

Exercise walk-through

Replication and division of nuclei and cells ■ 5.1

eXercise

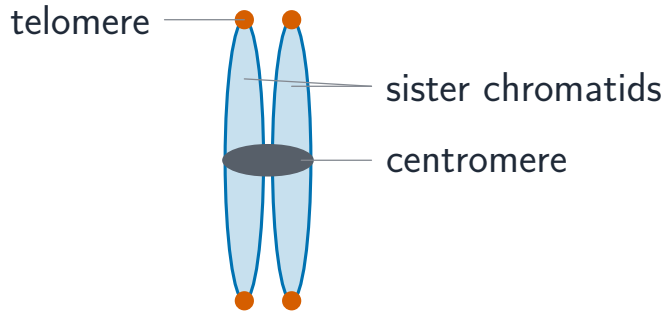
You must be able to

- describe the structure of a chromosome (DNA, histones, sister chromatids, centromere, telomeres)
- explain the importance of mitosis and outline the cell cycle (interphase, mitosis, cytokinesis)
- outline the roles of telomeres and stem cells, and how a tumour forms

Method — The structure of a chromosome

A chromosome is one long DNA molecule wound around **histone** 组蛋白 proteins. After **replication** 复制 it is two identical **sister chromatids** 姐妹染色单体 joined at the **centromere** 着丝粒, with **telomeres** capping the tips.

Method — The structure of a chromosome



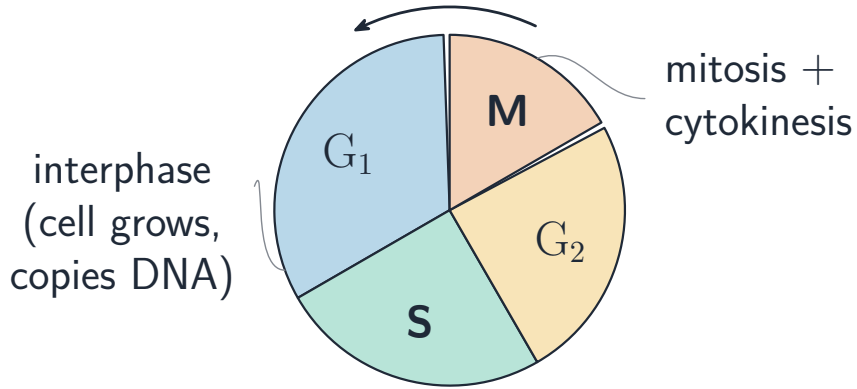
one chromosome = two identical copies after DNA replication

Method — The mitotic cell cycle

- **interphase** 间期 — growth (G), DNA replication (S), growth/preparation (G).
- **mitosis** 有丝分裂 — the nucleus divides into two **genetically identical** nuclei.
- **cytokinesis** 胞质分裂 — the cell splits into two daughter cells.

Mitosis matters for growth, replacement of dead cells, tissue repair and **asexual reproduction** 无性生殖.

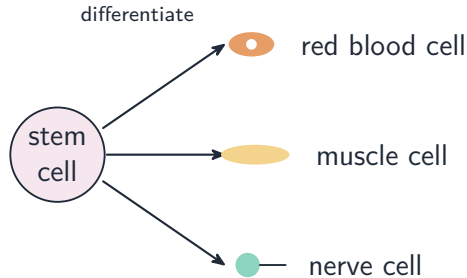
Method — The mitotic cell cycle



A pie chart of the cell cycle: a large interphase (G_1 , S , G_2) and a small M phase

Method — Telomeres, stem cells and tumours

Telomeres carry **no genes**, so the small amount lost at each replication does not lose genes. A **stem cell** is unspecialised, keeps dividing, and can **differentiate** 分化 into specialised cells. If the control of the cycle is lost, a cell divides uncontrollably to form a **tumour**.



Practice 2.1 ■ 2 marks

Name the parts of a chromosome labelled by these descriptions: (a) where two sister chromatids are joined; (b) the protective caps at the tips.

Solution 2.1

Method: The structure of a chromosome

Worked steps

(a) centromere **B1**; (b) telomeres **B1**.

Practice 2.2 ■ 1 mark

State what happens in the **S phase** of interphase.

Solution 2.2

Method: The mitotic cell cycle

Worked steps

the DNA is replicated / copied **B1**.

Exam-style 3.1 ■ 1 mark

During which phase of the cell cycle is DNA replicated?

A G

B S

C G

D mitosis

Solution 3.1

Method: The mitotic cell cycle

A G

B S



C G

D mitosis

Worked steps

B. DNA is replicated in the S phase.

Exam-style 3.2 ■ 1 mark

Why does the loss of a small length of telomere during replication **not** harm the cell?

- A** telomeres are made of protein
- B** telomeres carry no genes
- C** telomeres are replaced by histones
- D** the lost DNA is copied later

Solution 3.2

Method: Telomeres, stem cells and tumours

- A telomeres are made of protein
- B telomeres carry no genes
- C telomeres are replaced by histones
- D the lost DNA is copied later



Worked steps

B. Telomeres carry no genes, so losing a little does not lose genes.

Exam-style 3.3 ■ 3 marks

Explain why mitosis produces two genetically identical daughter cells, and give **two** situations where this is important.

Solution 3.3

Method: The mitotic cell cycle

Worked steps

mitosis copies the DNA exactly (S phase) and separates identical sister chromatids, so each daughter gets an identical set of genes **M1**; any two of: growth / replacement of dead cells / tissue repair / asexual reproduction **A1 A1**.

Exam-style 3.4 ■ 2 marks

- (a) State what is meant by a stem cell.
- (b) Explain how the loss of control of the cell cycle can lead to a tumour.

Solution 3.4

Method: Telomeres, stem cells and tumours

Worked steps

- (a) an unspecialised cell **B1** that can keep dividing and can differentiate into specialised cells **B1**.
- (b) the cell divides repeatedly without stopping **M1**, forming an uncontrolled mass of cells — a tumour **A1**.