

5.1 Replication and division of nuclei and cells

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS cell cycle • chromosome • mitosis • telomere
• stem cell

Objective

Build the skills to answer exam questions on **replication and division of nuclei and cells** – the structure of a **chromosome**, the **mitotic cell cycle**, **telomeres**, **stem cells** and **tumours**.

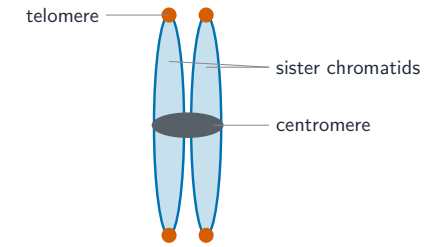
You must be able to:

- 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

1 Key knowledge and worked examples

■ The structure of a chromosome

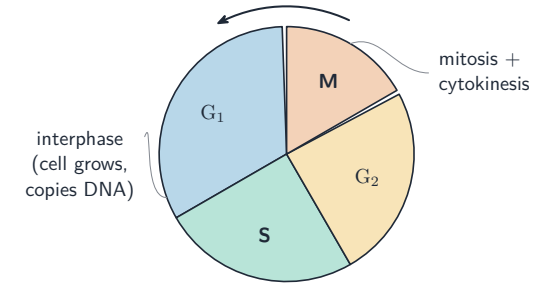
A chromosome is one long DNA molecule wound around **histone** proteins. After **replication** it is two identical **sister chromatids** joined at the **centromere**, with **telomeres** capping the tips.



one chromosome = two identical copies after DNA replication

After replication: two sister chromatids joined at the centromere, telomeres at the tips

■ The mitotic cell cycle



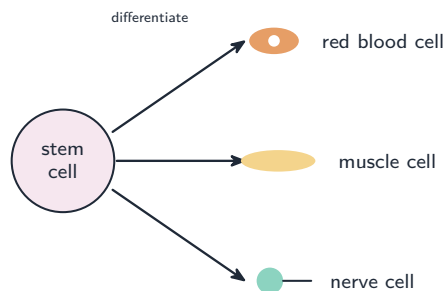
Most of the cycle is interphase (G₁, S, G₂); mitosis and cytokinesis are short

- interphase** – growth (G₁), DNA replication (S), growth/preparation (G₂).
- mitosis** – the nucleus divides into two **genetically identical** nuclei.
- cytokinesis** – the cell splits into two daughter cells.

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

■ 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** into specialised cells. If the control of the cycle is lost, a cell divides uncontrollably to form a **tumour**.



One stem cell can differentiate into many specialised cell types

2 Practice

2.1 Name the parts of a chromosome labelled by these descriptions: (a) where two sister chromatids are joined; (b) the protective caps at the tips. [2]

2.2 State what happens in the **S phase** of interphase. [1]

3 Exam-style questions

3.1 During which phase of the cell cycle is DNA replicated? [1]

- ☐ **A** G_1
☐ **B** S
☐ **C** G_2
☐ **D** mitosis

3.2 Why does the loss of a small length of telomere during replication **not** harm the cell? [1]

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

3.3 Explain why mitosis produces two genetically identical daughter cells, and give **two** situations where this is important. [3]

3.4 (a) State what is meant by a stem cell. [2]

(b) Explain how the loss of control of the cell cycle can lead to a tumour. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

(a)

- centromere

(b)

- telomeres

2.2

- the DNA is replicated / copied

3.1 B

- DNA is replicated in the S phase

3.2 B

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

3.3

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

3.4

(a)

- an unspecialised cell that can keep dividing and can differentiate into specialised cells

(b)

- the cell divides repeatedly without stopping, forming an uncontrolled mass of cells – a tumour