5.2 Chromosome behaviour in mitosis

Name: _____ Class: _____ Date: _____ **Total: 27 marks**

KEY WORDS telophase • prophase • anaphase • metaphase • spindle

Objective

Build the skills to answer exam questions on **chromosome behaviour in mitosis** – the four stages, the behaviour of the **spindle** and **nuclear envelope**, and identifying stages in **micrographs**.

You must be able to:

- describe what chromosomes, the nuclear envelope, the membrane and the spindle do in each stage
- name and identify prophase, metaphase, anaphase and telophase from diagrams and slides
- calculate a **mitotic index**

1 Key knowledge and worked examples

The four stages of mitosis

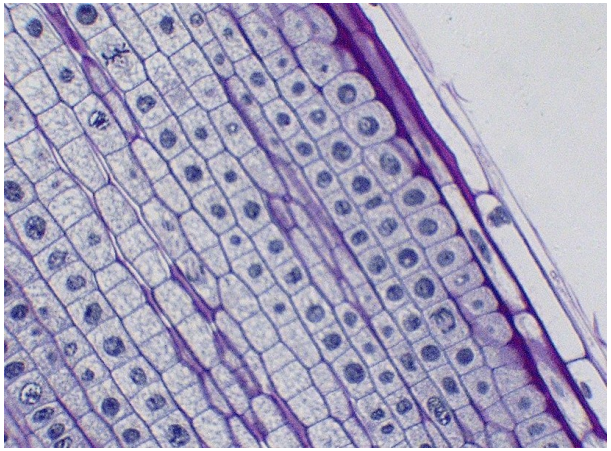
stage	what happens
prophase	chromosomes coil and become visible (two chromatids); nuclear envelope breaks down; spindle forms
metaphase	chromosomes line up at the **equator**; spindle fibres attach to each centromere
anaphase	centromeres split; sister chromatids are pulled to opposite **poles**
telophase	a set reaches each pole; a new nuclear envelope forms around each – two nuclei

The four stages: prophase, metaphase, anaphase, telophase

Then **cytokinesis** splits the cell into two genetically identical daughter cells.

Identifying stages in a micrograph

Look for the clue in each cell: chromosomes lined up in the middle = metaphase; chromatids being pulled apart in a V-shape = anaphase.



An onion root tip – a growing tip catches many cells in mitosis

The mitotic index

The **mitotic index** is the fraction of cells that are in mitosis:

$$\text{mitotic index} = \frac{\text{number of cells in mitosis}}{\text{total number of cells}}.$$

A high index means many cells are dividing (e.g. a growing tip or a tumour).

2 Practice

2.1 Name the stage of mitosis in which: (a) chromosomes line up at the equator; (b) sister chromatids are pulled to opposite poles. [2]

2.2 State what happens to the nuclear envelope during (a) prophase and (b) telophase. [2]

3 Exam-style questions

3.1 In which stage of mitosis do the centromeres split and the chromatids move apart? [1]

- **A** anaphase
- **B** metaphase
- **C** prophase
- **D** telophase

3.2 A cell is seen with its chromosomes lined up single-file across the centre of the cell. This cell is in: [1]

- **A** anaphase
- **B** interphase
- **C** metaphase
- **D** telophase

3.3 A student examines a root tip and counts the cells in each stage:

stage	interphase	prophase	metaphase	anaphase	telophase
number of cells	84	9	4	2	1

(a) Calculate the mitotic index for this sample. Show your working. [2]

(b) The cells of a tumour have a much higher mitotic index than normal tissue. Explain why. [2]

3.4 Describe the behaviour of the chromosomes and the spindle during metaphase and anaphase. [4]

3.5 Four cells from a root tip were each seen in a different stage of mitosis.

- **W** chromosomes lined up singly along the equator
- **X** chromatids being pulled towards opposite poles
- **Y** chromosomes at the poles, nuclear envelopes re-forming
- **Z** chromosomes condensing and becoming visible, nuclear envelope breaking down

(a) Name the stage shown by each cell, and put the four in the correct order. [5]

(b) Describe what the spindle does in stages **W** and **X**. [3]

(c) A root tip contained 240 cells, of which 12 were in stage **X**. The whole cell cycle takes 20 hours. Estimate how long stage **X** lasts, showing your working. [3]

(d) Explain why mitosis must produce genetically identical daughter nuclei, and name **one** process in the cell cycle that ensures this. [2]