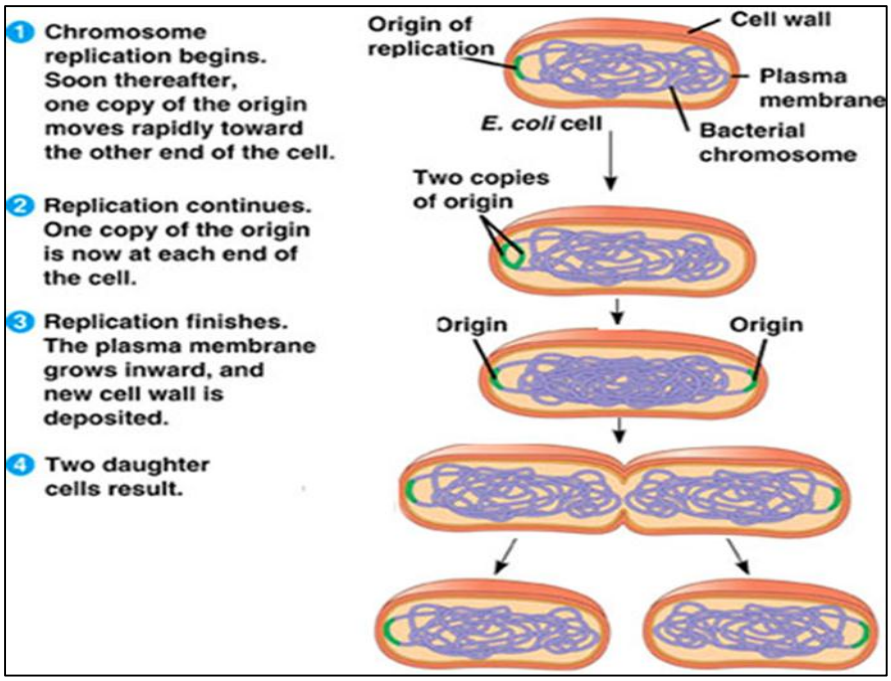
Cell Division

Cell division is a process by which cells reproduce. In prokaryotic organisms, cells divide by binary division



Binary division in prokaryotic cell (*E.coli*)

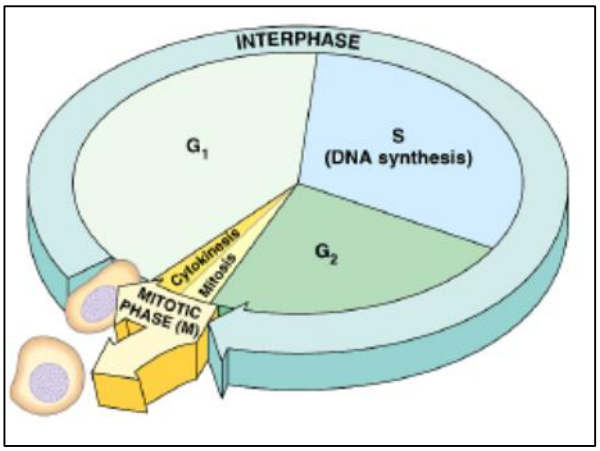
In eukaryotes, cell division may occur by one of two major processes: **mitosis or meiosis**. Mitosis is a process of cell duplication, or reproduction, during which one cell gives rise to two genetically identical daughter cells. Mitosis is performed by somatic, or body, cells such as skin cells and muscle cells. The chromosome number in mitosis is always diploid (2n). Diploid means two copies (pair) of each chromosome. For example, human body cells are diploid, they contain 46 chromosomes or 23 pairs of chromosomes. In contrast, meiosis is a form of cell division that is carried out only by germ cells, which give rise to the reproductive cells (e.g., sperm and eggs). Meiosis is much more elaborate than mitosis, since it involves two fissions of the nucleus. These fissions give rise to four mature gametes, or sex cells, each possessing half the number of chromosomes of the original cell. Each gamete is capable of combining with a sexually compatible gamete (e.g., sperm-egg fusion) to generate a new organism. Human germ (sex) cells are haploid. Gametes (sperm & egg) are haploid = 23 chromosomes.

Mitosis

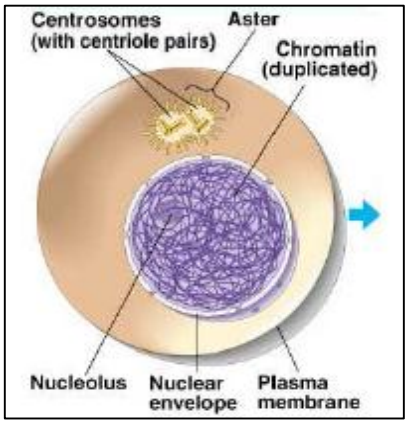
The life of a cell within 24 hours is divided into 2 phases: M phase or mitosis (division phase) and interphase (non-division phase). Interphase is subdivided into three phases: G1 phase, S-phase, and G2 phase. During G1 and G2 phases, proteins, and enzymes are synthesized. ***Centrioles*** also divide during these phases of interphase. During the S phase, DNA is synthesized.

The cell enters the M phase where division occurs. The M phase is subdivided into 4 phases: **prophase, metaphase, anaphase, and telophase.**

Centriole: *Organelle of animal cells that is made up of two orthogonally arranged cylinders each with nine microtubule triplets composing the wall.*



A diagrammatic view of cell cycle indicating formation of two cells from one cell



Interphase

Prophase

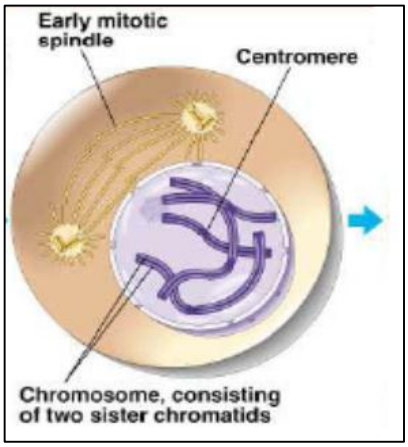
-Chromatin (Stainable material of interphase nucleus consisting of nucleic acid and associated histone protein packed into **nucleosomes)** condenses

-Visible chromosomes as double strands (each strand being termed a chromatid).

-Centrioles move to opposite poles of cell to form mitotic spindle. The mitotic spindle is composed of microtubules, each of which is a tubular assembly of molecules of the protein tubulin. Spindle coordinate movement of chromosomes and helps to ensure chromosomes separate properly.

- Nucleolus disappears

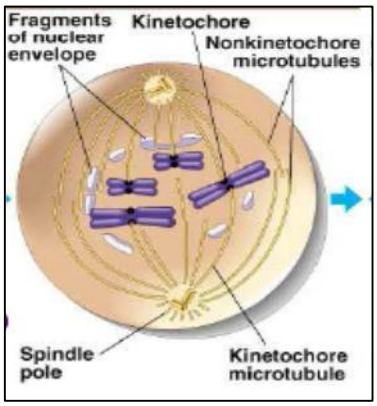
-Nuclear membrane breaks down



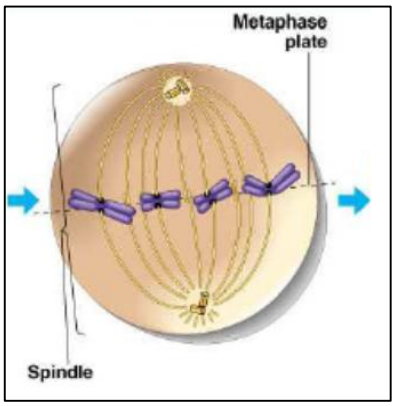
Prophase

Metaphase

The spindles produced at prophase rearrange themselves at each pole of the cell. The chromosomes also arrange themselves at the center of the cell, some spindles stretch out to attach themselves to the centromeres in the chromosomes (kinetichore microtubules); others stretch across to opposite pole of the cell (non-kinetichore microtubules), and a third group of the spindles (aster microtubules) remain at each pole of the cell.



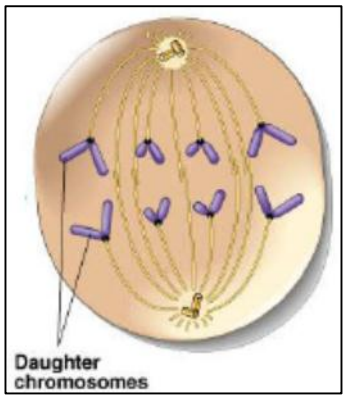
Prometaphase



Metaphase

Anaphase

The proteins in the microtubule of the spindles begin to contract to the poles, pull the centromere that held together the sister chromatids of each chromosome causing each sister chromatid to separate from each other. These chromatids move to opposite poles of the cell. This is followed by cytokinesis, a process where the cytoplasm of the cell divides as the sister chromatids move to opposite poles of the cell.



Anaphase

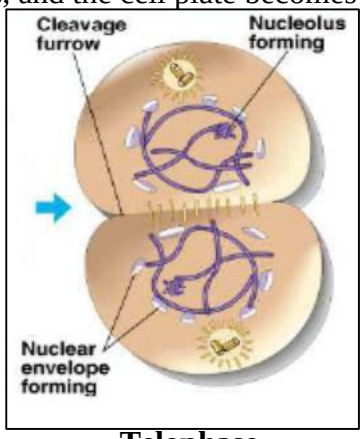
Telophase

A new nuclear envelope forms around each set of unraveling chromatids, the cytokinesis, the division of the cytoplasm is completed, and the cell divides into two.

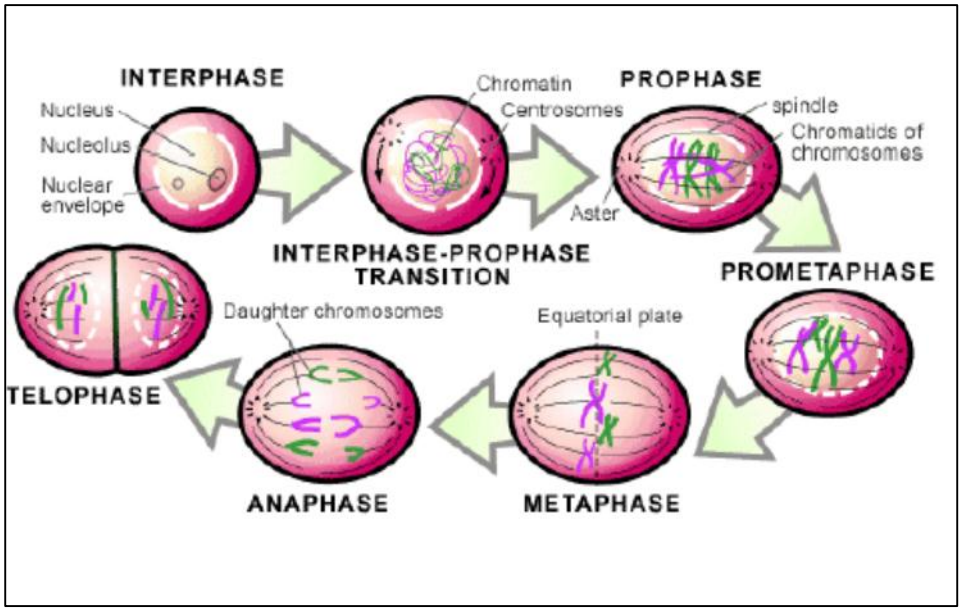
An essential feature of mitosis is the attachment of the chromatids to opposite poles of the mitotic spindle. This ensures that each of the daughter cells will receive a complete set of chromosomes.

This is another process in which animal and plant cells differ. In animal cells cytokinesis is achieved through the constriction of the cell by a ring of contractile microfilaments consisting of actin and myosin, the proteins involved in muscle contraction and other forms of cell movement. In plant cells the cytoplasm is divided by the formation of a new cell wall, called the cell plate, between the two daughter cells. The cell plate arises from small Golgi-derived vesicles that coalesce in a plane across the equator of the late telophase spindle to form a disk-shaped structure. In this process, each vesicle contributes its membrane to the forming cell membranes and

its matrix contents to the forming cell wall. A second set of vesicles extends the edge of the cell plate until it reaches and fuses with the sides of the parent cell, thereby completely separating the two new daughter cells. At this point, cellulose synthesis commences, and the cell plate becomes a primary cell wall.



Telophase



Overview of Mitosis

MEIOSIS: is the cell division in which the number of chromosomes is reduced by half. In animals the eggs and the sperms are produced through this cell division, while in plants the product of meiosis is the haploid spores or pollen grains. In meiosis there are two cycles of cell division, each cycle consists of 4 phases of prophase, metaphase, anaphase and telophase.

Cycle1

Prophase1

The nuclear membrane degenerates, and the centrioles produce spindles. The homologous chromosomes pair-up, a process called synapsis. They form chiasmata (a bridge that connects the homologous chromosomes together) where crossing over (gene exchange) occurs.

Metaphase 1

The homologous chromosomes line-up at the center of the cell.

Anaphase 1

The homologous chromosomes separate and move to opposite poles of the cell. Cytokinesis (division of the cytoplasm) occurs, a cell plate is formed.

Telophase 1

The cytokinesis completes. The nuclear membrane is formed and the cell divides into daughter cells, each contains one of each pair of homologous chromosomes. Each daughter cell therefore contains half the number of chromosomes as the mother cell.

Cycle 2

Prophase 2

Each daughter cell starts a second cycle of cell division. The nuclear membrane degenerates, and the centrioles form spindles.

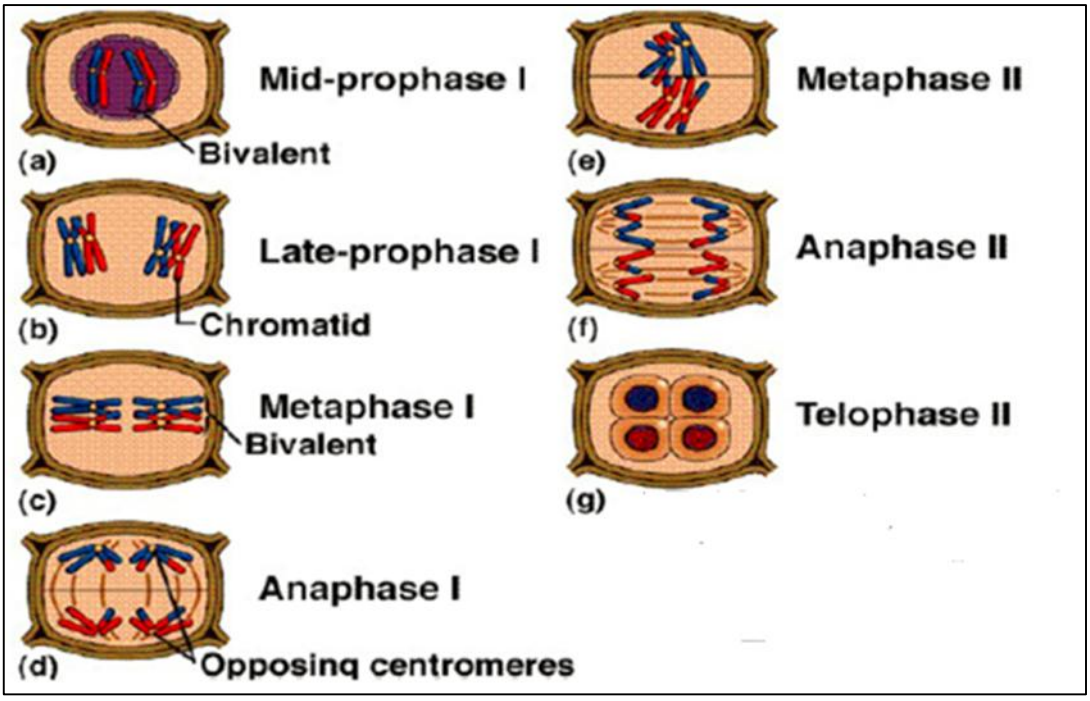
Metaphase 2

The chromosomes line at the center of the cell.

Anaphase 2 The sister chromatids of each chromosome separate at the centromere that holds them together. The chromatids move to opposite poles of the cell. Cytokinesis begins and a cell plate is formed.

Telophase 2

Cytokinesis is completed, each of the cells divides into daughter cells, and each daughter cell contains chromatid instead of full chromosome. The number of chromatids in each daughter cell is the same as the number of chromosomes in each of the cell at beginning of the second cycle before this second division.



Meiosis