

Mitosis

Mitosis is the process by which a cell separates the chromosomes in its nucleus into two identical sets in two nuclei. It is followed immediately by **cytokinesis**, which divides the original cell into two new cells, each of which contains an identical nucleus.

Mitosis and cytokinesis together form the **mitotic phase** of the cell cycle. This accounts for about 10% of the cell cycle. The primary result of the mitotic phase is the creation of two **daughter cells**. These two cells are identical to one another, and are also identical to the original parent cell.

The remaining 90% of the cell cycle is spent in **interphase**, where the cell prepares itself for cell division.

Phases of the Cell Cycle and Mitosis

Interphase

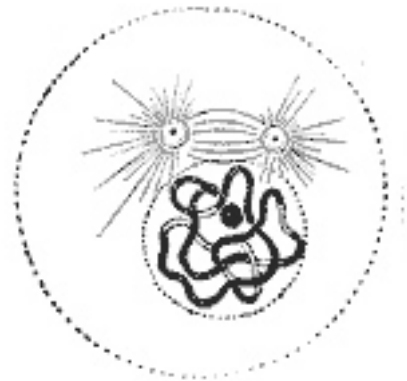
Interphase is the phase of the cell cycle in which the cell spends most of its time and carries out most of its functions, including preparation for cell division. In preparation for cell division, the cell increases in size and makes a copy of its DNA.

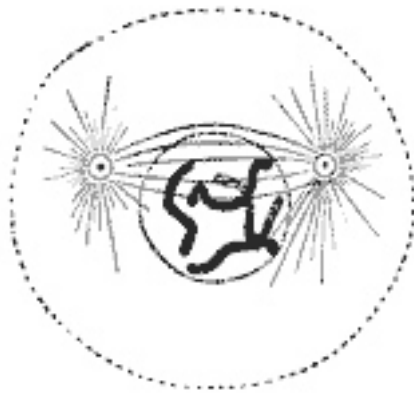
Interphase is considered the “living” phase of the cell. It is during this phase that the cell obtains food, grows, and conducts normal cell functions.

Prophase

Normally, the DNA in the nucleus is in a loosely bundled coil called **chromatin**. At the start of prophase, the chromatin condenses into a highly ordered structure called a **chromosome**. Since the DNA was already duplicated during interphase, each chromosome consists of two identical strands of chromatin, called sister chromatids, bound together by a **centromere**.

Close to the nucleus are structures called **centrosomes**, each of which is made of a pair of centrioles. Stretched between the two centrosomes are tiny **spindle fibers** (think of them like tiny ropes). As prophase continues, the centrosomes begin to move to opposite ends of the cell, creating a “net” of spindle fibers that spans the cell.



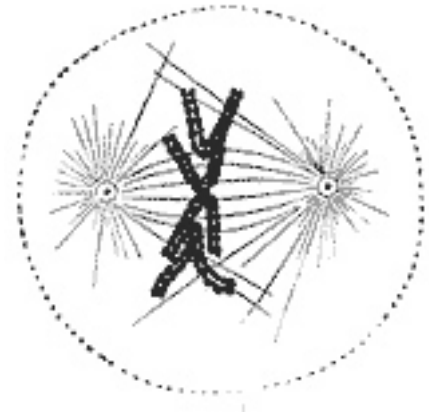


While the centrosomes are moving, the nuclear membrane begins to disappear. This allows the spindle fibers to penetrate the nucleus and reach the chromosomes.

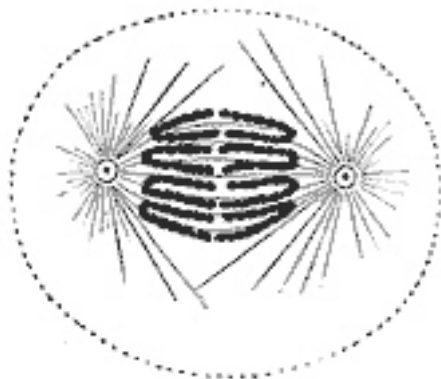
By the end of prophase, the centrosomes are at opposite ends of the cell, and the spindle fibers have attached themselves to the chromosomes.

Metaphase

Once the spindle fibers have found and attached to the chromosomes, the two centrosomes start pulling the chromosomes towards the two ends of the cell. (Think of this like a tug-of-war, with the chromosome in the middle of the rope.) As the two centrosomes pull in opposite directions, the chromosomes line up along the center of the cell, as in the picture to the right.



Anaphase



After the chromosomes have lined up along the center of the cell, the centrosomes continue to pull towards opposite ends of the cell. Eventually, they pull hard enough that the centromere binding the two sister chromatids together will break. At this point, each chromosome breaks into two identical chromatids.

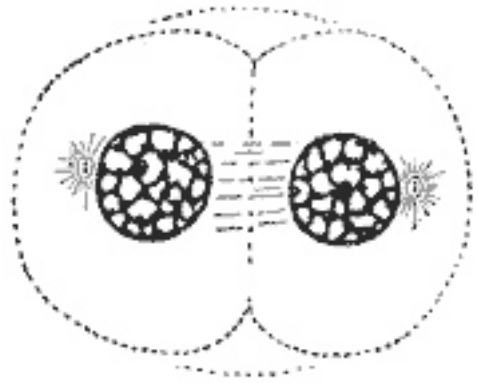
The now separate chromatids are pulled to opposite ends of the cell by the spindle fibers. At the end of anaphase, the cell has succeeded in separating identical copies of its DNA into two distinct groups...one at each end of the cell.

Telophase

Telophase is a reversal of prophase. It “cleans up” after mitosis.

During this phase, a nuclear membrane forms around each of the two groups of chromosomes (one at each end of the cell). Both sets of chromosomes, now surrounded by new nuclei, unfold back into chromatin.

Mitosis is now complete, but cell division is not.



Cytokinesis

Cytokinesis is a separate process that begins at the same time as telophase. It is necessary to complete cell division.

The process of cytokinesis is different in animal and plant cells, but the end result is the same. The parent cell, which contains two nuclei after mitosis, now splits into two daughter cells. Each daughter cell has a nucleus, along with a roughly equal amount of cytoplasm and other organelles.

In animal cells, the cell membrane begins to “pinch” inwards between the two nuclei. Once the two sides of the cell meet in the middle, they fuse together to form two distinct cells. Those two cells then separate.

In plant cells, a “wall” forms down the center of the cell between the two nuclei. This wall slowly solidifies to form a new cell wall, resulting in two distinct plant cells.

Mitosis Worksheet

Match each description below to the phase of the cell cycle during which it occurs. To save time, you may write the first letter of the phase's name, rather than the whole name.

Interphase Prophase Metaphase Anaphase Telophase Cytokinesis

1. The sister chromatids are moving apart. _____
2. A new nuclear membrane is forming around the chromosomes. _____
3. The cytoplasm of the cell is being divided. _____
4. The chromosomes are aligned at the center of the cell. _____
5. The nuclear membrane begins to fade from view. _____
6. The chromosomes are moving towards opposite ends of the cell. _____
7. The spindle fibers are formed. _____
8. The parent cell divides into two daughter cells, each with a complete nucleus. _____
9. Chromosomes are replicated. _____
10. The reverse of prophase. _____

In the following questions, use the word list to fill in the blanks. Some words may be used more than once. To save time, you may write the letters instead of the words.

A. Interphase
B. Prophase
C. Metaphase

D. Anaphase
E. Telophase
F. Cytokinesis

G. Centromere
H. Chromatid
I. Mitosis

11. During what phase of the cell cycle are the daughter cells formed? _____
12. During what phase of mitosis does the centromere break and the chromosomes move toward opposite ends of the cell? _____
13. During what phase does the chromatin condense to form chromosomes? _____
14. What is the name of the structure that connects the two chromatids? _____
15. In a chromosome pair connected by a centromere, what is each individual chromosome called? _____
16. What are the two parts of cell division? _____
17. What is the last phase of mitosis during which the sister chromatids are held together? _____
18. During which phase of the cell cycle is the cell not dividing? _____
19. Name the period of cell growth and development between mitotic divisions? _____
20. Name the phase where the cell physically divides to form two cells. _____