PEARSON EDEXCEL · INTERNATIONAL A-LEVEL · BIOLOGY • EXERCISE SHEET

2.3 Mitosis, the cell cycle and mitotic index

Name: _____ Class: _____ Date: _____ **Total: 19 marks**

KEY WORDS prophase • metaphase • anaphase • telophase • cytokinesis • mitotic index

Objective

Practise statements 3.14-3.16 with Core Practical 6: the cell cycle, the four stages of mitosis, the mitotic index and its calculation.

1 Key knowledge and worked examples

■ The cycle and the four stages

Interphase (G_1 growth, **S** DNA replication, G_2 preparation) fills most of the cycle. Mitosis: **prophase** – chromosomes condense and become visible, spindle forms; **metaphase** – chromosomes line up on the equator; **anaphase** – spindle fibres shorten and pull chromatids to opposite poles; **telophase** – nuclear membranes reform, chromosomes uncoil. Then **cytokinesis** divides the cytoplasm.

■ Mitotic index

$$\text{mitotic index} = \frac{\text{cells in mitosis}}{\text{total cells counted}}$$

High index = fast division (growing tissue, tumour).

■ Worked example: index to time

450 root-tip cells: 36 in mitosis → index 0.08. If the full cycle takes 16 hours, mitosis lasts $0.08 \times 16 = 1.3$ hours. A tumour sample with index 0.35 is dividing over four times faster – and the fraction in S phase tells you how many cells are copying DNA, the target of several cancer drugs.

2 Practice

2.1 Name the stage of mitosis in which chromosomes first condense, and the stage in which chromatids separate. [2]

2.2 State two roles of mitosis in a plant. [2]

2.3 A tissue sample of 600 cells shows 42 in mitosis. Calculate the mitotic index. [1]

3 Exam-style questions

3.1 Describe what happens to chromosomes and to the spindle in metaphase and anaphase of mitosis, and state one difference you would see under the microscope between a cell in anaphase and one in telophase. [5]

3.2 The table shows the mitotic index of two tissue samples taken from a patient.

Sample	Cells counted	Cells in mitosis
A (skin)	500	25
B (biopsy)	500	210

Calculate both mitotic indices, state which sample is more likely to be tumour tissue, and explain what a high index means about the proportion of cells in interphase. [4]

3.3 A student prepares a root-tip squash to observe mitosis. Describe how the root tip should be treated before observation, why the cells can be seen without cutting sections, and how the student should decide which stage a cell is in. [5]

Solutions

Original-task marking: M1 method, A1 accuracy, B1 reasoning.

2.1 Prophase; anaphase.

2.2 Any two of growth, repair of damaged tissue, asexual reproduction.

2.3 $42/600 = 0.07$.

3.1 Metaphase: chromosomes, each of two chromatids joined at the centromere, line up on the equator attached to the spindle by their centromeres. Anaphase: spindle fibres shorten and pull the chromatids apart to opposite poles. In telophase two new nuclear membranes reform around each group, while anaphase cells show one cell with two separating groups and no reformed membranes.

3.2 A: $25/500 = 0.05$; B: $210/500 = 0.42$. B – a far higher fraction dividing. Only 58% of B's cells are in interphase, against 95% in A: the tumour tissue has proportionally left the resting stage.

3.3 Treat with a stain and a dilute acid to soften the tissue, then press the cover slip to squash the tip to a single layer of cells so light passes through without sectioning. Identify the stage by the chromosomes' state: condensed and equatorial = metaphase; chromatids separating toward poles = anaphase.