

Exercise walk-through

# 32.1

## Cell division: count nuclei and chromosomes carefully

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International Baccalaureate · IB Diploma · Biology · HL

# 32.1 Cell division: count nuclei and chromosomes carefully

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Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ **Total: 10 marks**

**KEY WORDS** chromatid • mitotic index

# Objective

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

## 1 Key knowledge and worked examples

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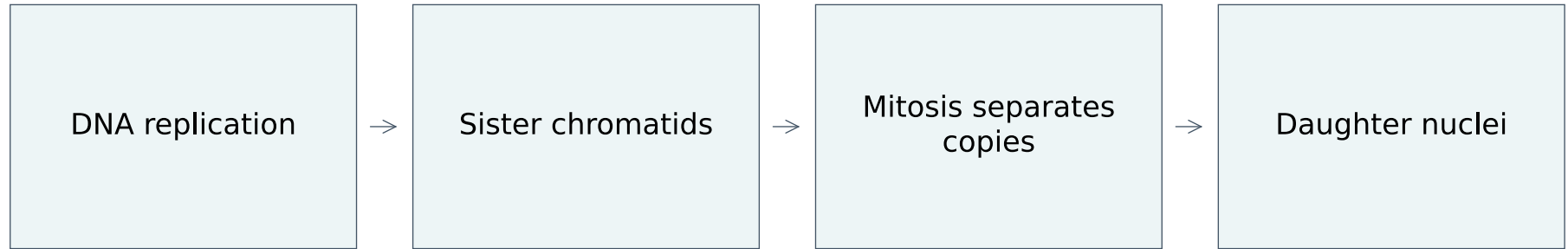
- What would explain this observation?
  - A root-tip image contains cells at different stages of mitosis. A snapshot can estimate the fraction of cells dividing, but it does not time one observed cell directly.

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## ■ 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.



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■ **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.

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■ **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.

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### ■ 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 cen-

tromere 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 20 percent**

- 8 of 40 scored cells are dividing.
- Find the mitotic index as a percentage. Chromosome number is not the same as DNA

amount.

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## Exercises 2.1-2.3

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**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]

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**2.2** 18 of 120 scored cells are dividing. Calculate mitotic index as a percentage. Show the relation, substitution and units. [2]

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**2.3** Decide whether this claim is true and justify: DNA replication immediately doubles chromosome number under the centromere convention. [2]

## Exercises 2.1-2.3

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**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]

**2.1 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.

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**2.2** 18 of 120 scored cells are dividing. Calculate mitotic index as a percentage. Show the relation, substitution and units. [2]

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

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**2.3** Decide whether this claim is true and justify: DNA replication immediately doubles chromosome number under the centromere convention. [2]

**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.

## Exercises 2.4·3.1

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**2.4** Fraction of scored cells undergoing mitosis: write the technical term. [1]

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**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]

## Exercises 2.4·3.1

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**2.4** Fraction of scored cells undergoing mitosis: write the technical term. [1]

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

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**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]

**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.