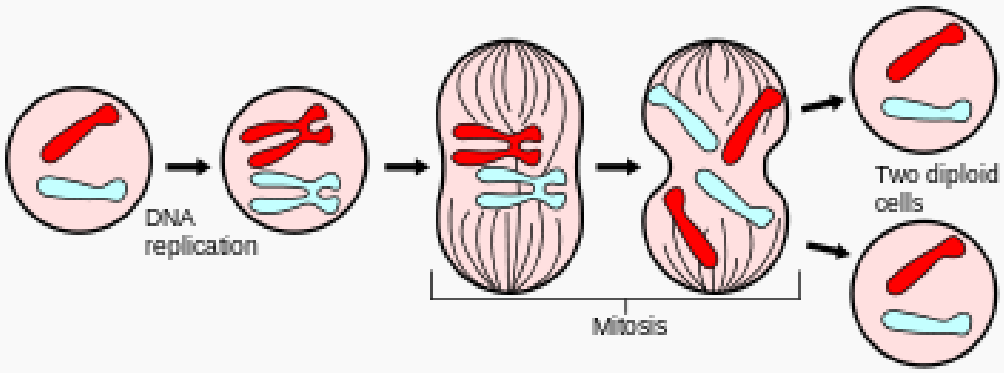
Mitosis

Mitosis in an animal cell.



Mitosis divides the chromosomes in a cell nucleus.

Mitosis is a part of the cell cycle process by which chromosomes in a cell nucleus are separated into two identical sets of chromosomes, each in its own nucleus. In general, karyokinesis (division of the nucleus) is followed by cytokinesis, which divides the cytoplasm, organelles and cell membrane into two new cells containing roughly equal shares of these cellular components. Mitosis and cytokinesis together define the **mitotic** (**M**) **phase** of the cell cycle—the division of the mother cell into two daughter cells, genetically identical to each other and to their parent cell.

These stages are prophase, prometaphase, metaphase, anaphase, and telophase. **During mitosis**, the chromosomes, which have already duplicated, condense and attach to fibers that pull one copy of each chromosome to opposite sides of the cell.

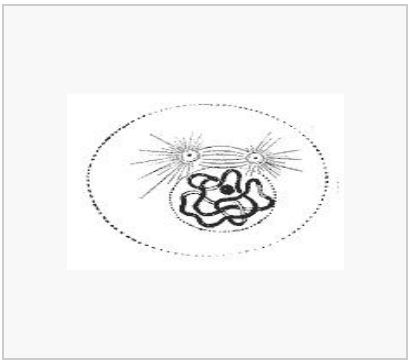
Mitosis occurs only in eukaryotic cells and the process varies in different organisms. For example, animals undergo an "open" mitosis, where the nuclear envelope breaks down before the chromosomes separate, while fungi undergo a "closed" mitosis, where chromosomes divide within an intact cell nucleus. Prokaryotic cells, which lack a nucleus, divide by a different process called binary fission.

When mitosis begins, the chromosomes condense and become visible. In most eukaryotes, the nuclear envelope, which segregates the DNA from the cytoplasm, disintegrates into small vesicles. The nucleolus, which makes ribosomes in the cell, also disappears. Microtubules project from opposite ends of the cell, attach to the centromeres, and align the chromosomes centrally within the cell. The microtubules then contract to pull the sister chromatids of each chromosome apart. Sister chromatids at this point are called *daughter chromosomes*. As the cell elongates, corresponding daughter chromosomes are pulled toward opposite ends of

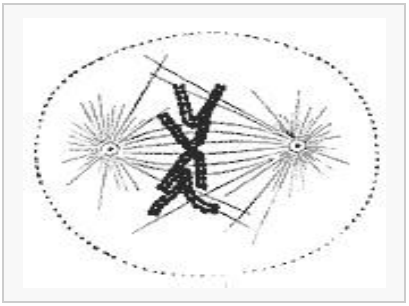
the cell. A new nuclear envelope forms around the separated daughter chromosomes.

As mitosis concludes, the cell begins cytokinesis. In animal cells, the cell membrane pinches inward between the two developing nuclei to produce two new cells. In plant cells, a cell plate forms between the two nuclei.

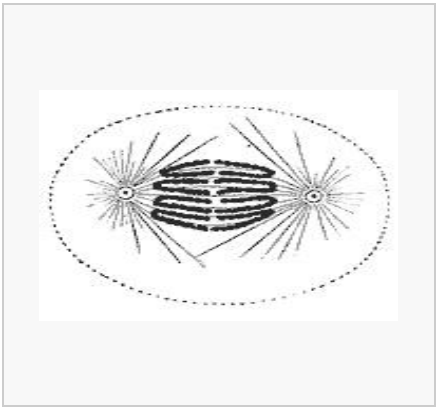
Phases of mitosis



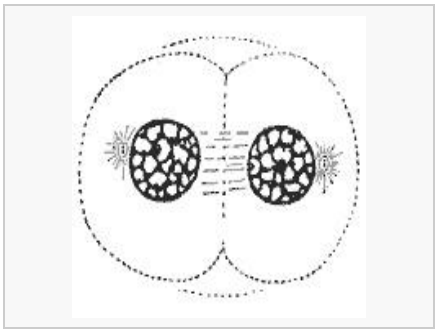
Prophase: The two round objects above the nucleus are the centrosomes. The chromatin is condensing into chromosomes.



Metaphase: The chromosomes align at the metaphase plate.



Anaphase: The chromosomes split and the kinetochore microtubules shorten.



Telophase: The decondensing chromosomes are surrounded by newly formed nuclear envelopes. Cytokinesis has already begun; the pinched area is known as the *cleavage furrow*.

Cytokinesis

Cilliate undergoing cytokinesis, with the cleavage furrow being clearly visible

Cytokinesis is not, in the technical sense, a phase of mitosis but rather a separate process, necessary for completing cell division. In animal cells, a cleavage furrow (pinch) containing a contractile ring develops where the metaphase plate used to be, pinching off the separated nuclei. In both

animal and plant cells, cell division is also driven by vesicles derived from the Golgi apparatus, which move along microtubules to the middle of the cell. The end of cytokinesis marks the end of the M-phase.

SIGNIFICANCE

Mitosis is important for the maintenance of the chromosomal set; each cell formed receives chromosomes that are alike in composition and equal in number to the chromosomes of the parent cell.

Mitosis occurs in the following circumstances:

Development and growth

The number of cells within an organism increases by mitosis. This is the basis of the development of a multicellular body from a single cell, i.e., zygote and also the basis of the growth of a multicellular body.

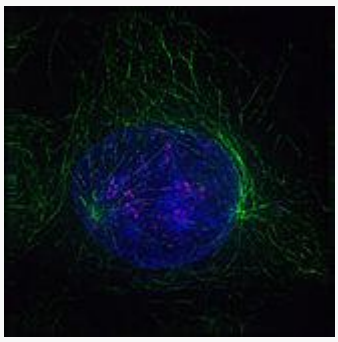
Cell replacement

In some parts of body, e.g. skin and digestive tract, cells are constantly sloughed off and replaced by new ones. New cells are formed by mitosis and so are exact copies of the cells being replaced.

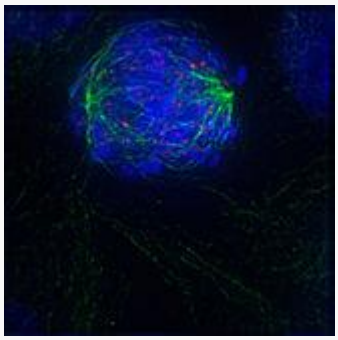
Regeneration

Some organisms can regenerate body parts. The production of new cells in such instances is achieved by mitosis. For example, starfish regenerate lost arms through mitosis.

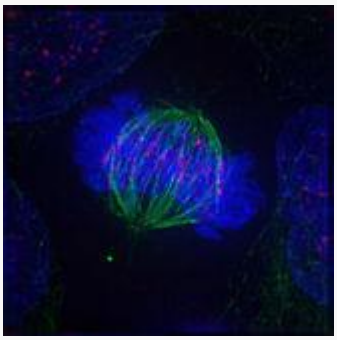
Mitotic cells can be visualized microscopically by staining them with fluorescent antibodies and dyes.



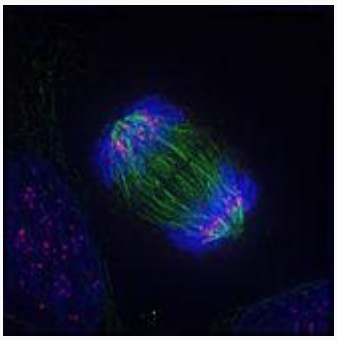
Early prophase: Nonkinetochore microtubules, shown as green strands, have established a matrix around the degrading nucleus, in blue. The green nodules are the centrosomes.



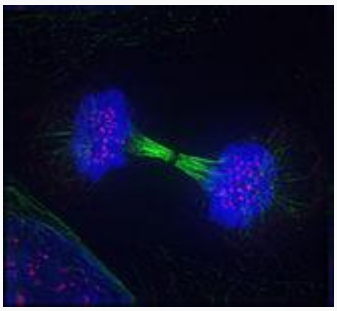
Early prometaphase: The nuclear envelope has just disintegrated, allowing the microtubules to quickly interact with the kinetochores on the chromosomes, which have just condensed.



Metaphase: The centrosomes have moved to the poles of the cell and have established the mitotic spindle. The chromosomes have assembled at the metaphase plate.



Anaphase: Lengthening nonkinetochore microtubules push the two sets of chromosomes further apart.



Telophase: Reversal of prophase and prometaphase events.