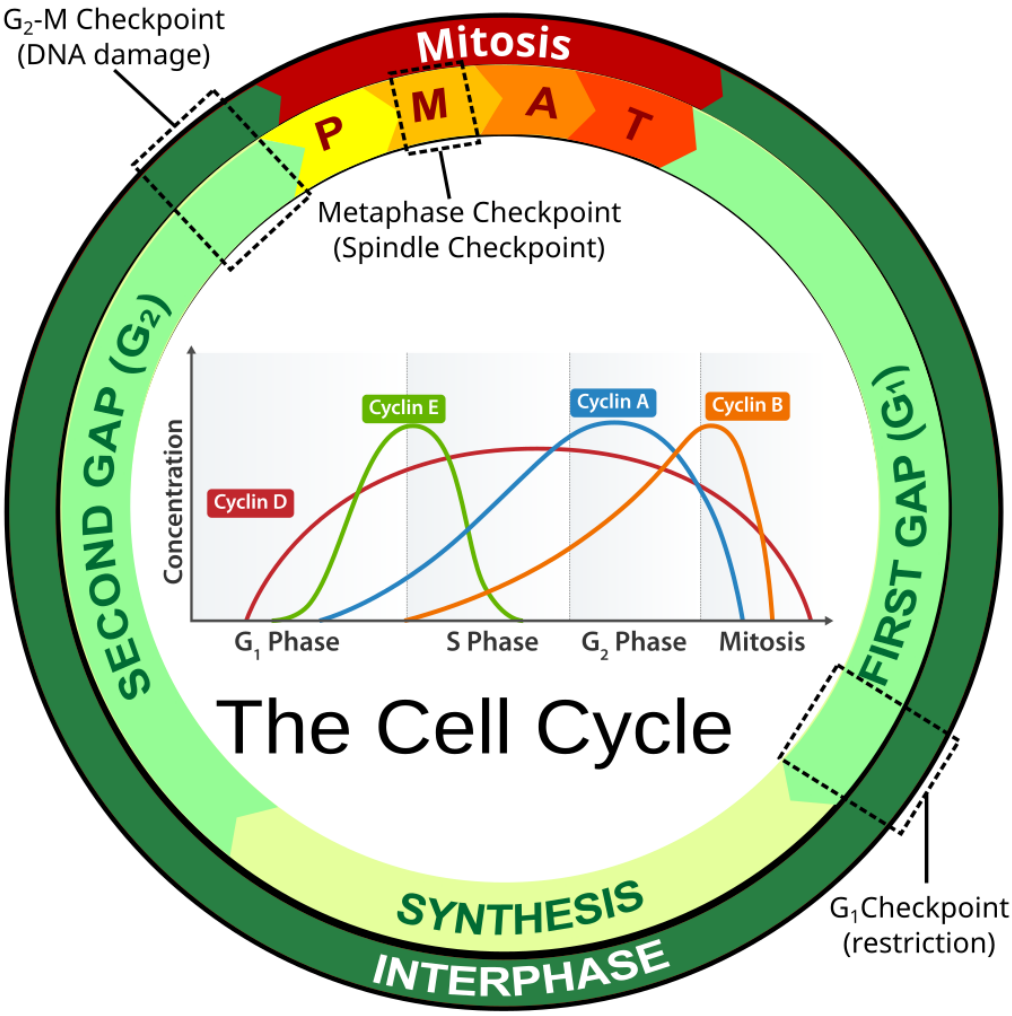
1. Discuss the molecular composition of the eukaryotic chromosome.
2. Explain the importance of cell division in the lives of organisms.
3. Distinguish between the prokaryotic cell cycle and the eukaryotic cell cycle.
4. Explain what is meant by the cell cycle.
5. List the three parts of interphase, and explain the events that occur in each.
6. Give examples showing how cell types differ in their regulation of the cell cycle.
7. List the various components of the mitotic spindle, and explain the difference between a centromere and a kinetochore.
8. Describe the role of the microtubule organizing center (MTOC).
9. List the phases of mitosis, and describe the events that occur in each.
10. Compare cytokinesis in animal and plant cells.
11. Discuss the relationship between mitosis and asexual reproduction.

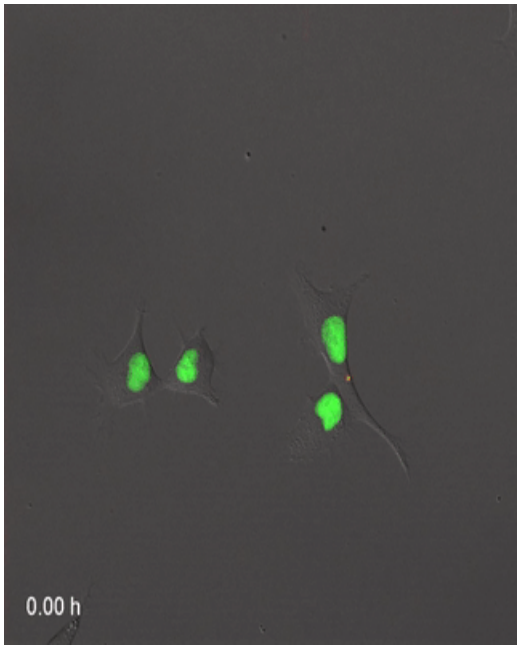
Contents

Introduction: The Cell Cycle and Mitosis

The cell cycle refers to the a series of events that describe the metabolic processes of growth and replication of cells. The bulk of the cell cycle is spent in the “living phase”, known as **interphase**. Interphase is further broken down in to 3 distinct phases: G_1 (Gap 1), S (Synthesis) and G_2 (Gap 2). **G_1** is the phase of growth when the cell is accumulating resources to live and grow. After attaining a certain size and having amassed enough raw materials, a checkpoint is reached where the cell uses biochemical markers to decide if the next phase should be entered. If the cell is in an environment with enough nutrients in the environment, enough space and having reached the appropriate size, the cell will enter the S phase. **S phase** is when metabolism is shifted towards the replication (or synthesis) of the genetic material. During S phase, the amount of DNA in the nucleus is doubled and copied exactly in preparation to divide. The chromosomes at the end of G_1 consist of a single **chromatid**. At the end of S phase, each chromosome consists of two identical **sister chromatids** joined at the **centromere**. When the DNA synthesis is complete, the cell continues on to the second growth phase called **G_2**. Another checkpoint takes place at the end of G_2 to ensure the fidelity of the replicated DNA and to re-establish the success of the cell’s capacity to divide in the environment. If conditions are favorable, the cell continues on to mitosis.



Eukaryotic cell cycle is governed by expression of cyclin proteins along with their activity. Credit: Jeremy Seto (CC-BY-SA)



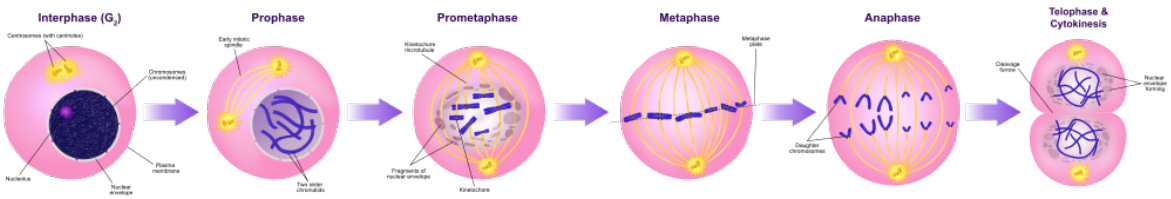
Mammalian cells in culture going through the Cell Cycle. Green marker proteins expressed during the G1 phase. Red marker proteins are expressed during S/G2/M. During the G1 to S transition, fluorescence disappears as the marker proteins also transition in expression.

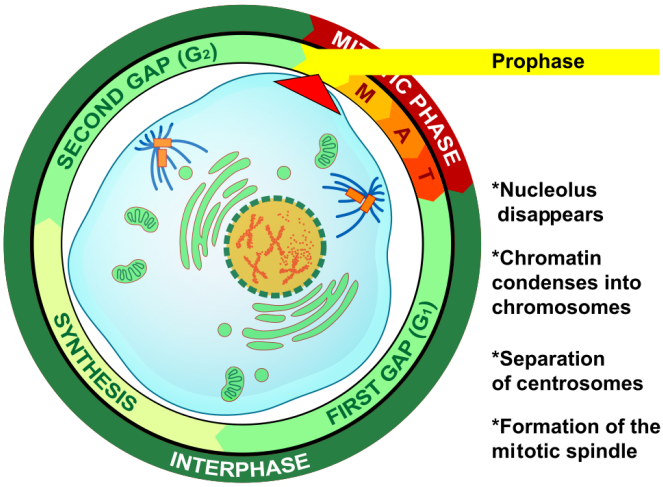
https://youtu.be/542CMooowNY

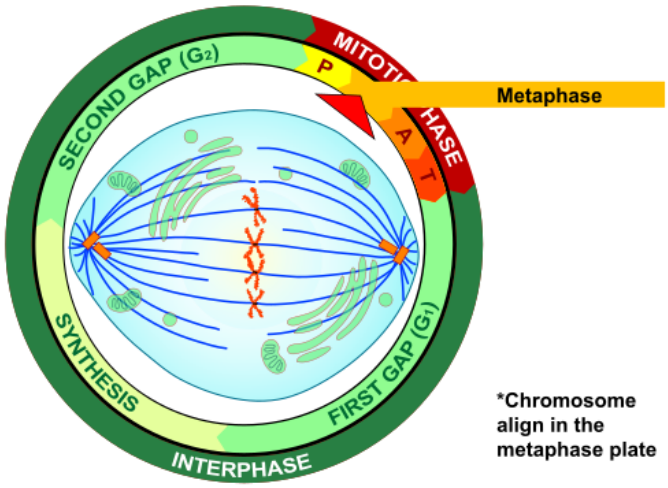
Mitosis is the process of nuclear division used in conjunction with cytokinesis to produce 2 identical daughter cells. **Cytokinesis** is the actual separation of these two cells enclosed in their own cellular membranes. Unicellular organisms utilize this process of division in order to reproduce asexually. Prokaryotic organisms lack a nucleus, therefore they undergo a different process called binary fission.

Multicellular eukaryotes undergo mitosis for repairing tissue and for growth. The process of mitosis is only a short period of the lifespan of cells. Mitosis is traditionally divided into four stages: **prophase**, **metaphase**, **anaphase** and **telophase**. The actual events of mitosis are not discreet but occur in a continuous sequence—separation of mitosis into four stages is merely convenient for our discussion and organization. During these stages important cellular structures are synthesized and perform the mechanics of mitosis. For example, in animal cells two microtubule organizing centers called **centrioles** replicate. The pairs of centrioles move apart and form an axis of proteinaceous microtubules between them called

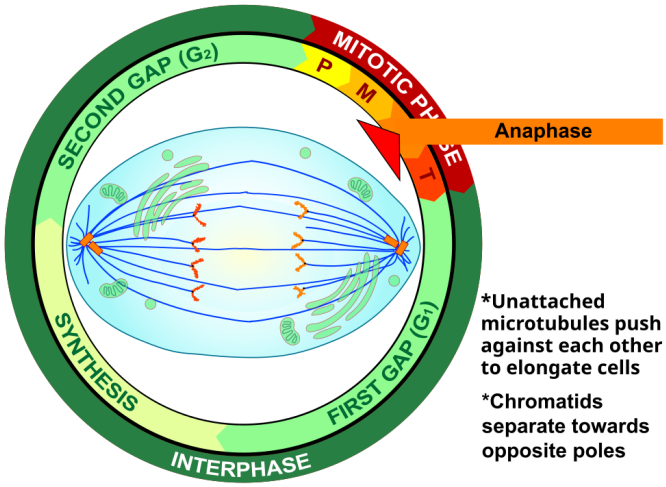
spindle fibers. These spindle fibers act as motors that pull at the centromeres of chromsomes and separate the sister chromatids into newly recognized chromosomes. The spindles also push against each other to stretch the cell in preparation of forming two new nuclei and separate cells. In animal cells, a contractile ring of actin fibers cinch together around the midline of the cell to coordinate cytokinesis. This cinching of the cell membrane creates a structure called the **cleavage furrow**. Eventually, the cinching of the membrane completely separates into two daughter cells. Plant cells require the production of new cell wall material between daughter cells. Instead of a cleavage furrow, the two cells are separated by a series of vesicles derived from the Golgi. These vesicles fuse together along the midline and simultaneously secrete cellulose into the space between the two cells. This series of vesicles is called the **cell plate**.





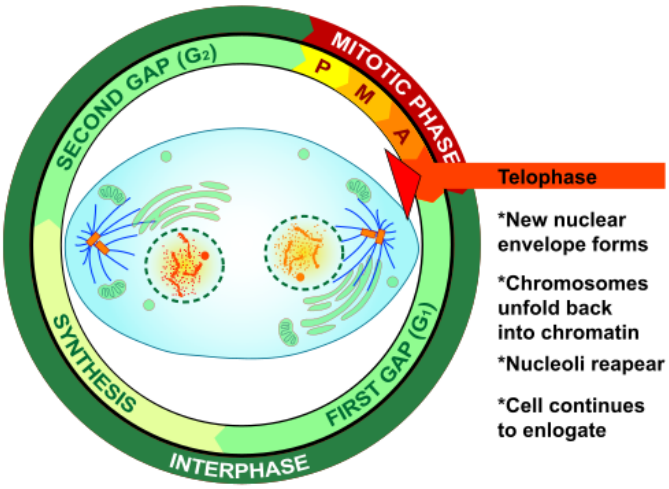


*Chromosome align in the metaphase plate



*Unattached microtubules push against each other to elongate cells

*Chromatids separate towards opposite poles

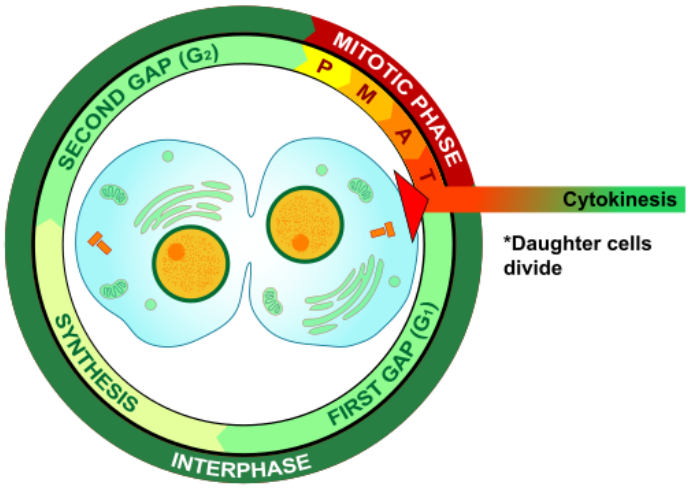


*New nuclear envelope forms

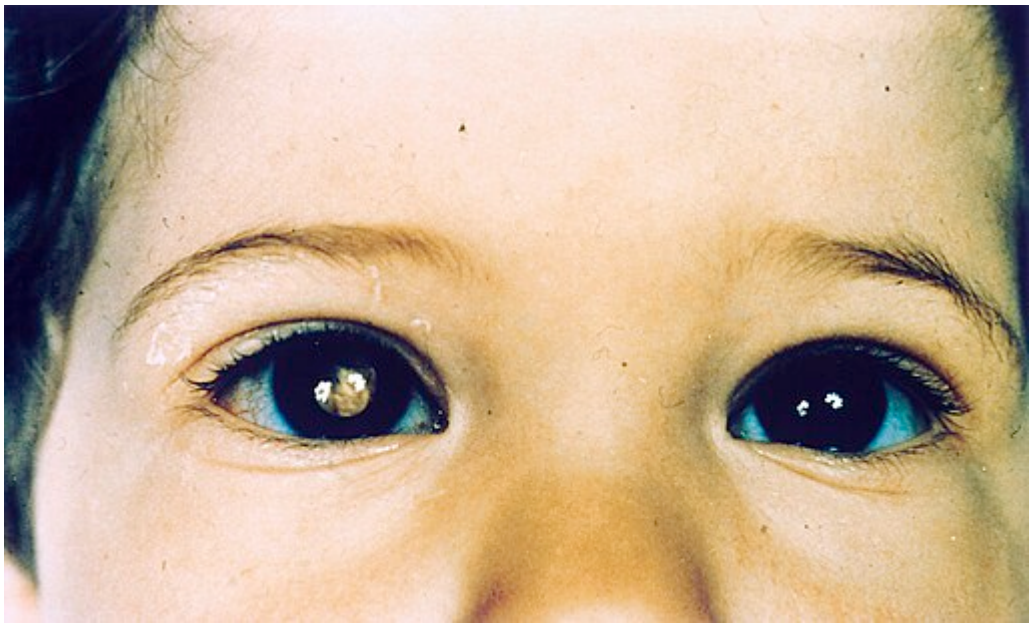
*Chromosomes unfold back into chromatin

*Nucleoli reapear

*Cell continues to enlogate



Defective Cell Cycle Checkpoints



A white light shone on a child's eye should yield a clear view of the retina. Int eh above image, the right eye shows a white light reflecting and indicates a retinoblastoma. This cancer is caused by a defect in the Rb gene, a tumor suppressor gene. This defect permits the continuation of the cell cycle despite damage to DNA. Retinoblastoma is the most common primary childhood cancer which often stems from a genetic background.

Mitosis Review

- Khan Academy Review
- Mitosis Flash Card Review
- Mitosis Sequence Review