

## 5.2 Chromosome behaviour in mitosis

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

Total: 14 marks

### Objective

Build the skills to answer exam questions on **chromosome behaviour in mitosis** — the four stages, the behaviour of the **spindle** 纺锤体 and **nuclear envelope** 核膜, and identifying stages in **micrographs** 显微照片.

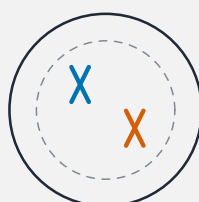
You must be able to:

- 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

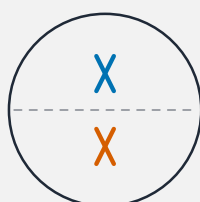
### 1 Worked examples

#### ■ The four stages of mitosis

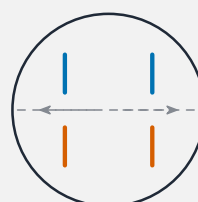
| stage               | what happens                                                                                      |
|---------------------|---------------------------------------------------------------------------------------------------|
| <b>prophase</b> 前期  | chromosomes coil and become visible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



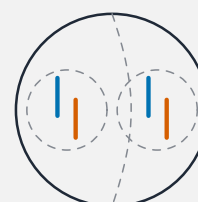
prophase



metaphase



anaphase



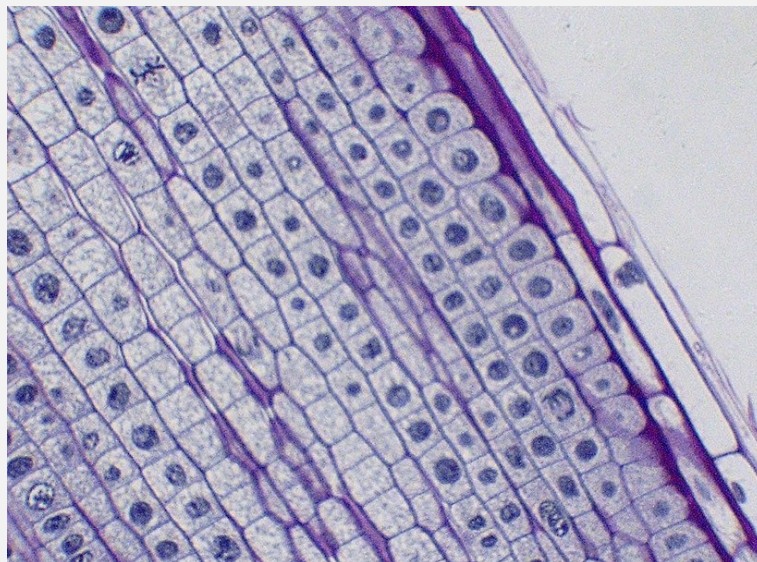
telophase

*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*

Image: source

### ■ 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]

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

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### 3 Exam-style questions

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**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
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**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         |

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(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]

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## 4 Go further

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You are now ready for the real exam questions on this subtopic. Open the **5.2 Chromosome behaviour in mitosis** past-paper sheet in the Library, or try these in **Practice mode**:

- 9700/11 N25 —Q19 (stages of mitosis)
- 9700/13 N25 —Q23 (identifying mitosis stages)
- 9700/22 N25 —Q1 (mitosis, structured calculation)

## Solutions

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

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

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

**3.2 C.** Chromosomes lined up across the centre is metaphase.

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

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

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