

Baker's Dozen Lab 7: Mitosis and Meiosis

Objectives

Before doing this lab you should understand the events of mitosis in animal and plant cells.

After doing this lab you should be able to recognize the stages of mitosis in a plant and/or animal cell and calculate the relative duration of the cell cycle stages.

Introduction

All new cells come from preexisting cells. New cells are formed by the process of cell division, which involves both division of the cell's nucleus (**karyokinesis**) and division of the cytoplasm (**cytokinesis**).

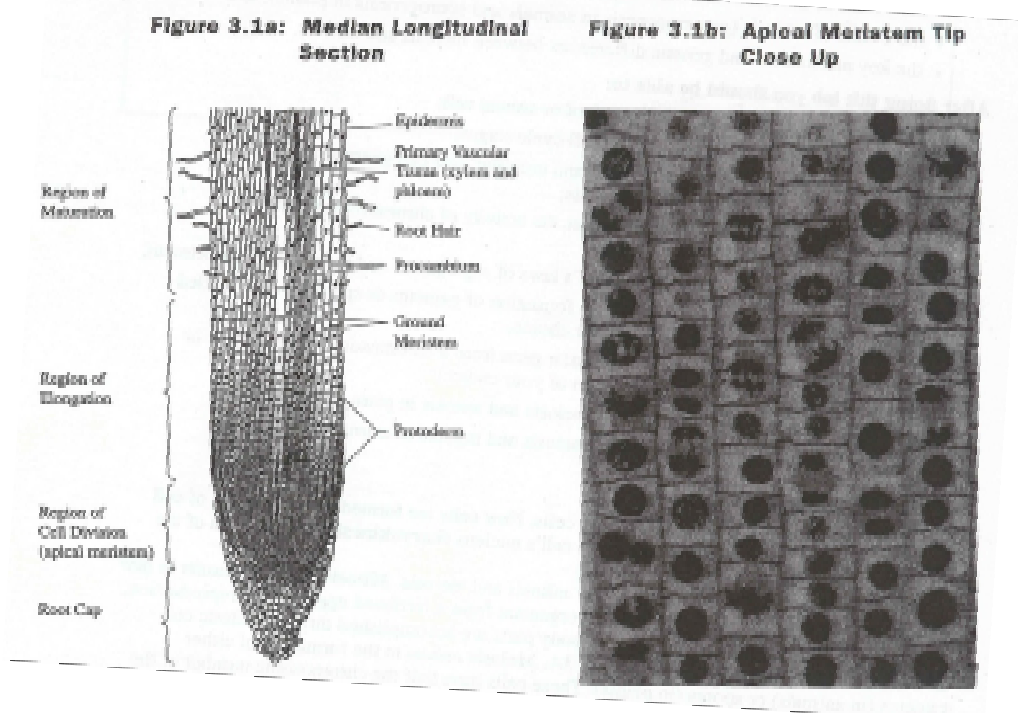
There are two types of nuclear division: mitosis and meiosis. **Mitosis** typically results in new somatic (body) cells. Formation of an adult organism from a fertilized egg, asexual reproduction, regeneration, and maintenance or repair of body parts are accomplished through mitotic cell division. You will study mitosis in Exercise 3A. **Meiosis** results in the formation of either gametes (in animals) or spores (in plants). These cells have half the chromosome number of the parent cell. You will study meiosis another day.

Where does one find cells undergoing mitosis? Plants and animal differ in this respect. In higher plants the process of forming new cells is restricted to special growth regions called **meristems**. These regions usually occur at the tips of stems or roots. In animals, cell division occurs anywhere new cells are formed or as new cells replace old ones. However, some tissues in plants and animals rarely divide once the organism is mature.

To study the stages of mitosis, you need to look for tissues where there are many cells in the process of mitosis. This restricts your search to the tips of growing plants, such as the onion root tip, or, in the case of animals, to developing embryos, such as the whitefish blastula.

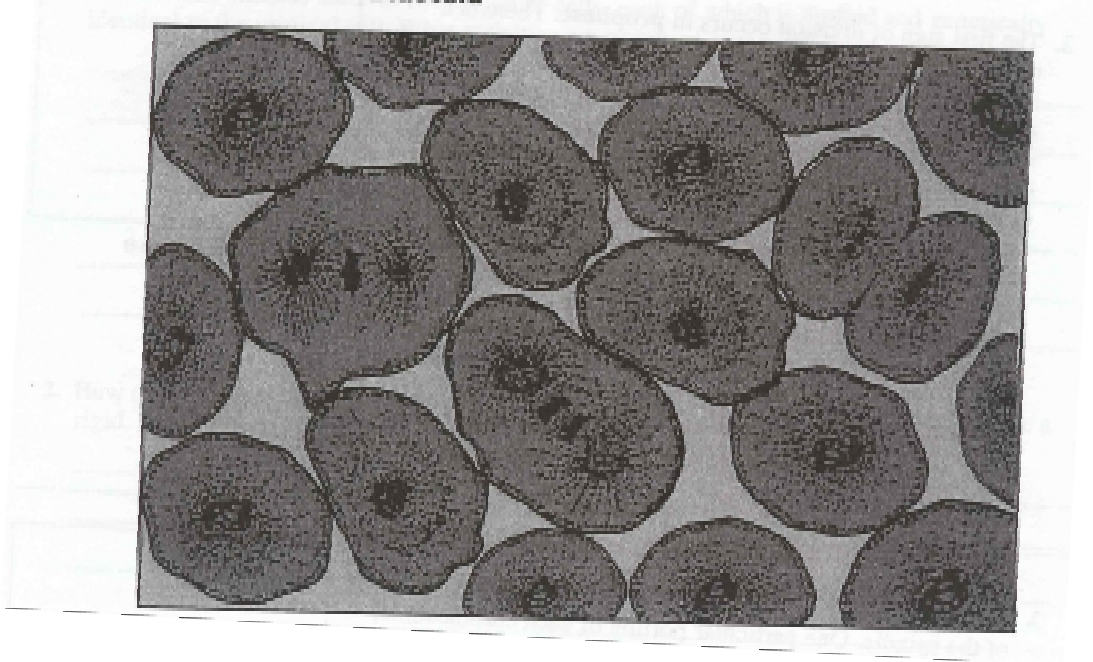
Exercise 7A: Observing Mitosis in Plant Cells using www.biology.arizona.edu

Roots consist of different regions (see Figure 3.1a). The **root cap** functions in protection. The **apical meristem** (Figure 3.1b) is the region that contains the highest percentage of cells undergoing mitosis. The **region of elongation** is the area in which growth occurs. The **region of maturation** is where root hairs develop and where cells differentiate to become xylem, phloem, and other tissues.



The whitefish blastula is often used for the study of cell division. As soon as the egg is fertilized it begins to divide, and nuclear division after nuclear division follows. The image below represents a whitefish blastula which has been sectioned in various planes in relation to the mitotic spindle. You can see side and polar views of the spindle apparatus.

Figure 3.2: Whitefish Blastula



Procedure

Go to www.biology.arizona.edu and click on "Onion Root Tips" in the upper left hand corner. Read through the introductory page and click "Next." Using the next page, sketch and label the cell showing each phase in the boxes provided.

1. The nondividing cell is in a stage called **interphase**. The **nucleus** may have one or more dark-stained **nucleoli** and is filled with a fine network of threads, the **chromatin**. During **interphase**, DNA replication occurs.
2. During **prophase**, the chromatin threads thicken until it has condensed into **chromosomes**. Each chromosome is composed of two **chromatids** joined at a **centromere**. In late prophase, the nuclear envelope and nucleoli are no longer visible, and the chromosomes are free in the cytoplasm. The spindle appears, made up of **microtubules**.
3. Proteins attach to the centromere, forming **kinetochores**. The spindle microtubules attach to the kinetochore and align the chromosomes in the middle of the spindle on a plane called the **metaphase plate**.

Big Idea 3

Genetics and Information Transfer

4. At the beginning of **anaphase**, the centromere regions of each pair of chromatids separate and are moved by the spindle fibers toward opposite poles of the spindle, dragging the rest of the chromatid behind them. Once the chromatids separate, each is called a **chromosome**. These daughter chromosomes move toward the poles until they form two compact clumps.

5. **Telophase**, the last stage of division, is marked by pronounced condensation of the chromosomes, followed by the formation of a new nuclear envelope around each group of chromosomes. They uncoil to form chromatin again, and the nucleoli reappear. **Cytokinesis** occurs, which is the division of the cytoplasm into two cells. In plants, a new cell wall is laid down between the daughter cells. In animal cells, the old cell will pinch off in the middle along a **cleavage furrow** to form two new daughter cells.

Analysis Questions

1. Explain how mitosis leads to two daughter cells, each of which is diploid and genetically identical to the original cell. What activities are going on in the cell during interphase?

2. How does mitosis differ in plant and animal cells? How does plant mitosis accommodate a rigid, inflexible cell wall?

3. What is the role of the centrosome (the area surrounding the centrioles)? Is it necessary for mitosis? Defend your answer.

Big Idea 3

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Exercise 7B: Time for Cell Replication

To estimate the relative length of time that a cell spends in the various stages of cell division, you will work through the next part of the Online Onion Root Tip activity. The length of the cell cycle is approximately 24 hours for cells in actively dividing onion root tips. With this knowledge, it takes 1,440 minutes for onion root tip cells to complete the cell cycle.

Procedure

Click "Next" and read the directions. Click "Next" and follow the directions. Record the data at the end below .

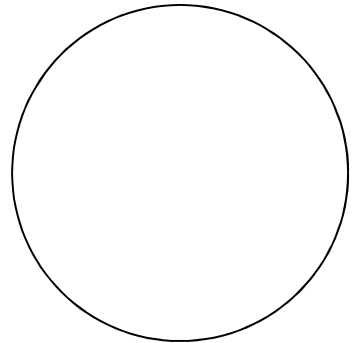
	Interphase	Prophase	Metaphase	Anaphase	Telophase	Total
# of cells						36
% of cells						100%
Time/stage						1,440 min

$\% \text{ of cells in stage} \times 1,440 \text{ minutes} = \underline{\hspace{2cm}} \text{ minutes of cell cycle spent in stage}$

Questions

- Based on the data table above, what can you infer about the relative length of time an onion root tip cell spends in each stage of cell division?

- Draw and label a pie chart of the onion root tip cell cycle using your data.
Title _____



- Which phase of the cell cycle was not shown in the cells? _____
- Discuss the differences among the terms *chromatid*, *chromosome*, and *chromatin*. (Click on *Vocabulary* and then *Terms to know about Mitosis and Meiosis* if needed).
