

Exercise walk-through

Chromosome behaviour in mitosis ■ 5.2

eXercise

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** 有丝分裂指数

Method — The four stages of mitosis

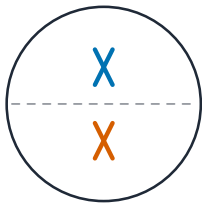
stage	what happens
prophase 前期	chromosomes coil and become visible (two chromatids); nuclear envelope breaks down; spindle forms
metaphase 中期	chromosomes line up at the equator 赤道; spindle fibres attach to each centromere
anaphase 后期	centromeres split; sister chromatids are pulled to opposite poles 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

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

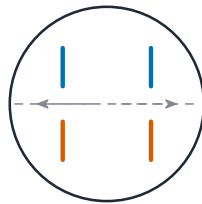
Method — The four stages of mitosis



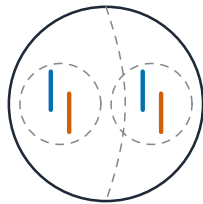
prophase



metaphase



anaphase



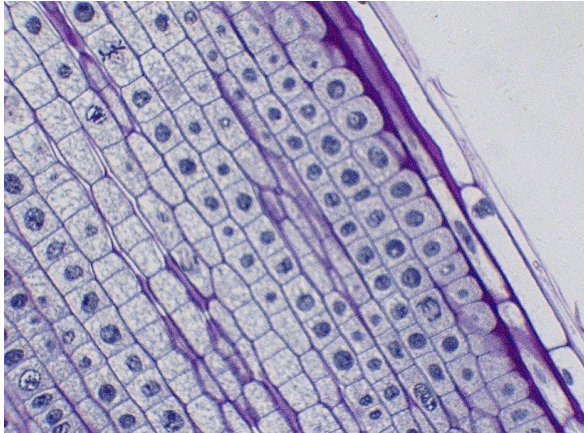
telophase

Four cells showing prophase, metaphase, anaphase and telophase

Method — 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.

Method — Identifying stages in a micrograph



A stained light micrograph of an onion root tip with many cells, several dividing

Method — 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).

Practice 2.1 ■ 2 marks

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

Solution 2.1

Method: The four stages of mitosis

Worked steps

(a) metaphase **B1**; (b) anaphase **B1**.

Practice 2.2 ■ 2 marks

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

Solution 2.2

Method: The four stages of mitosis

Worked steps

(a) it breaks down / disappears **B1**; (b) it re-forms around each set of chromosomes **B1**.

Exam-style 3.1 ■ 1 mark

In which stage of mitosis do the centromeres split and the chromatids move apart?

A anaphase

B metaphase

C prophase

D telophase

Solution 3.1

Method: The four stages of mitosis

A anaphase



B metaphase

C prophase

D telophase

Worked steps

A. In anaphase the centromeres split and chromatids move to opposite poles.

Exam-style 3.2 ■ 1 mark

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

A anaphase

B interphase

C metaphase

D telophase

Solution 3.2

Method: Identifying stages in a micrograph

A anaphase

B interphase

C metaphase



D telophase

Worked steps

C. Chromosomes lined up across the centre is metaphase.

Exam-style 3.3 ■ 2 marks

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

Solution 3.3

Method: The four stages of mitosis

Worked steps

(a) cells in mitosis = $9 + 4 + 2 + 1 = 16$; total = $84 + 16 = 100$ (M1). mitotic index
 $= \frac{16}{100} = 0.16$ (A1).

(b) the tumour cells divide uncontrollably / continuously (M1), so at any moment a larger fraction are in mitosis (A1).

Exam-style 3.4 ■ 4 marks

Describe the behaviour of the chromosomes and the spindle during metaphase and anaphase.

Solution 3.4

Method: The four stages of mitosis

Worked steps

metaphase: chromosomes line up at the equator **B1**; spindle fibres attach to the centromeres **B1**; anaphase: centromeres split **B1**; sister chromatids are pulled by the spindle to opposite poles **B1**.