning sign in other tissue.

Count **every** cell in the field, not just the dividing ones. Cells with **visible chromosomes** are in mitosis; a plain nucleus means interphase.

Topic 5 – key takeaways

1

Chromosome

sister chromatids joined at a centromere

2

Cell cycle

interphase (G_1 , S, G_2) then mitosis

3

Mitosis

prophase, metaphase, anaphase, telophase

4

Control

stem cells differentiate; lost control → tumour

Check yourself

- 1 What joins two sister chromatids?
- 2 In which interphase stage is DNA copied?
- 3 At which stage do chromosomes line up at the equator?
- 4 What forms when cell-cycle control is lost?



Answers 1. the centromere 2. the S phase 3. metaphase 4. a tumour