Name _____ Period _____ Date _____

Recognizing the Stages of Mitosis and Timing of the Cell Cycle in an Onion Root Tip Adapted from von Bargen

1.6.S1: Identification of phases of mitosis in cells viewed with a microscope or in a micrograph

1.6.S2: Determination of a mitotic index from a micrograph

Grading Rubric

Section	**Points Possible**	**Points Received**
Format / Communication	2	
Drawings of Stage of Mitosis (titles and at least 2 labels)	5	
Data Tables (title, units and organization)	6	
Calculations • Fully worked exemplar for each type of calculation with units	2	
Graph • Title and labeled axes with units • Proper type of graph utilized • Data plotted properly	3	
Post Lab Questions	2	
Total Points Earned	20	

Introduction

The genetic information of plants, animals and other eukaryotic organisms resides in several (or many) individual DNA molecules, or **chromosomes**. For example, each human cell possesses 46 chromosomes, while each cell of an onion possesses 8 chromosomes. All cells must replicate their DNA when dividing. During **DNA replication**, the two strands of the DNA double helix separate, and for each original strand a new complementary strand is produced, yielding two identical DNA molecules. DNA replication yields an identical pair of DNA molecules (called sister **chromatids**) attached at a region called the **centromere**.

DNA replication in eukaryotes is followed by the process called mitosis. Mitosis assures that each daughter cell receives one copy of each of the replicated chromosomes. During the process of mitosis, the chromosomes pass through several stages known as **prophase, metaphase, anaphase and telophase**. The actual division of the cytoplasm is called **cytokinesis** and occurs during telophase. During each of the preceding stages, particular events occur that contribute to the orderly distribution of the replicated chromosomes prior to cytokinesis.

- **Prophase -** Chromosomes supercoil and the fibers of the spindle apparatus begin to form between **centrosomes** located at the pole of the cells. The nuclear membrane also disintegrates at this time, freeing the chromosomes into the surrounding cytoplasm.
- **Metaphase -** Chromosomes have come to rest along the center plane of the cell known as the metaphase plate.
- **Anaphase - Centromeres split** and the sister chromatids begin to **migrate** toward the opposite poles of the cell.
- **Telophase -** Chromosomes at either end of the cell cluster begin to cluster together, which facilitates the formation of a new nuclear membrane. This also is when **cytokinesis** occurs, leading to two separate cells. One way to identify that telophase has begun is by looking for the formation of the **cell plate**, the new cell wall forming between the two cells.

Materials

1 Microscope per pair

1 prepared onion root tip slide

PART I: Stages of Mitosis in an Onion Root Tip Pre-Lab

1. In your lab notebook, **draw one eukaryotic cell in each of the following phase of the cell cycle**. Examples are shown below. Be sure to title each drawing. The observable phases are:
   - Interphase
   - Prophase
   - Metaphase
   - Anaphase
   - Telophase/cytokinesis*

*Remember that telophase and cytokinesis often happen simultaneously

2. Label the following structures in your drawings. Each drawing should have at **least two** appropriate labels.
   - Cell membrane
   - Cell plate
   - Cell wall
   - Chromatin
   - Chromosome
   - Nuclear envelope
   - Sister chromatid

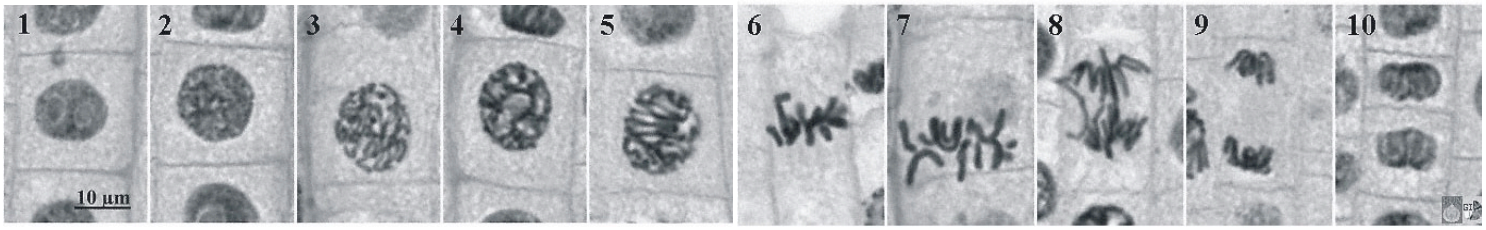

Image	Phase	Image	Phase	Image	Phase
1 → 2	Interphase	6 → 7	Metaphase	10	Telophase
3 → 5	Prophase	8 → 9	Anaphase		

PART II: Timing of the Cell Cycle in an Onion Root Tip

Procedures

1. Focus on one of the onion root tips in the slide on low power.
2. Switch the magnification to medium power, focus, and then repeat with high power. Note: you may need to center the root tip in the field of view each time so as to not lose your specimen.
3. On high power, observe **every cell in in the two different tips** of onion root tissue and determine which phase of the cell cycle it is in. This is best done in pairs. The partner observing the images calls out the phase of each cell while the other partner records the data in a tally chart. Switch roles so the recorder becomes the observer and visa versa.
4. Record your results in an IB quality data collection table.

Example data collection table:

Onion Root Tip	# of Cells in Interphase	# of Cells in Prophase	# of Cells in Metaphase	# of Cells in Anaphase	# of Cells in Telophase	Total # of Cells
1						
2						
Total						

Data Processing Table and Graph

1. In a second table gather the CLASS TOTAL for the number of cells in each phase of the cell cycle **for both views.**

Example data collection table:

Group	# of Cells in Interphase	# of Cells in Mitosis				Total # of Cells
		# of Cells in Prophase	# of Cells in Metaphase	# of Cells in Anaphase	# of Cells in Telophase	
1						
2						
Class Total						

2. In a third table, convert the number of cells in each stage of the cell cycle to a percentage, using the total number of cells counted as 100%.

Example data collection table:

	Cells in Interphase	Cells in Mitosis			
		Cells in Prophase	Cells in Metaphase	Cells in Anaphase	Cells in Telophase
Percentage					
Time (hr/min)					

3. In an onion root tip, the mitotic cycle generally takes about 24 hours. This is an approximation; the actual time may vary depending on the condition of the roots during growth. On the basis of a 24-hr cycle, work out the approximate time in hours and minutes that is spent in each stage. Include this information in your third data processing table. **HINT:** A common mistake is incorrectly converting decimals to minutes. For example, many people would incorrectly say that 10.33 hours is 10 hours and 33 minutes, when it is actually 10 hours and 20 minutes.
4. Show a worked example calculation for:
    1) The percentage of cells
    2) The time per each stage.
5. Create an appropriate IB quality graph that displays the time of a 24 hour cycle for each stage of the cell cycle.

Calculations

In any population of mitotically active cells, only some of the cells are in mitosis at any one time. The proportion of dividing cells is defined as the mitotic index.

Mitotic Index = Number of Cell in Mitosis / Total Number of Cells

1. Calculate the mitotic index based on the class data showing a completely worked calculation. Use the **Class Total** row on the number of cells in either **interphase or mitosis** to complete your calculations.
2. Record this value in your lab notebook.

Questions (answer in complete sentences in your lab notebook)

1. Which of the stages is the shortest? Explain if this complies with what you know to be the chromosomal events during the stage.
2. Which of the stages seems to be the longest in duration? Explain if this complies with the information you have received about the events during this stage.
3. If your observations had not been restricted to the area of the root tip that is actively dividing, how would your results have been different?
4. How can calculations of the mitotic index be used in the prediction and/or diagnosis of cancer? Knowing that cancer is a result of uncontrolled cell division, would a cancerous-tumor have a larger or smaller mitotic index than a non-cancerous tissue?