

Mitotic index and Duration of the cell cycle

Objectives:

Upon completion of this lab, the students should be able to:

1. Understand the meaning of mitotic index and duration of stages (phases)
2. Calculate the mitotic indexes
3. Calculate the duration of stages (phases) of different organisms
4. Comment on any experimental results

Mitotic Index (MI)

It is defined as the percentage ratio of cells undergoing mitosis (as seen in the region of most mitotic activity) to the total number of observed.

On the basis of the equation namely

$$\text{MI} = \frac{\text{Total number of dividing cells}}{\text{Total number of counted cells}} \times 100$$

Mitotic index is used to quantify the differences in cell division when environmental parameters are changed.

N.B.

Mitotic activity (and MI in turn) decreases with increasing distance from the zone of meristematic cells in the root tip.

Duration of the Cell Cycle:

On the basis of nuclear events, cell cycle is usually divided into a short mitosis (M) phase followed by a much longer interphase. The division cycle of cell cycle phases varies considerably in different kinds of organisms, whereas

The duration of any stage (or phase) in the cell cycle (minutes) =

- Cycle duration of higher plants = **1440** min (divide every 24 hr).
- Cycle duration of yeast cells = **120** min (divide every 2 hr).

The duration of any phase in the cell cycle (in minutes) =

Number of phase cells x Cell cycle duration of the organism (in min.)

Total number of cells

Dissolved Problem:

Cells of *Saccharomyces cerevisiae* (yeast) were treated with the fungicide 'Chlorothalonil'. The following data show the effect of the treatment on the various mitotic stages as compared with control cells.

Phases of cell cycle	Number of cells in the phase	
	Control	Treatment
Interphase	180	187
Prophase	9	5
Metaphase	7	6
Anaphase	2	1
Telophase	2	1
Total	200	200

- a. Calculate the mitotic indices in both cases.
- b. Calculate the time spent in each phase (in **min.**) of both cases.
- c. Comment on both (a) and (b) data.

1. Calculation of MI

$$\text{MI} = \frac{\text{Number of dividing cells}}{\text{Total number of counted cells}} \times 100$$

$$\text{MI (control)} = (20 / 200) \times 100 = \mathbf{10}$$

$$\text{MI (treatment)} = (13 / 200) \times 100 = \mathbf{6.5}$$

Comment on MI:

- **Since MI control > MI treatment**, so the treatment decreases the no. of cells undergoing mitosis, as compared to control.
- This reveals the cytotoxic effect of the applied fungicide on the test organism.

2. Calculation of Phases Duration:

The duration of any phase in the cell cycle (in minutes) =

$$\frac{\text{Number of phase cells}}{\text{Total number of cells}} \times \text{Cell cycle duration of the organism (in min.)}$$

The cycle duration of yeast cell = 2 hour/cell cycle = **120 min**

The duration of different phases in the cell cycle in minutes is calculated in the following table:

	Control	Treatment
Interphase	$(180/200) \times 120 = \mathbf{108 \text{ min}}$	$(187/200) \times 120 = \mathbf{112.2 \text{ min}}$
Prophase	$(9/200) \times 120 = \mathbf{5.4 \text{ min}}$	$(5/200) \times 120 = \mathbf{3 \text{ min}}$
Metaphase	$(7/200) \times 120 = \mathbf{4.2 \text{ min}}$	$(6/200) \times 120 = \mathbf{3.6 \text{ min}}$
Anaphase	$(2/200) \times 120 = \mathbf{1.2 \text{ min}}$	$(1/200) \times 120 = \mathbf{0.6 \text{ min}}$
Telophase	$(2/200) \times 120 = \mathbf{1.2 \text{ min}}$	$(1/200) \times 120 = \mathbf{0.6 \text{ min}}$

Comment on Duration:

- Longer duration of interphase in treated cells than that of control cells confirms that MI of treated cells is lower than that of control cells.
- This is accompanied by a general decline in the duration of different dividing stages of the treated cells.

Student name:**Code number:**

STUDENT'S ASSIGNMENT
Give it to your laboratory instructor

Problem:

Vicia faba roots were treated with a nano-fungicide 'Trifloxystrobin'. The following data show the effect of the treatment on the various mitotic stages as compared with control plants.

phases of cell cycle	Number of cells in the phase	
	Control	Treatment
Interphase	176	189
Prophase	11	4
Metaphase	8	5
Anaphase	3	1
Telophase	2	1

- Calculate** the mitotic indices in both cases.
- Calculate** the time spent in each phase (in **min.**) of both cases.
- Comment** on both (a) and (b) data.

N.B.

equations must be written