STAGES OF CELL CYCLE (MITOSIS)

During the mitotic (M) phase, the cell divides its copied DNA and cytoplasm to make two new cells. M phase involves two distinct division-related processes: mitosis and cytokinesis.

Mitosis is a type of cell division in which one cell (the mother cell) divides to produce two new cells (the daughters) that are genetically identical or copies of 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.

The great majority of the cell divisions that happen in your body involve mitosis. During development and growth, mitosis populates an organism's body with cells, and throughout an organism's life, it replaces old, worn-out cells with new ones. For single-celled eukaryotes like yeast, mitotic divisions are actually a form of reproduction, adding new individuals to the population.

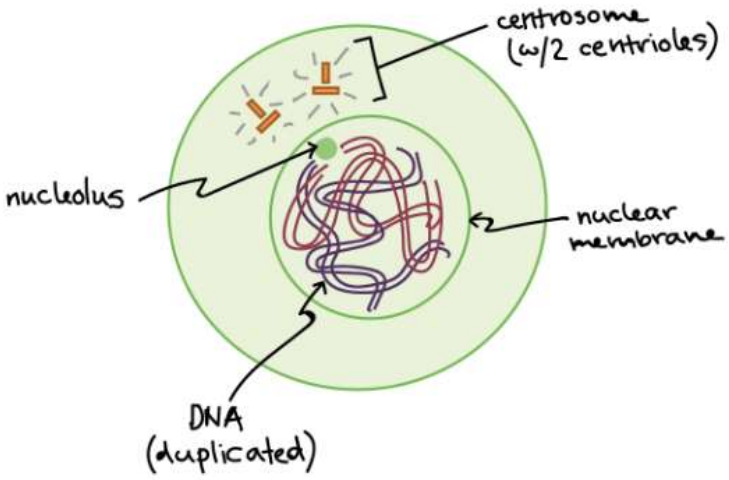
In all of these cases, **the "goal" of mitosis is to make sure that each daughter cell gets a perfect, full set of chromosomes**. Cells with too few or too many chromosomes usually don't function well: they may not survive, or they may even cause cancer. So, when cells undergo mitosis, they don't just divide their DNA at random and toss it into piles for the two daughter cells. Instead, they split up their duplicated chromosomes in a carefully organized or choreographed series of steps.

Prokaryotic cells undergo a process similar to mitosis called binary fission. However, prokaryotes cannot be properly said to undergo mitosis because they lack a nucleus and only have a single chromosome with no centromere.

Mitosis is made up of two different processes – karyokinesis (which is made up of prophase, prometaphase, metaphase, anaphase and telophase) and cytokinesis (the cytoplasm of the cell is split into two, thereby making two new copies which are identical to one another). After karyokinesis cytokinesis is well underway. Cytokinesis usually begins just as mitosis is ending, with a little overlap. Importantly, cytokinesis takes place differently in animal and plant cells.

PHASES OF MITOSIS

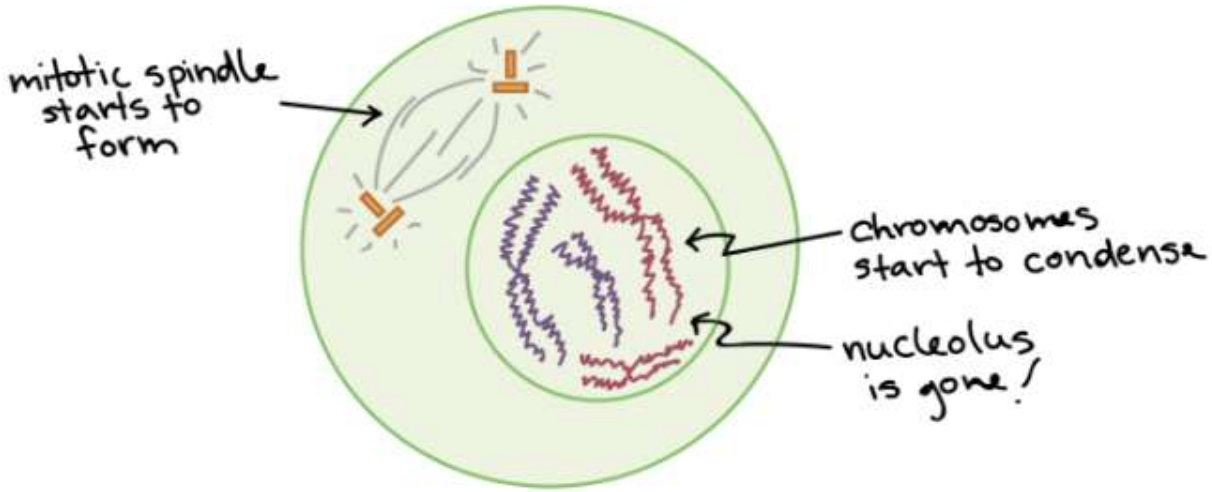
Mitosis consists of five basic phases: prophase, prometaphase, metaphase, anaphase, and telophase. These phases occur in a strict sequential order, and terminating in cytokinesis - the process of dividing the cell contents to make two new cells.



INTERPHASE or Late G2

Before the onset of Mitosis, the cell is in Interphase (or late G2 phase) and has already copied its DNA, so the chromosomes in the nucleus each consist of two connected copies, called sister chromatids. This cell above has also made a copy of its centrosome, an organelle that will play a key role in orchestrating or arranging mitosis, so there are two centrosomes. (Plant cells generally don't have centrosomes with centrioles, but have a different type of microtubule organizing center that plays a similar role.)

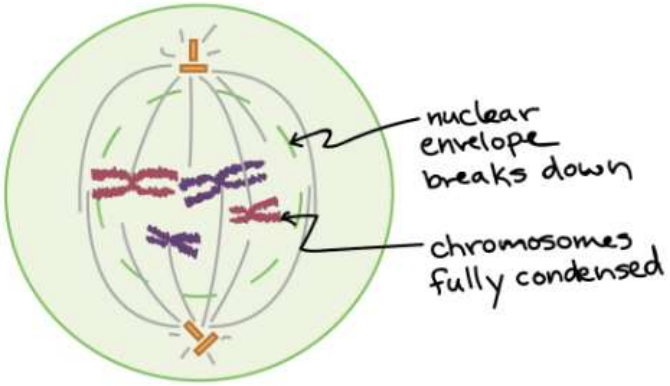
PROPHASE



During prophase, the cell starts to break down some structures and build others up, setting the stage for division of the chromosomes.

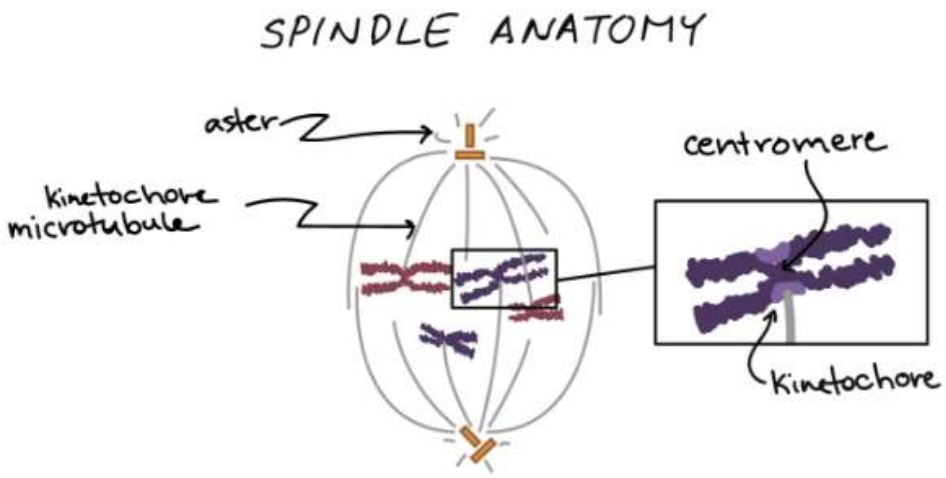
- The chromosomes start to condense (making them easier to pull apart later on).
- The mitotic spindle begins to form. The spindle is a structure made of microtubules, strong fibers that are part of the cell's "skeleton." Its job is to organize the chromosomes and move them around during mitosis. The spindle grows between the centrosomes as they move apart.
- The nucleolus (or nucleoli, plural), a part of the nucleus where ribosomes are made, disappears. This is a sign that the nucleus is getting ready to break down.

PROMETAPHASE



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.

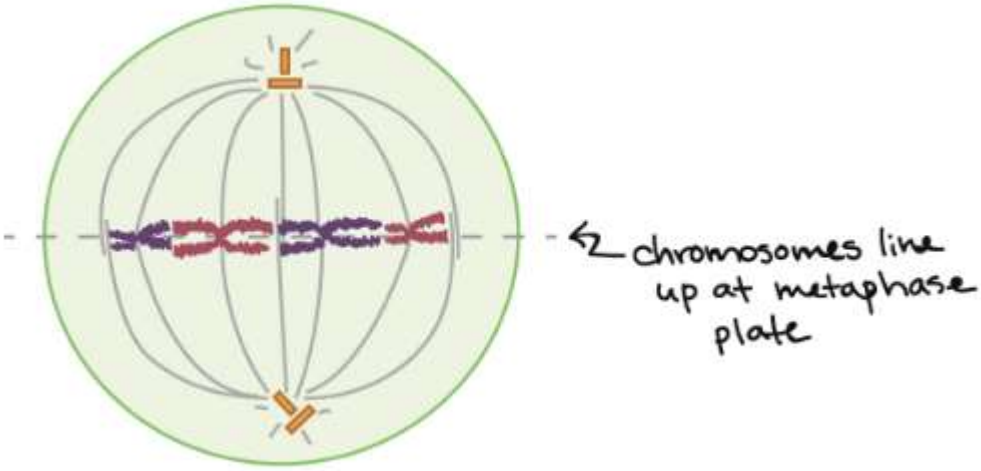


Spindle Anatomy

Microtubules can bind to chromosomes at the kinetochore, a patch of protein found on the centromere of each sister chromatid. (Centromeres are the regions of DNA where the sister chromatids are most tightly connected.)

Microtubules that bind a chromosome are called kinetochore microtubules. Microtubules that don't bind to kinetochores can grab on to microtubules from the opposite pole, stabilizing the spindle. More microtubules extend from each centrosome towards the edge of the cell, forming a structure called the aster.

METAPHASE

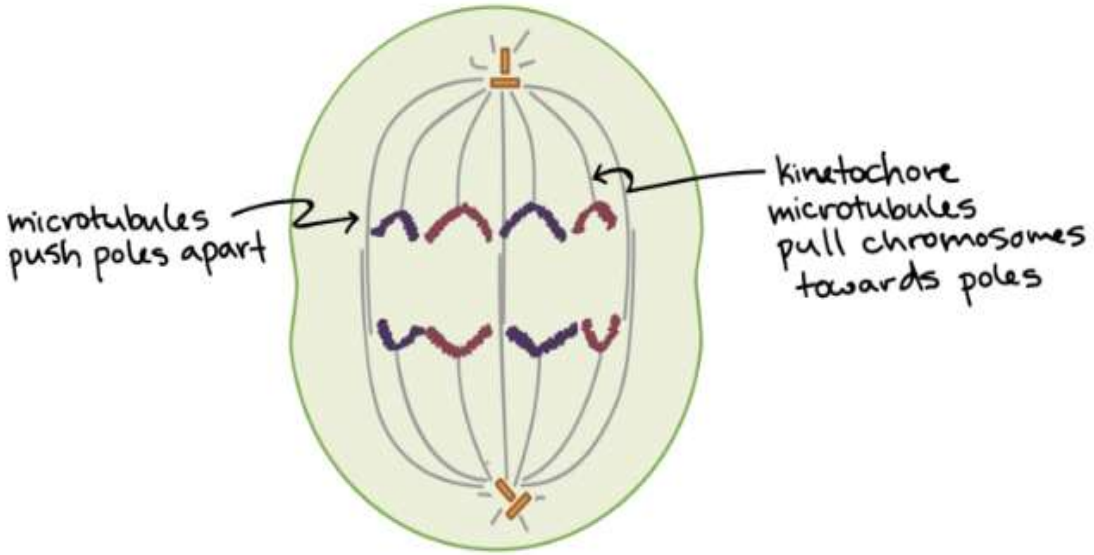


In metaphase, the spindle has captured all the chromosomes and lined them up at the middle of the cell, ready to divide.

- All the chromosomes align at the metaphase plate (not a physical structure, just a term for the plane where the chromosomes line up).
- At this stage, the two kinetochores of each chromosome should be attached to microtubules from opposite spindle poles.

Before proceeding to anaphase, the cell will check to make sure that all the chromosomes are at the metaphase plate with their kinetochores correctly attached to microtubules. This is called the spindle checkpoint and helps ensure that the sister chromatids will split evenly between the two daughter cells when they separate in the next step. If a chromosome is not properly aligned or attached, the cell will halt division until the problem is fixed.

ANAPHASE

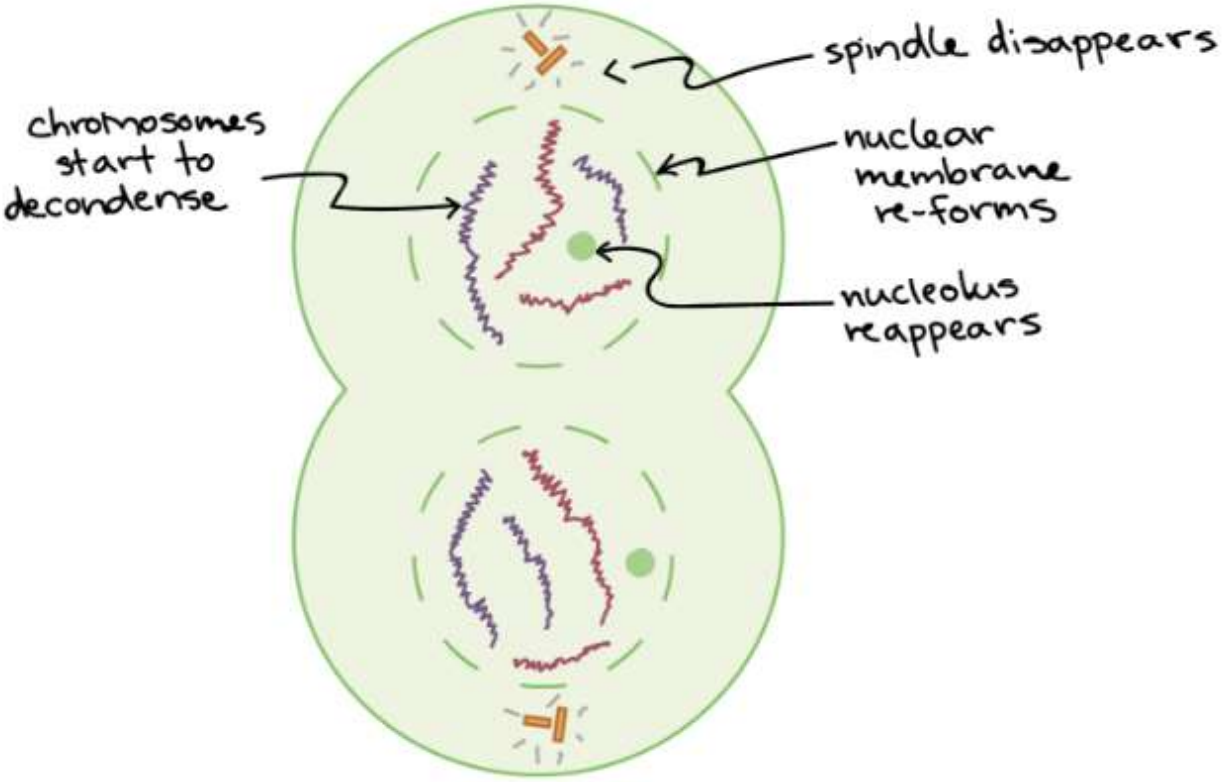


In anaphase, the sister chromatids separate from each other and are pulled towards opposite ends of the cell.

- 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.

TELOPHASE

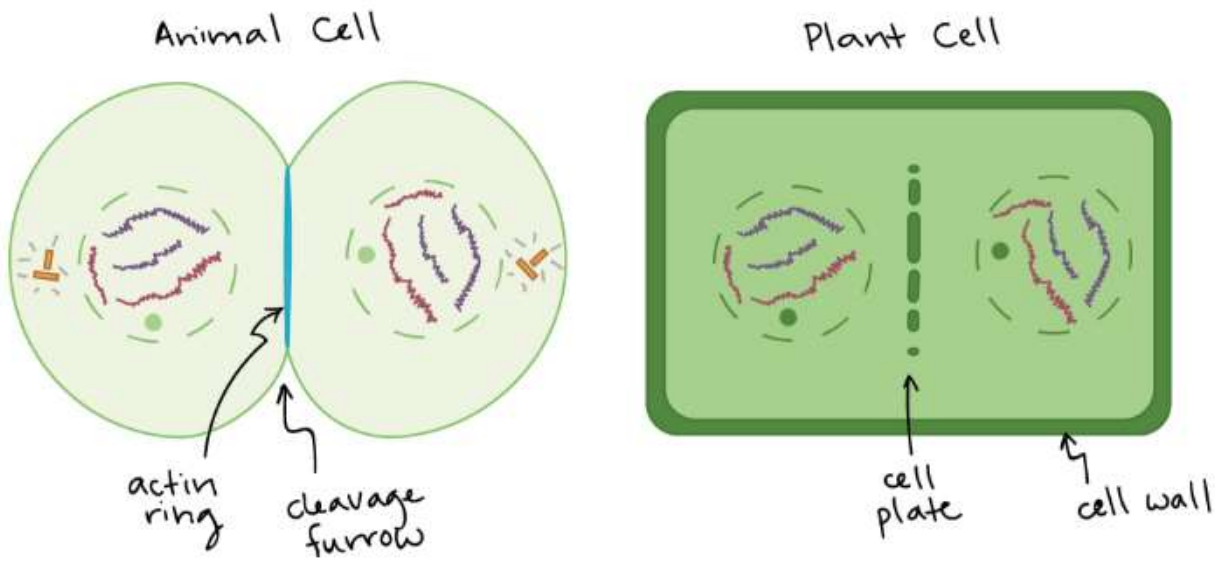


In telophase, the cell is nearly done dividing, and it starts to re-establish its normal structures as cytokinesis (division of the cell contents) takes place.

- 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



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.

In animals, cell division occurs when a band of cytoskeletal fibers called the contractile ring contracts inward and pinches the cell in two, a process called contractile cytokinesis (The pinching of the cell membrane to form the two daughter cells is called cleavage furrow) separating the two developing nuclei. The indentation produced as the ring contracts inward is called the cleavage furrow. Animal cells can be pinched in two because they're relatively soft and squishy.

Plant cells are much stiffer than animal cells; they're surrounded by a rigid cell wall and have high internal pressure. Because of this, plant cells divide in two by building a new structure down the middle of the cell. This structure, known as the cell plate, is made up of plasma membrane and cell wall components delivered in vesicles, and it partitions the cell in two, giving rise to two daughter cells, each with an equivalent and complete copy of the original genome.