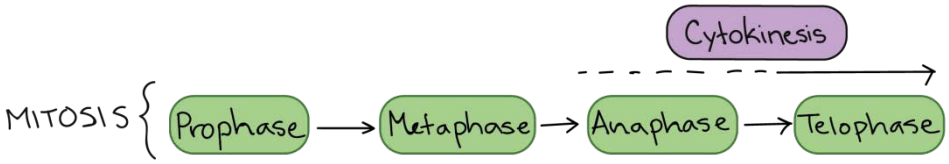
# Mitosis

**Mitosis** is a type of cell division in which one cell (the **mother**) divides to produce two new cells (the **daughters**) that are genetically identical to itself. In the context of the cell cycle, mitosis is the part of the division process in which the DNA of the cell's nucleus is split into two equal sets of chromosomes.

## Phases of mitosis

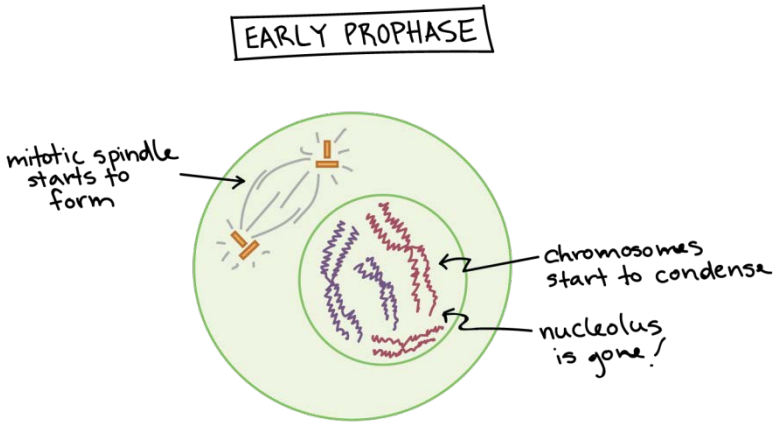
Mitosis consists of four basic phases: prophase, metaphase, anaphase, and telophase. These phases occur in a sequence order, and cytokinesis - the process of dividing the cell contents to make two new cells - starts in anaphase or telophase.

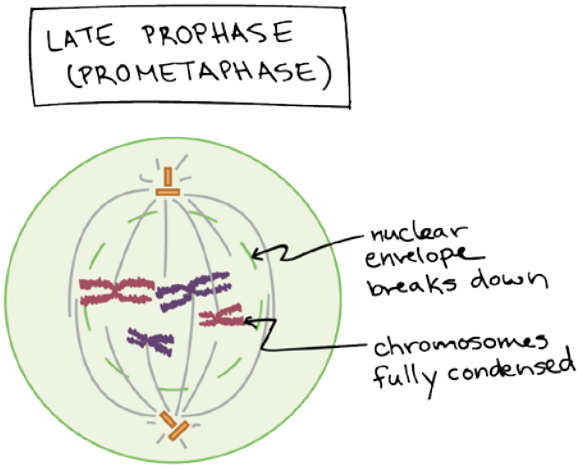



## Early prophase

The mitotic spindle starts to form, the chromosomes start to condense, and the nucleolus disappears.

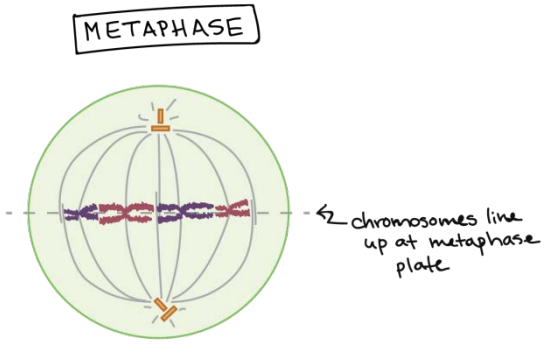
- In early **prophase**, the cell starts to break down some structures and build others up, setting the stage for division of the chromosomes.
- The chromosomes start to condense (making them easier to pull apart later on).
- The **mitotic spindle** begins to form. The spindle is a structure made of microtubules, strong fibers that are part of the cell's "skeleton." Its job is to organize the chromosomes and move them around during mitosis.
- The spindle grows between the centrosomes as they move apart.
- The **nucleolus** (or nucleoli, plural), a part of the nucleus where ribosomes are made, disappears.





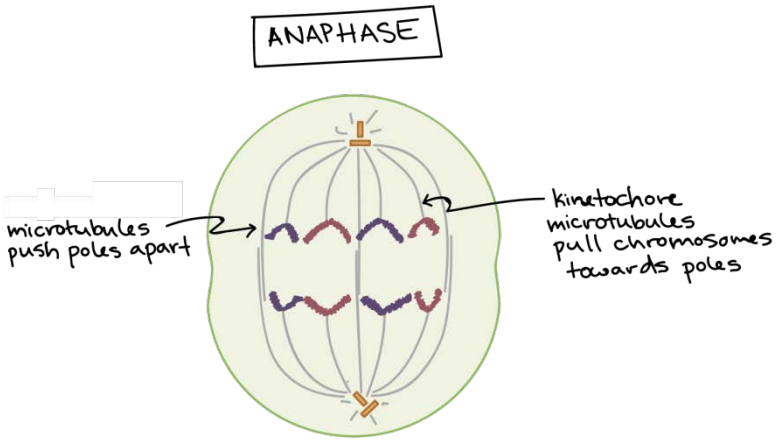

Late prophase (prometaphase). The nuclear envelope breaks down and the chromosomes are fully condensed.
In late prophase (sometimes also called **prometaphase**), the mitotic spindle begins to capture and organize the chromosomes.

- The chromosomes finish condensing, so they are very compact.
- The nuclear envelope breaks down, releasing the chromosomes.
- The mitotic spindle grows more, and some of the microtubules start to “capture” chromosomes.



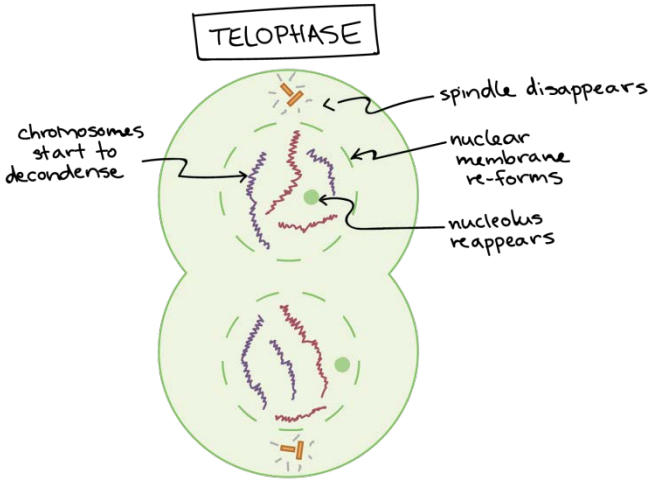

Chromosomes line up at the metaphase plate, under tension from the mitotic spindle. The two sister chromatids of each chromosome are captured by microtubules from opposite spindle poles.
In **metaphase**, the spindle has captured all the chromosomes and lined them up at the middle of the cell, ready to divide.

- All the chromosomes align at the **metaphase plate**
- At this stage, the two kinetochores of each chromosome should be attached to microtubules from opposite spindle poles.



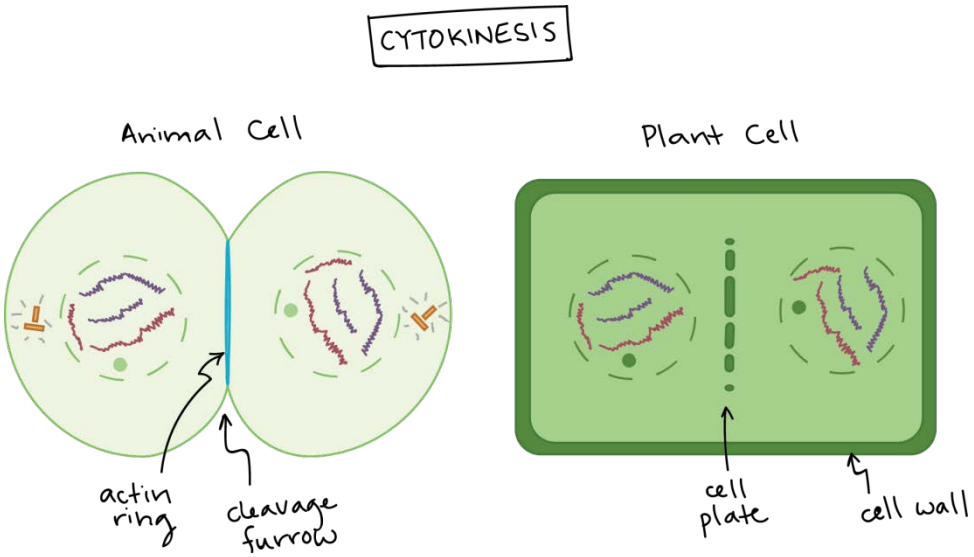

The sister chromatids separate from one another and are pulled towards opposite poles of the cell. The microtubules that are not attached to chromosomes push the two poles of the spindle apart, while the kinetochore microtubules pull the chromosomes towards the poles.

- In **anaphase**, the sister chromatids separate from each other and are pulled towards opposite ends of the cell.
- The protein “glue” that holds the sister chromatids together is broken down, allowing them to separate. Each is now its own chromosome. The chromosomes of each pair are pulled towards opposite ends of the cell.
- Microtubules not attached to chromosomes elongate and push apart, separating the poles and making the cell longer.
- All of these processes are driven by **motor proteins**, molecular machines that can “walk” along microtubule tracks and carry a cargo. In mitosis, motor proteins carry chromosomes or other microtubules as they walk.




The spindle disappears, a nuclear membrane re-forms around each set of chromosomes, and a nucleolus reappears in each new nucleus. The chromosomes also start to decondense.
In **telophase**, the cell is nearly done dividing, and it starts to re-establish its normal structures as cytokinesis (division of the cell contents) takes place.

- The mitotic spindle is broken down into its building blocks.
- Two new nuclei form, one for each set of chromosomes. Nuclear membranes and nucleoli reappear.
- The chromosomes begin to decondense and return to their “stringy” form.




**Cytokinesis in animal and plant cells.**

**Cytokinesis**, the division of the cytoplasm to form two new cells, overlaps with the final stages of mitosis. It may start in either anaphase or telophase, depending on the cell, and finishes shortly after telophase.

Cytokinesis in an animal cell: an actin ring around the middle of the cell pinches inward, creating an indentation called the cleavage furrow.
Cytokinesis in a plant cell: the cell plate forms down the middle of the cell, creating a new wall that partitions it in two.

In animal cells, cytokinesis is contractile, pinching the cell in two like a coin purse with a drawstring. The "drawstring" is a band of filaments made of a protein called actin, and the pinch crease is known as the **cleavage furrow**. Plant cells can't be divided like this because they have a cell wall and are too stiff. Instead, a structure called the **cell plate** forms down the middle of the cell, splitting it into two daughter cells separated by a new wall.