

Cell Division

Introduction

Multicellular organisms generally begin life as a single fertilized cell, the zygote. These organisms must then repeatedly copy this cell to produce the many cells needed to make up the organism. The process used for this event is referred to as the cell cycle.

The Mitotic Phase is that part of the cell cycle where a single cell divides its chromosomes (mitosis) and its cytosol (cytokinesis) to produce two identical daughter cells. It is also used for growth, maintenance and repair of tissues in multicellular organisms. You will be observing interphase, and the stages of the mitotic phase: prophase, prometaphase, metaphase, anaphase, telophase and cytokinesis in both plant and animal cells. Interphase and the Mitotic phase make up one cell cycle.

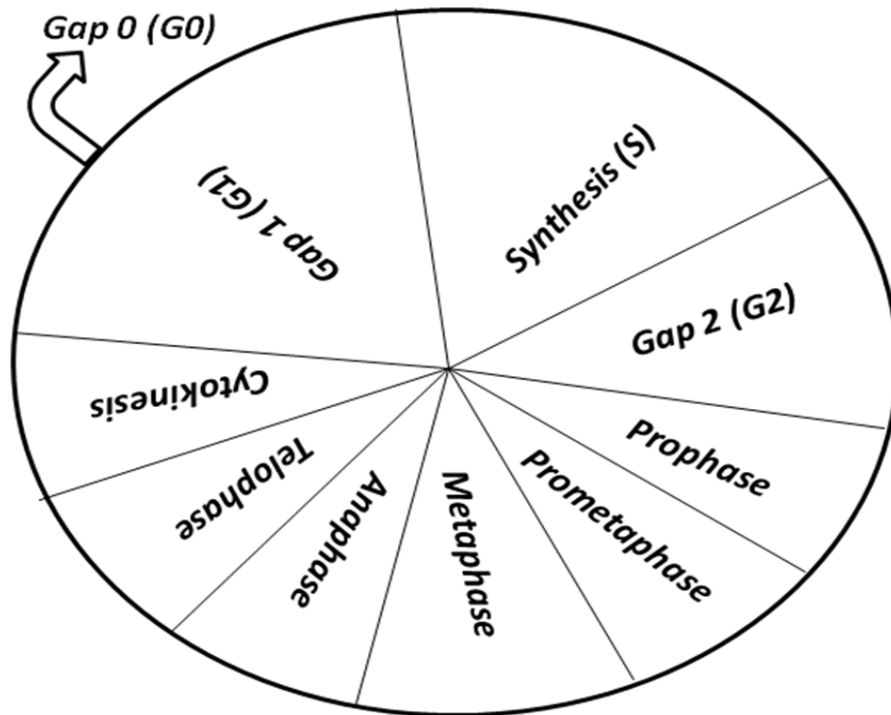


Fig. 1 - Diagram of the Cell cycle. G1 or G0, S and G2 make up Interphase. Prophase, Prometaphase, Metaphase, Anaphase, Telophase and Cytokinesis make up the Mitotic (M) phase. Be sure and mark Interphase and M phase on this diagram. What you will be studying in lab today is mitosis which you can see in the diagram is just part of the cell cycle. The S phase is when the DNA is replicated to form the sister chromosomes. You will be following their movement during mitosis.

Plant Mitosis

For plant mitosis use the slide in your slide box labeled Onion or *Allium* root tip that contains 3 cross sections. Using the low power of your microscope examine one of the root tips noting the number of cells that have darkly stained filamentous chromosomes.

Now increase the magnification up to 40X and using the mechanical stage move the slide to find each of the mitotic stages described below. You may need to look at all 3 root tips to find all of the stages. As you locate each stage make a drawing either in your lab notebook or on a piece of paper and be sure to label the distinctive parts.

Interphase (Figure 2A). As noted in Fig. 1 Interphase is the non-dividing stage of the cell cycle. During this time the **nucleus** is visible and contains 1 or more small, round, darker-staining structures called **nucleoli** (nucleolus is singular). The individual chromosomes are not visible during this stage but are replicated in S phase. This replication produces a pair of identical chromatids held together by a centromere.

Prophase (Figure 2B). The chromosomes, now containing two chromatids joined by a centromere, condense and become visible as dark linear structures. The spindle begins to form. You should be able to see the **chromosomes** but neither the chromatids nor the centromere will be visible at this magnification.

Prometaphase (Figure 2C). During this stage, the nuclear envelope will be disassembled and the nucleolus will no longer be visible. The spindle continues to form and the spindle fibers begin to attach to the chromosomes.

Metaphase (Figure 2D). The **spindle apparatus** is completely formed and spindle fibers have attached to each chromosome at the centromere. This causes the chromosomes to become aligned on the equator. You should be able to see the spindle fibers. Make sure you identify the **chromosomes** and the **equator**.

Anaphase (Figure 2E). The centromere divides allowing the **sister chromatids** to begin to move apart. At this point since the chromatids have separated and each has its own centromere they are each called a chromosome. The chromosomes have begun to move to their respective poles. Be sure to identify the chromosomes and the **spindle**.

Telophase (Figure 2F). Once the chromosomes have reached their respective poles they will uncoil and gradually become less visible. The nuclear envelope will be reformed around each complete set of uncoiling chromosomes. The nucleolus will once again become visible. Look for a cell in which the chromosomes have arrived at their respective poles.

Cytokinesis (Figure 2F). During telophase a **cell plate** will form from the center of the equator outward separating the cytoplasm of the two new **daughter cells**. When the cell plate has completely divided the two daughter cells they are considered to be in interphase. Look for cells in late telophase where the cell plate should be visible and the chromosomes are being reorganized into a nucleus.

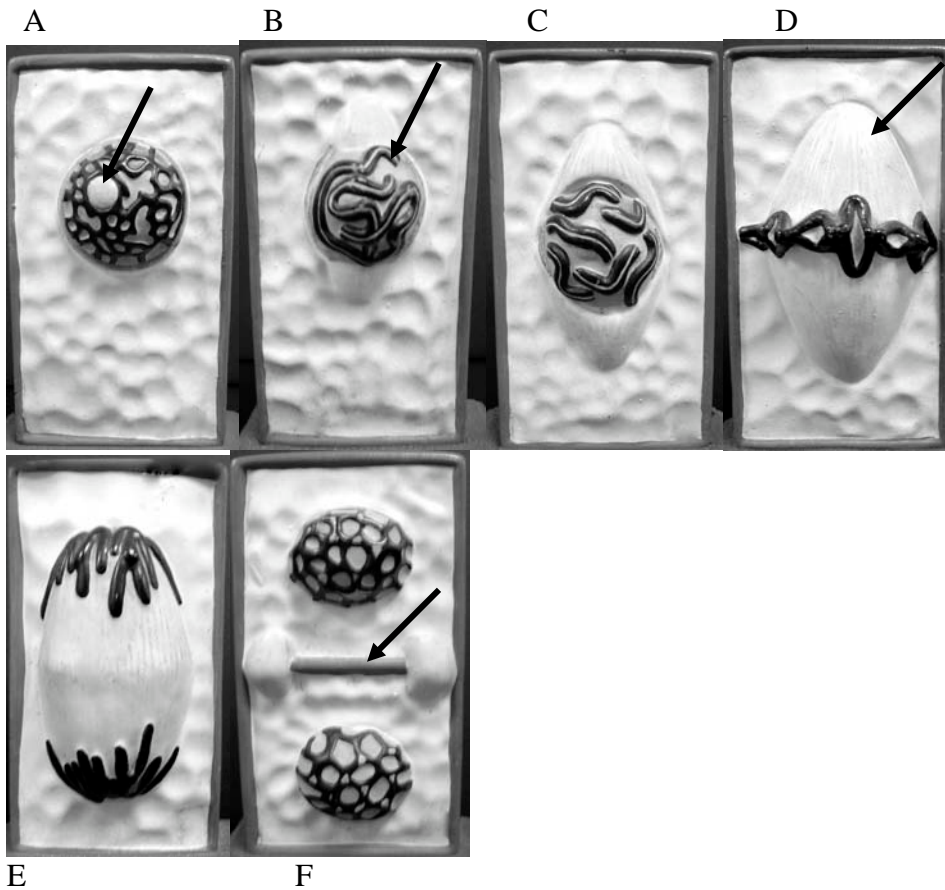


Fig. 2 Diagrams of mitotic stages in onion root tip cells. A. Interphase – Arrow indicates the nucleolus B. Prophase – Arrow indicates a chromosome C- Prometaphase - the spindle fibers have begun to form. D Metaphase- Arrow indicates the spindle apparatus E. Late Anaphase – Note the chromosomes have arrived at the opposite poles F. Late Telophase and cytokinesis – the nuclei have reformed and the cell plate has formed. The cell plate is indicated with the arrow.

Animal Mitosis

The same stages exist in animals as in plants. Place the whitefish blastula slide under low power and locate a group of dividing cells. Focus it on high power and notice that the cells are less ordered than you saw in the onion root tip. This may allow you to view mitosis from several angles causing some stages to look atypical. Look for cells that are more typical in appearance. You have several groups of cells to look at so if you can't find a particular stage in the group you are in use the mechanical stage to move to another group of cells. Draw each phase labeling any structures indicated in bold print.

Interphase This stage will be similar to what you saw in the plant cell but you may not be able to see the nucleolus and there is no cell wall present.

Prophase The chromosomes become visible as thread like structures. You will notice that the chromosomes are smaller and more numerous than in the plant cell. Two cytoplasmic structures not found in the plant cell called centrioles have migrated to opposite poles and are beginning to align the microtubules of the spindle. While each centriole is not visible the microtubules migrating out from it will be visible and have a star like appearance. These star like structures are **asters** (a cluster of microtubules that radiate out toward the poles when a dividing cell has centrioles). Make sure you can also locate the **chromosomes** and the **spindle fibers**.

Prometaphase (Figure 3A) The nuclear membrane and the nucleoli disassemble. The **asters** move towards opposite poles of the cell as the spindle fibers begin attaching to chromosomes.

Metaphase (Figure 3B) Events in this stage are very similar to the onion root tip. One difference you might note is that the spindle and its individual fibers are easier to see. Be sure to identify the **aster**, **spindle fibers**, **chromosomes** and **equator**.

Anaphase (Figure 3C and D) Events here are like in the onion root tip. Identify the **aster**, **spindle**, **spindle fibers**, and **chromosomes**.

Telophase and cytokinesis (Figure 3E and F) Unlike the onion root tip no cell plate forms during cytokinesis. Instead the plasma membrane appears to pinch in on either side of the equator forming a V like structure called the cleavage furrow. This will continue to deepen until it divides the cell into half to form two identical daughter cells. Each daughter cell is about half the size of the parent cell.

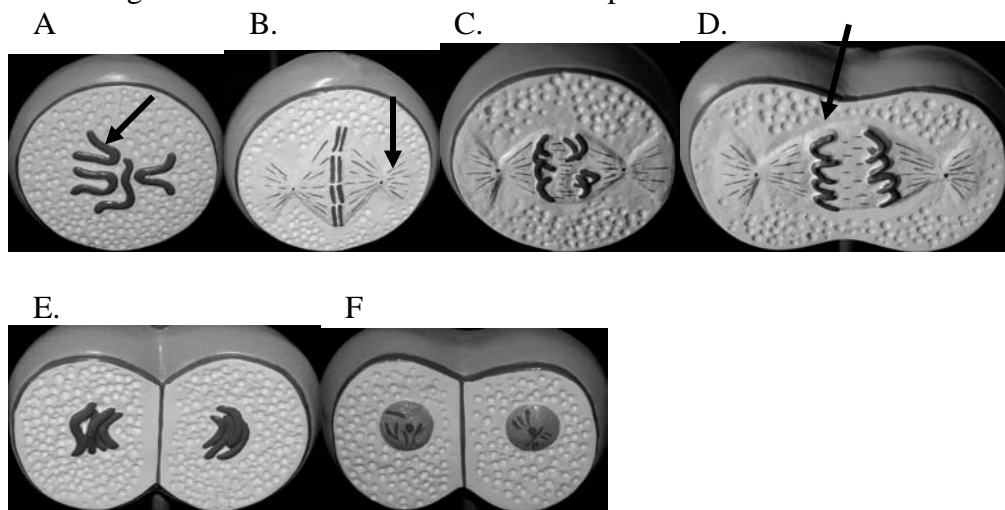


Fig. 3 Models of mitosis in the whitefish blastula. A. Prometaphase-arrow denotes a chromosome. B. Metaphase - arrow denotes aster. C. Anaphase - notice the chromosomes are moving to the poles. D. Early telophase - cytokinesis has begun as noted by the presence of a cleavage furrow marked by the arrow. E. Late Telophase F. Final stages of cytokinesis