

27.1 Cell division: count nuclei and chromosomes carefully

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS chromatid • mitotic index

Objective

Cell division: count nuclei and chromosomes carefully. Original classroom practice for IB SL; not an official IB paper.

1 Key knowledge and worked examples

■ What would explain this observation?

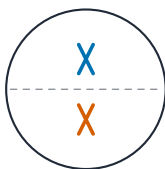
- A root-tip image contains cells at different stages of mitosis. A snapshot can estimate the fraction of cells dividing, but it does not time one observed cell directly.

■ Build the model

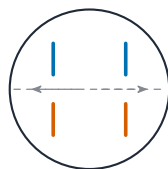
- DNA replication occurs before mitosis.
- Mitosis separates sister **chromatids**, preserving chromosome number in daughter nuclei.
- Meiosis includes homologous chromosome separation and normally halves the chromosome number while generating variation.
- **mitotic index**: Fraction of scored cells undergoing mitosis.
- chromatid: One copy of a replicated chromosome before separation.



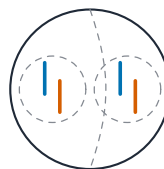
prophase



metaphase



anaphase



telophase

■ Choose evidence that can test it

- Count chromosomes by centromeres under the stated convention.
- DNA amount and chromosome number are different quantities.
- Crossing over and independent assortment contribute to meiotic variation.

In the lab: Use a prepared root-tip slide or a labelled image. Define a counting rule and field selection before counting. Distinguish dividing cells from damaged or ambiguous cells and report exclusions.

■ Work from known quantities

- Known: 25 dividing cells among 200 scored cells.
- Mitotic index = $25/200 = 0.125$, or 12.5%.
- Estimating phase duration from this proportion requires assumptions about a steady, representative cell population.

Your turn: 18 of 120 scored cells are dividing. Calculate mitotic index as a percentage.

■ Check the conclusion and its limits

- Replication doubles DNA amount without immediately doubling the chromosome count.
- Meiosis does not simply produce two identical diploid cells.

Not true: DNA replication immediately doubles chromosome number under the centromere convention. Under the centromere convention a chromosome with two sister chromatids still counts as one chromosome. Replication doubles DNA content; only sister-chromatid separation later doubles the chromosome count.

Key:

- DNA replication occurs before mitosis.
- Count chromosomes by centromeres under the stated convention.
- Watch for: replication doubles DNA amount without immediately doubling the chromosome count.

■ Write from a mitotic index of 12 percent

- 9 of 75 scored cells are dividing.
- Find the mitotic index. Under the centromere convention, replication does not immediately double the chromosome number.

2 Practice

2.1 What happens to DNA amount during replication before mitosis? Choose one answer.

- **A** It disappears
 - **B** It doubles
 - **C** It always halves
- [1]

2.2 18 of 120 scored cells are dividing. Calculate mitotic index as a percentage. Show the relation, substitution and units.

[2]

2.3 Decide whether this claim is true and justify: DNA replication immediately doubles chromosome number under the centromere convention.

[2]

2.4 Fraction of scored cells undergoing mitosis: write the technical term.

[1]

3 Exam-style questions

3.1 In fictional snapshots, 30/200 cells and 18/120 cells are dividing. Does the smaller dividing count imply slower division? Could these observations establish phase duration?

[4]

Solutions

2.1 B Replication copies every DNA molecule, so the DNA amount doubles before mitosis while each chromosome still counts as one (two sister chromatids joined at a centromere). The DNA never disappears or halves during replication.

2.2 mitotic index = $18/120 \times 100 = 15\%$.

2.3 False. Under the centromere convention a chromosome with two sister chromatids still counts as one chromosome. Replication doubles DNA content; only sister-chromatid separation later doubles the chromosome count.

2.4 mitotic index. mitotic index means Fraction of scored cells undergoing mitosis.

3.1 Both indices are 15%. Counts have different denominators. Duration inference additionally needs a representative asynchronous steady population and cycle information; a snapshot alone is insufficient.