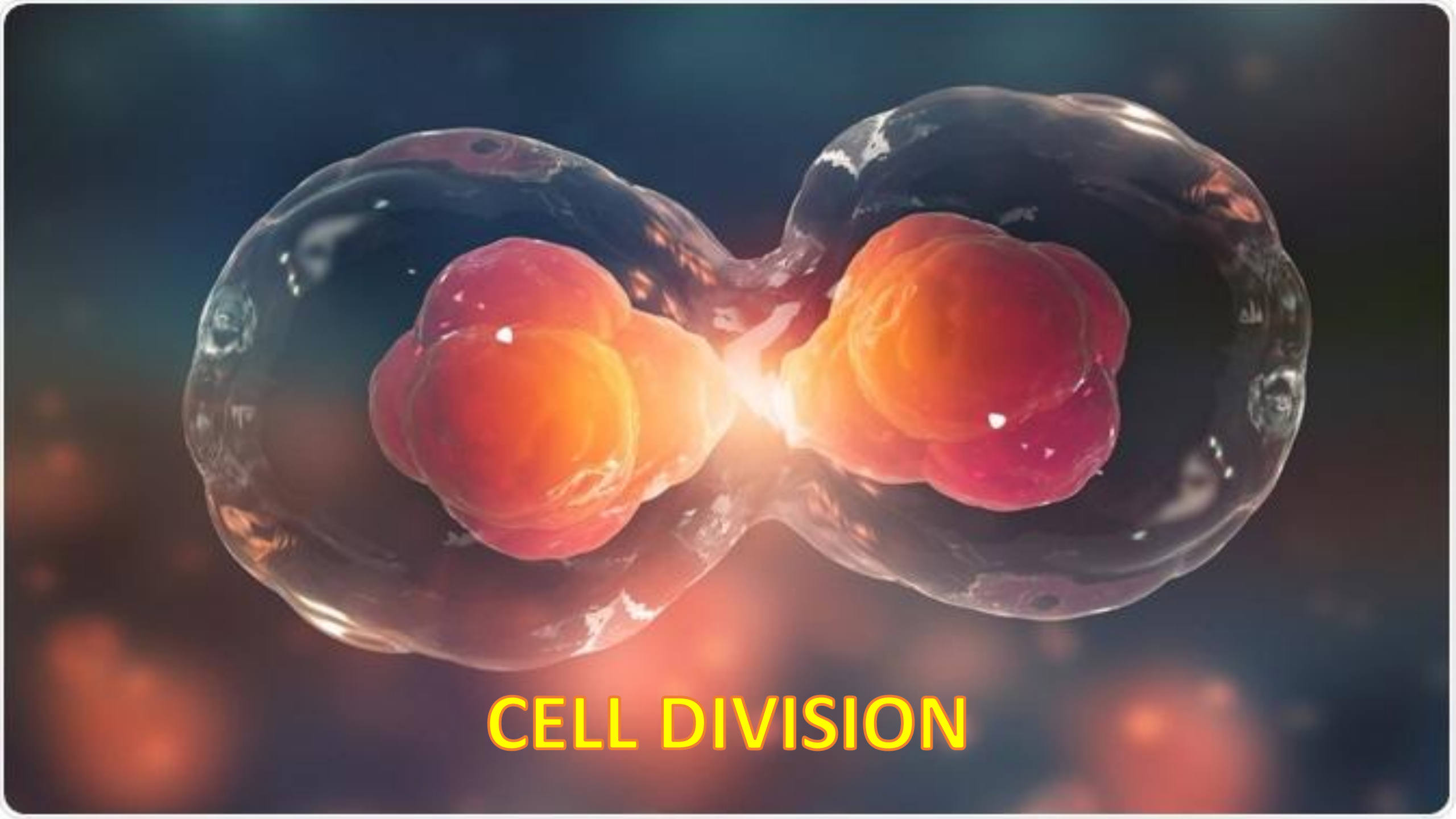
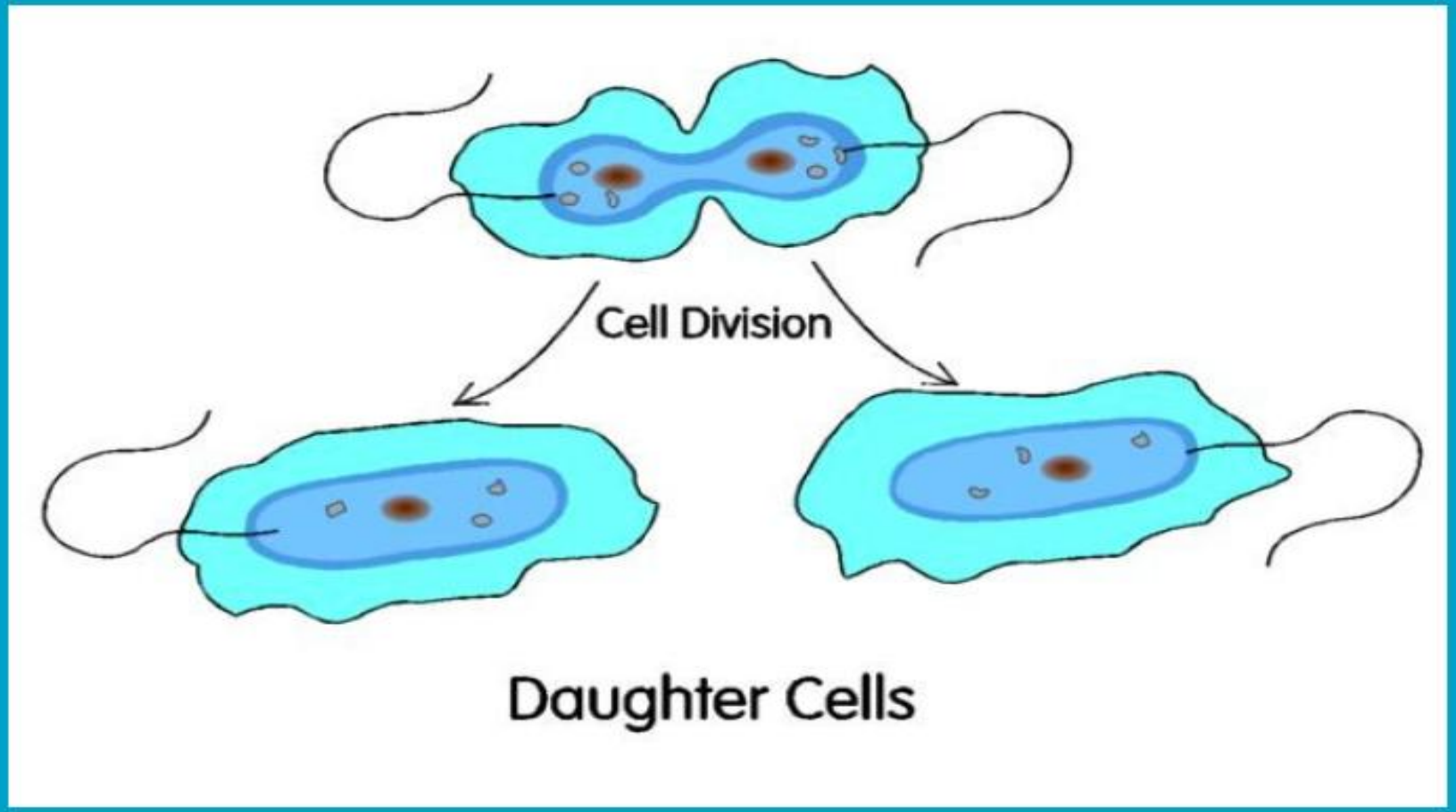

CELL DIVISION

Cell Division

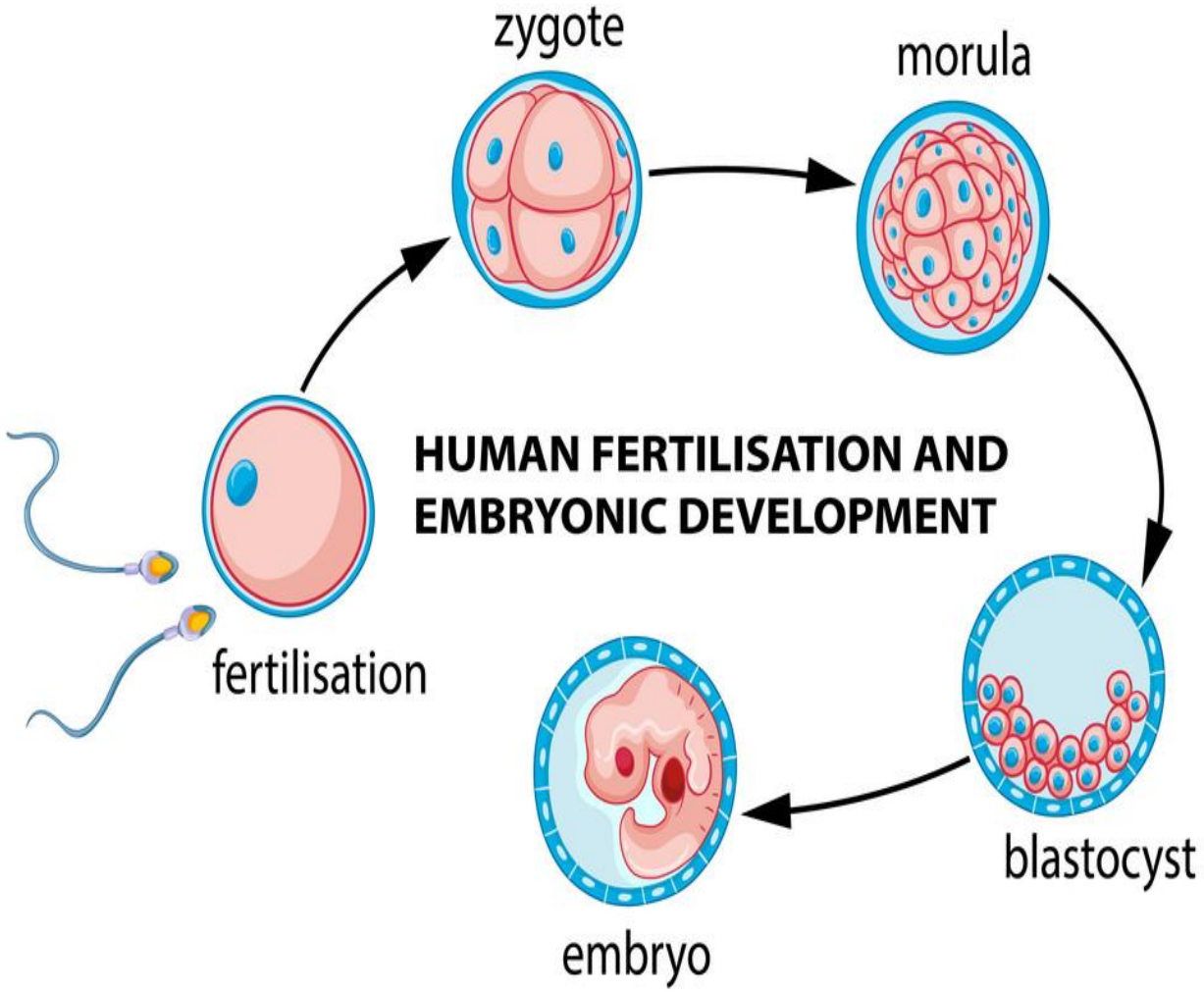
What is it?

Why do Cells do it?

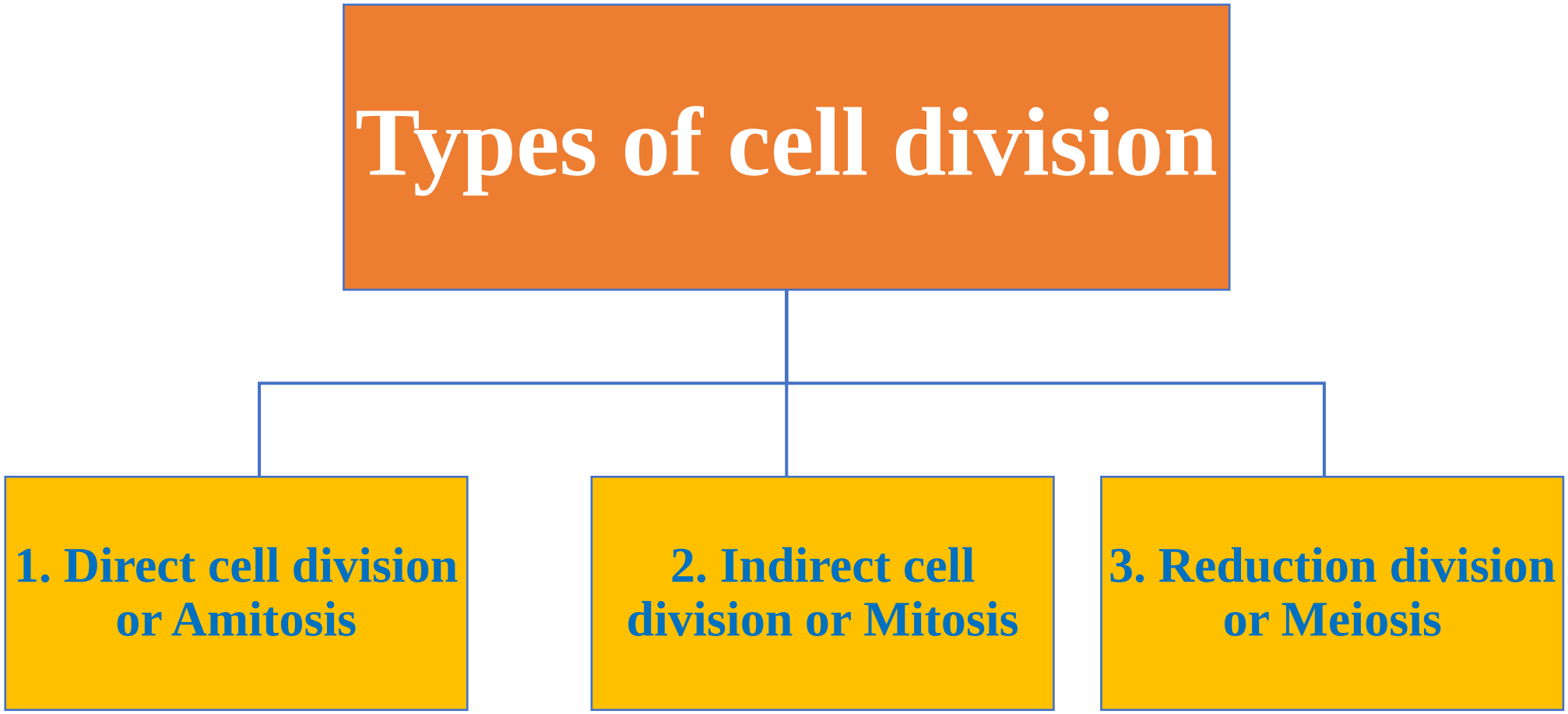
Why is it important to me?



- Living cells have the power to grow and divide.
- A multicellular organism starts its life as a single cell and undergo repeated divisions.
- Growth and multiplication of every living organism depends on the growth and multiplication of its cells.
- The cell increases in size due to growth and then it begins to divide.
- The vegetative growth of an organism takes place by an increase in the number of cells through cell divisions.



Types of cell division

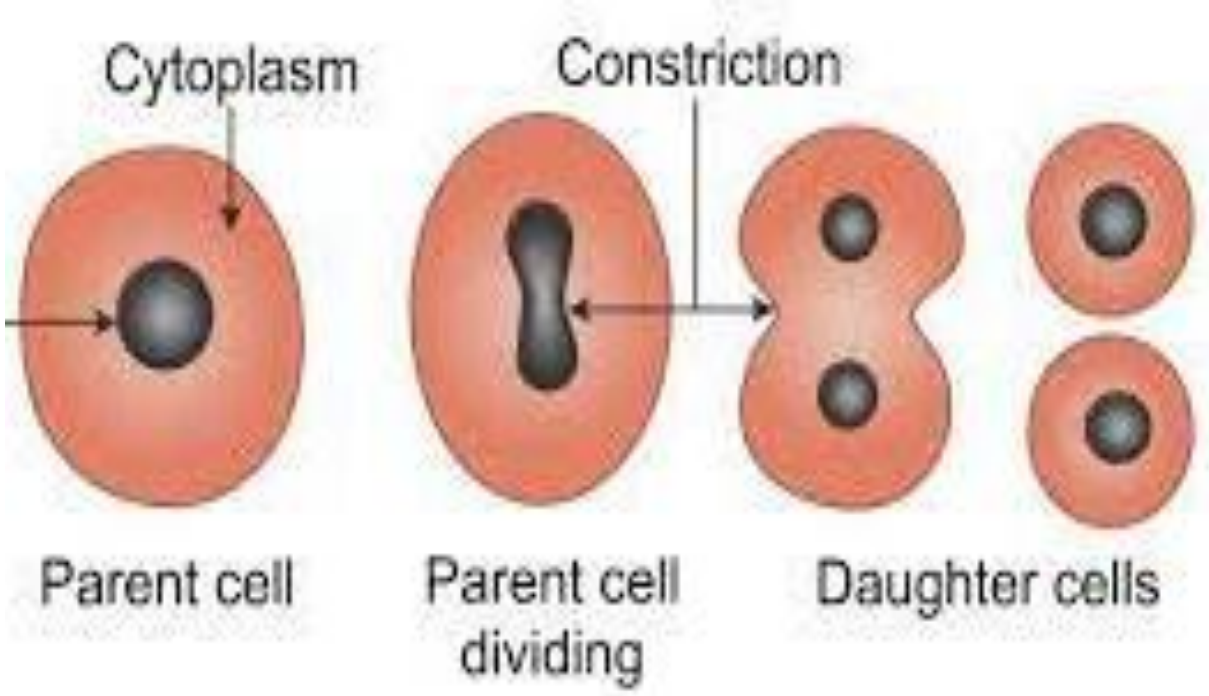


1. Amitosis:

It is the means of asexual reproduction in unicellular organisms like bacteria and protozoans. In amitosis type of cell division, the splitting of nucleus takes place by cytoplasmic constriction.

During amitosis, the nucleus elongates first and then a depression or constriction is formed in middle. This constriction increases in size and ultimately divides the nucleus into two nuclei. After division of nucleus a constriction is formed in cytoplasm, which divides the cell into two equal halves. Thus, without any nuclear events two daughter cells are formed.

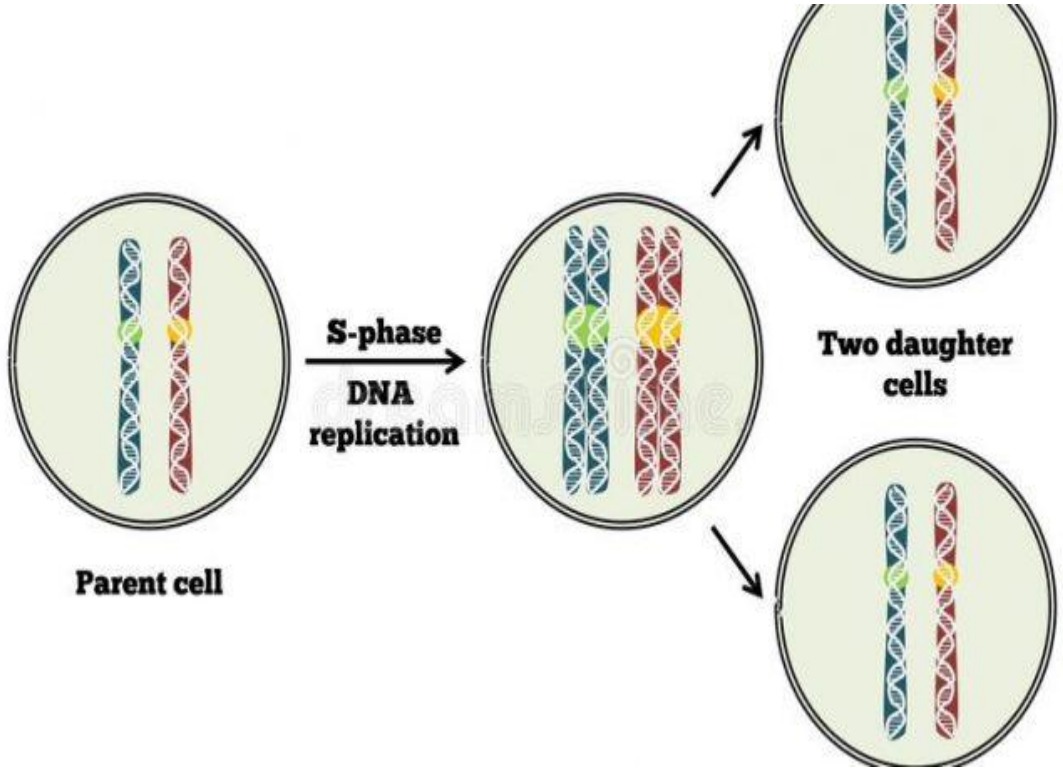
e.g., Binary fission in paramoecium.



2. Mitosis:

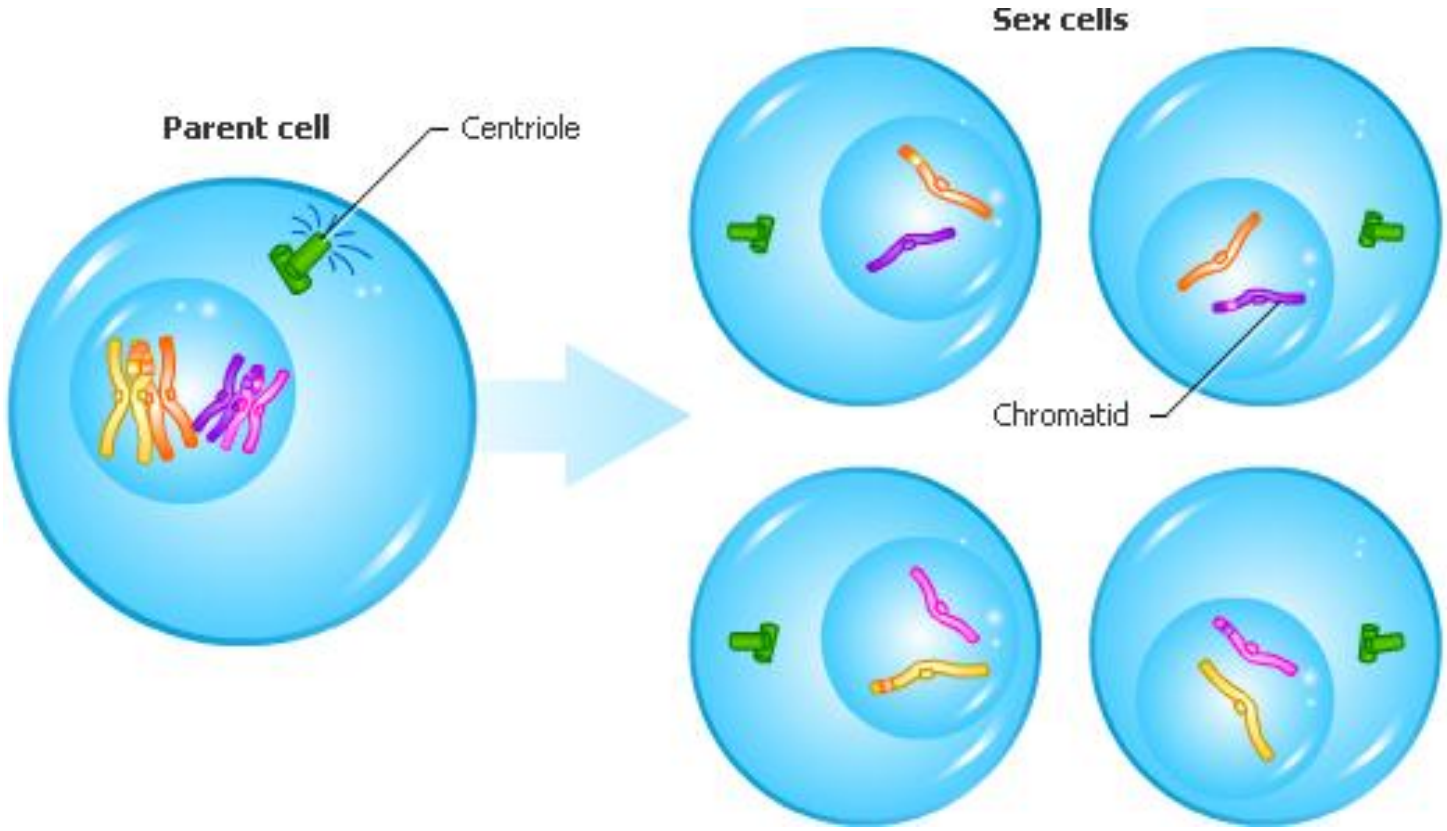
Mitosis is the division of somatic cells. It is multiplication of somatic cells into daughter cells of equal size containing same number of chromosomes as the parent cell. At the time of mitosis nucleus becomes completely reorganized. the mitotic cycle is divided into series of phases such as- prophase, metaphase, anaphase and telophase.

Mitosis involves a series of complex changes in both nucleus and cytoplasm. the division of nucleus is called karyokinesis and division of cytoplasm is called cytokinesis.



3. Meiosis:

Meiosis occurs only in gonads (in germ cells) during the formation of gametes like sperm and ovum. It is a process in which double number or 2N (diploid chromosomes) is reduced to its half number or N (haploid chromosomes). It is also called reduction division.

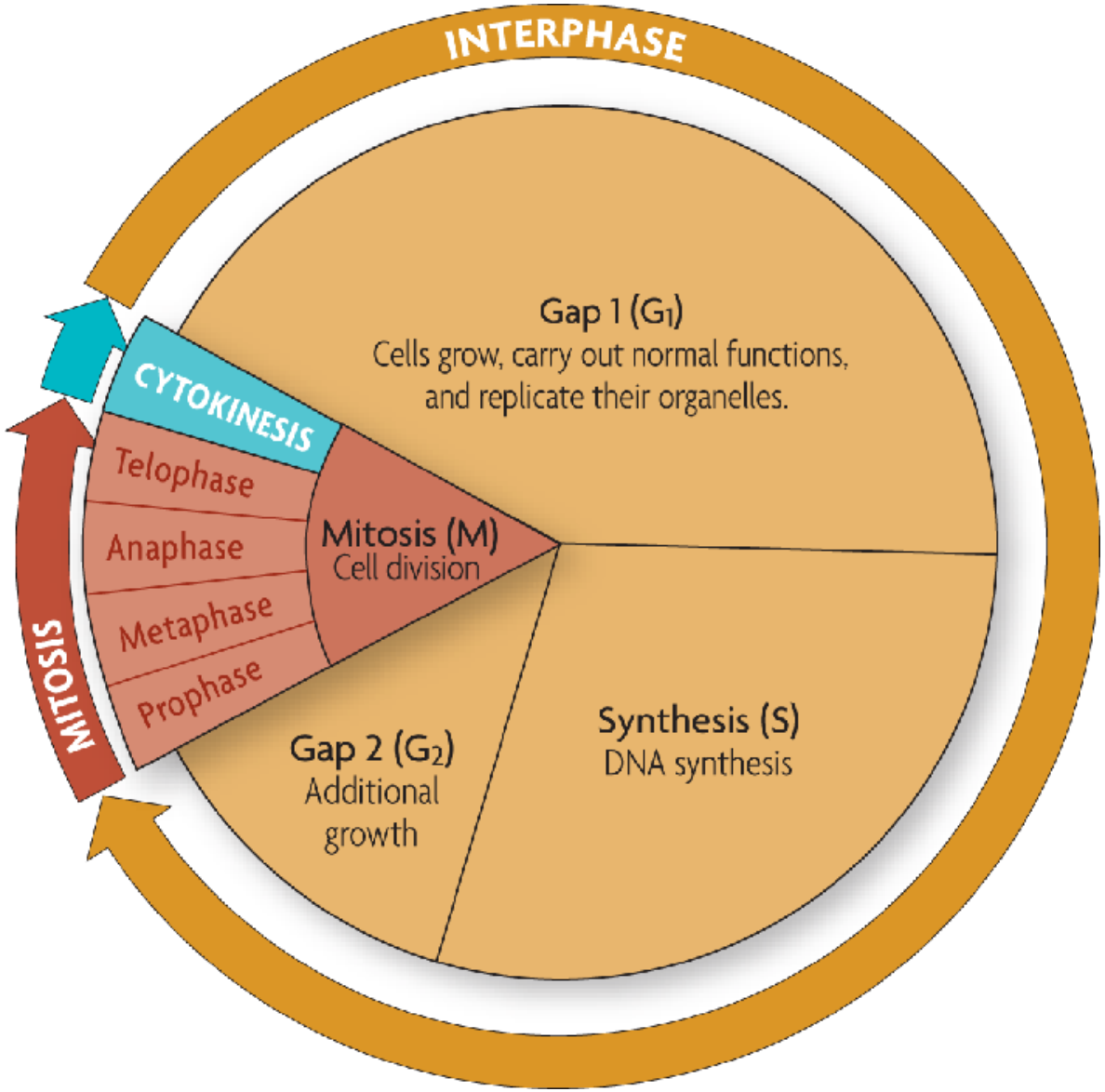


Cell Cycle:

The events occurring in the life of a cell from its formation to its division into daughter cells constitute a cell cycle.

The cell cycle consists of two stages-

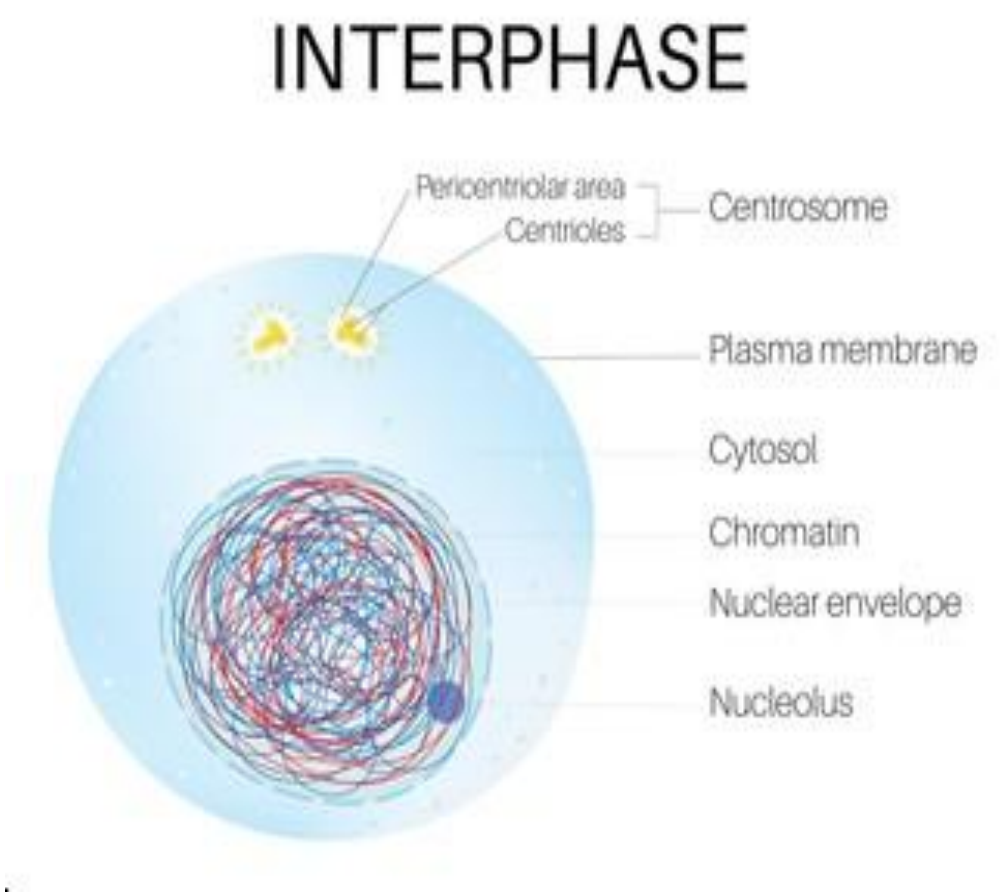
1. Interphase (Growth phase or non-dividing phase)
2. Mitotic phase or M-phase (division phase)



1. Interphase:

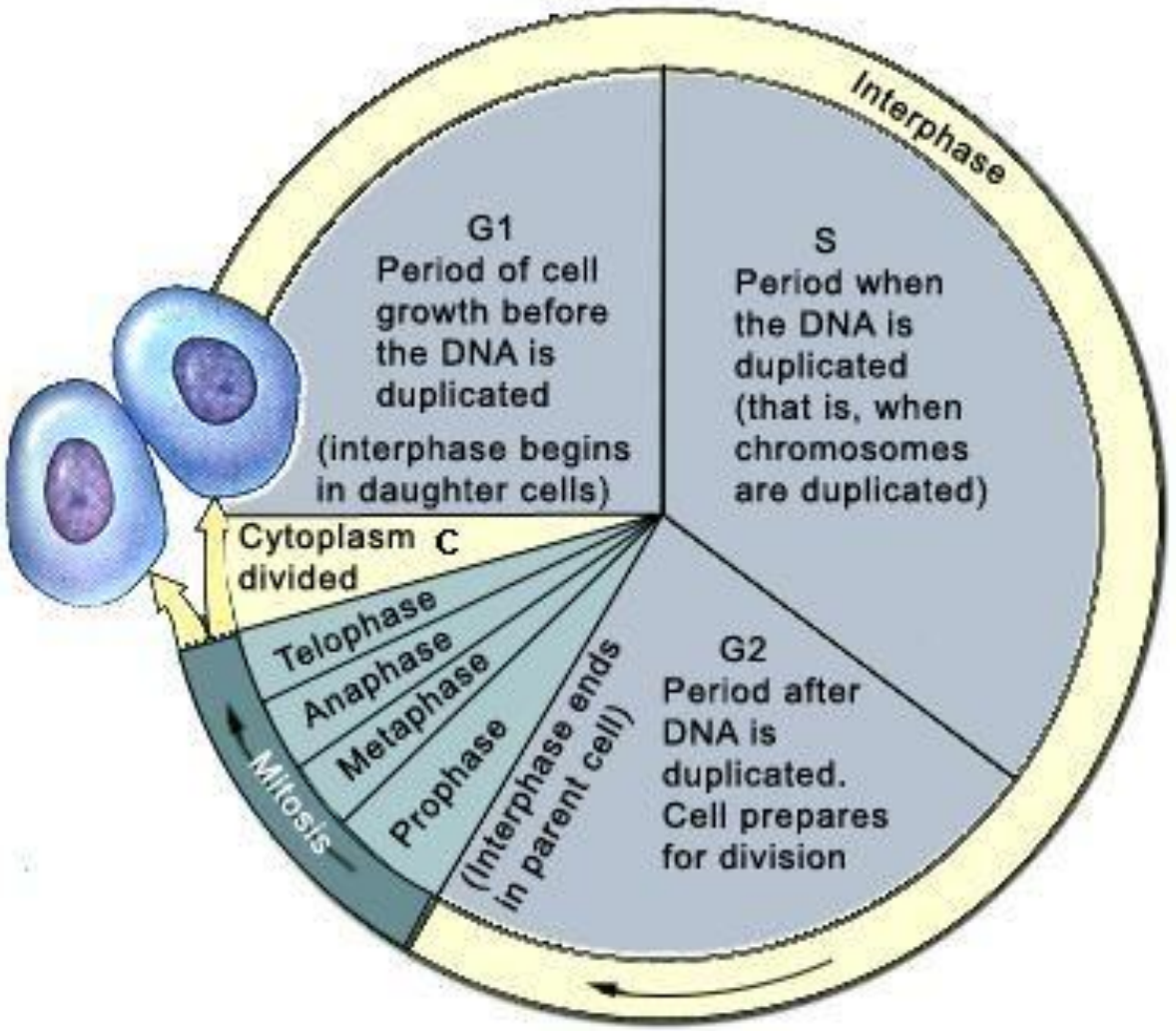
It is the resting phase between the two mitotic divisions. The time between the end of telophase and beginning of the next M-phase is called interphase. In interphase no division of chromosomes and cytoplasm occurs. The nucleus and cytoplasm remain metabolically active. These activities prepare the cell for next mitosis phase. It is the longest phase and the cell grows in this phase.

Interphase is divided into three sub phases- G1 phase, S phase and G2 phase.



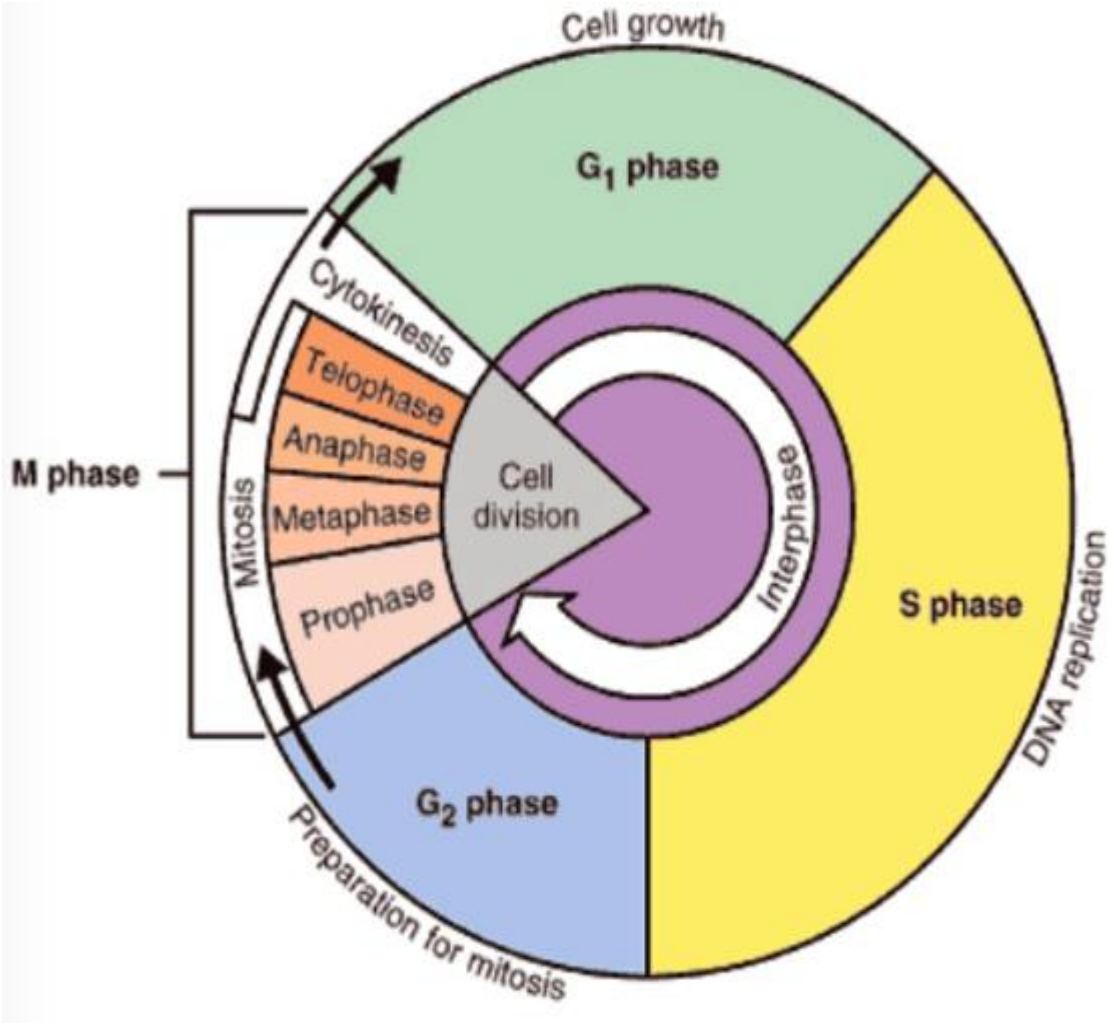
i. G1 Phase: (G stands for Gap)

The gap between previous mitosis and the S phase of the subsequent cycle. It is gap period or first growth period. This period starts immediately after division. In this stage initial growth of a newly formed cell takes place. The daughter cells grow and increase in size during G1 phase. It synthesizes and stores enzymes, mRNA, tRNA, rRNA, ribosomes and proteins. Cell organelles such as mitochondria, ER, ribosomes, lysosomes, vacuoles etc. are produced. Generally, this phase lasts for 30-50% of the complete cell cycle.



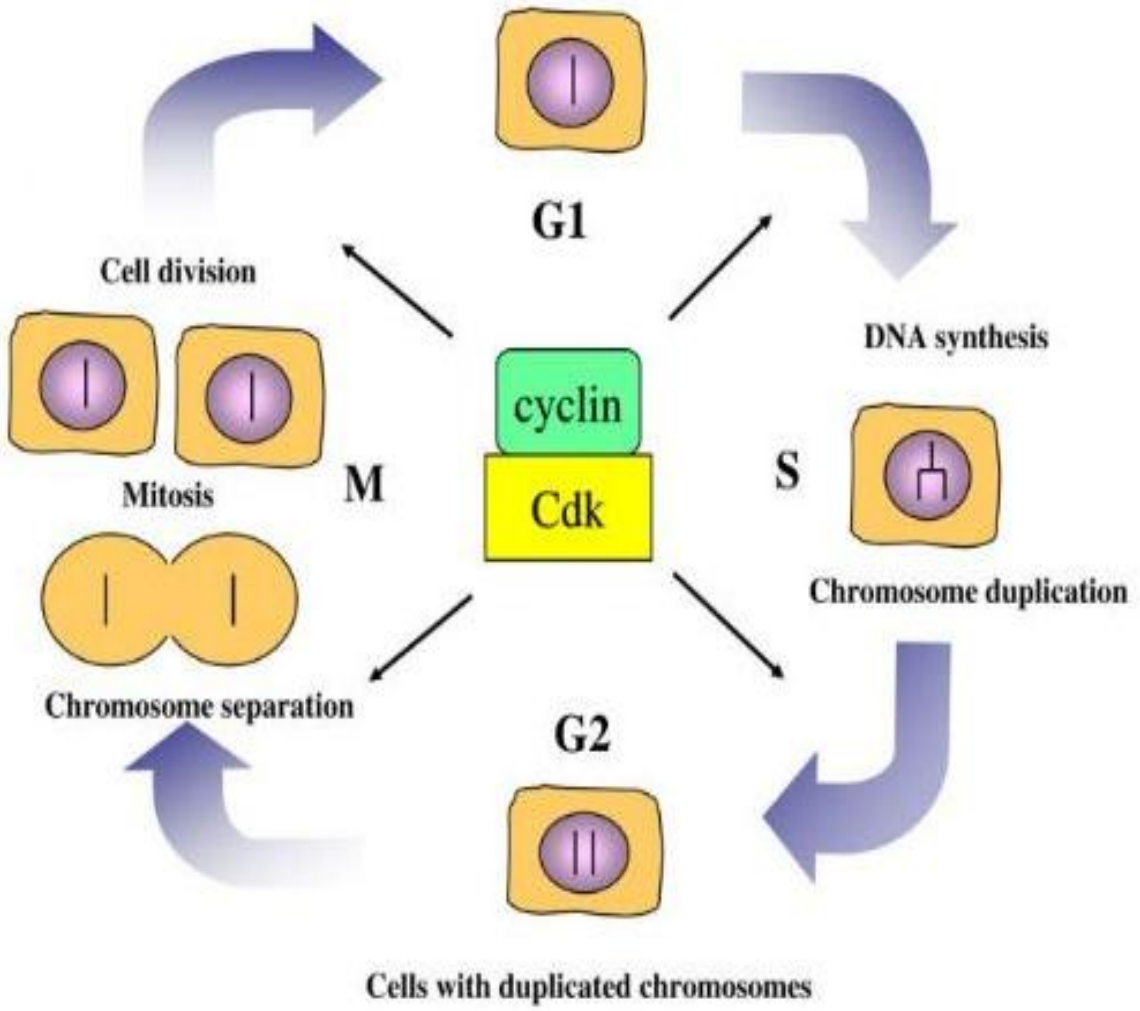
ii. S Phase: (S stands for Synthesis)

It is the synthetic phase of interphase. During this phase, duplication of chromosomes takes place. It occupies about 35-45 % time of the cell cycle. The cell growth continues along with the synthesis of a number of proteins and enzymes that are involved in DNA synthesis. Once DNA replication is complete, the cell contains twice its normal number of chromosomes. Each chromosome becomes divided into two chromatids. The cell is now ready to enter the G2 phase.



iii. G2 Phase:

It is the second gap or growth phase of interphase. It is the interval between the completion of DNA synthesis and beginning of DNA segregation. It is the post DNA synthesis period. In this phase, cell makes preparations for the initiation of mitosis. The cytoplasmic organelles like centrioles, mitochondria and golgi complex are doubled. Proteins for spindles and asters are synthesized. Active metabolism stores energy for the next mitosis. This phase occupies only 10-20% time of the cell cycle.

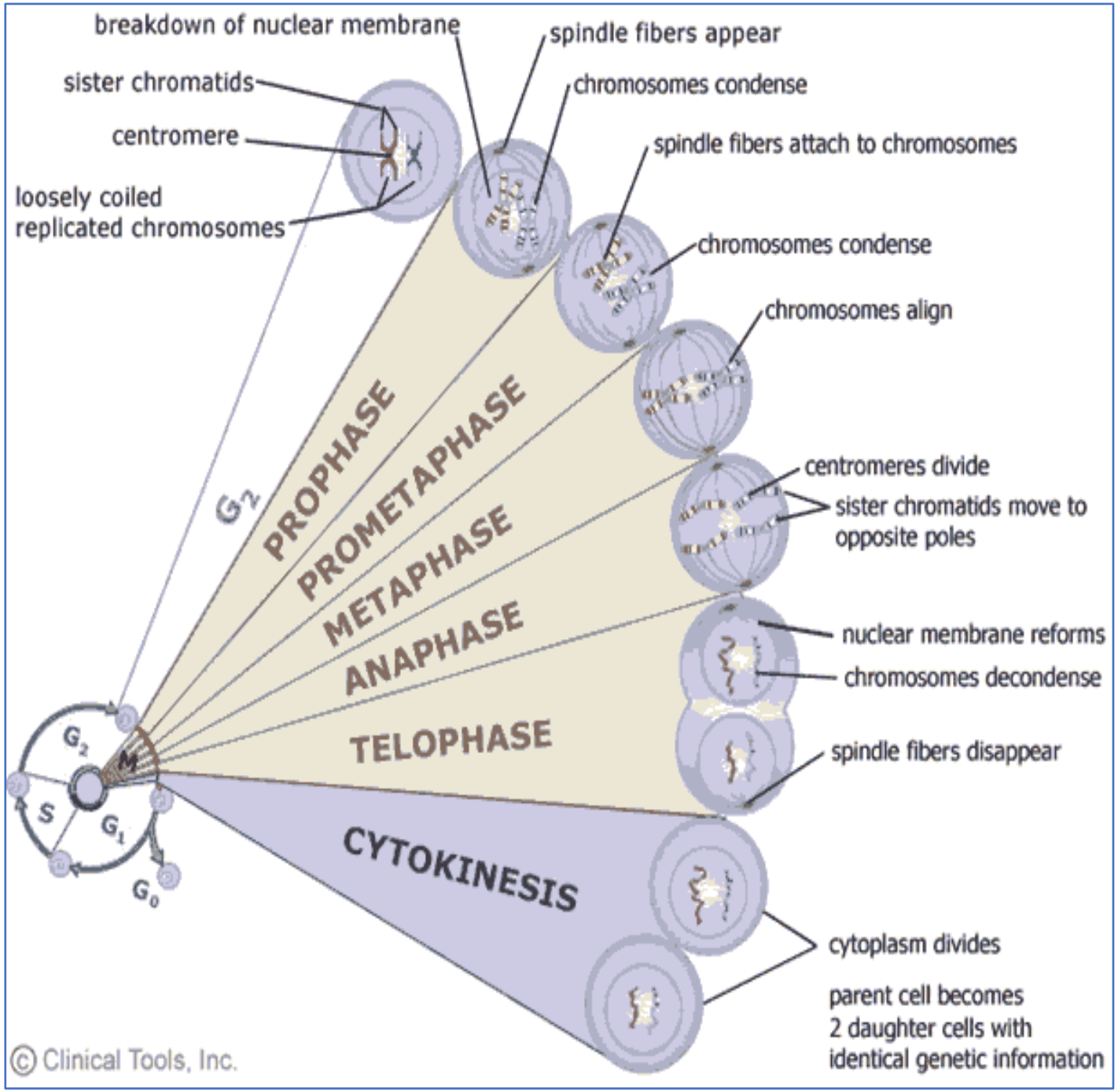


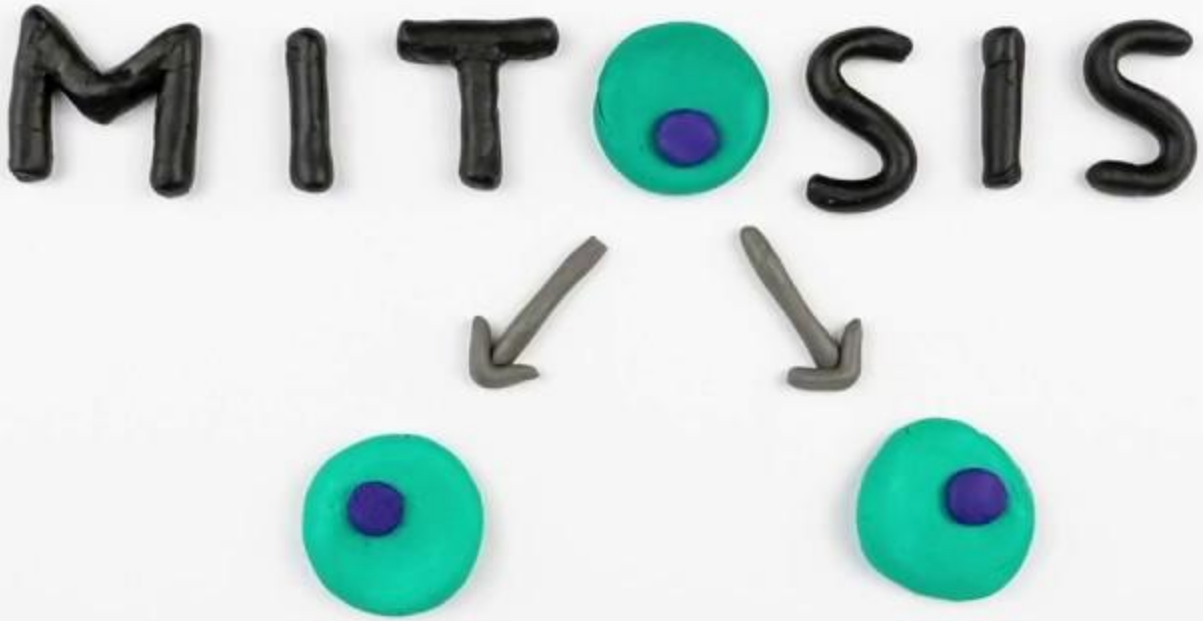
2. **Mitotic Phase:** (Division Phase)

Interphase is followed by mitotic phase.
It is also called as **M-phase**.
It occurs in somatic cells (eukaryotic cells) and gives rise to two identical daughter cells.
This phase has two sub-phases:
Karyokinesis and Cytokinesis.

Karyokinesis refers to the division of nucleus into two daughter nuclei.
It has 4 phases- **Prophase, Metaphase, Anaphase** and **Telophase**.

Cytokinesis refers to the division of the cytoplasm resulting into two daughter cells.




MITOSIS

MITOSIS (Greek; mitos=thread)

"The division of a cell into two identical daughter cells each with a nucleus having the same amount of DNA, the same number of chromosomes and the same number of genes as the parent cell."

- **Eduard Strasburger**, a German biologist described mitosis for the first time in 1875.
- **Walter Fleming** described the same in 1879 and also termed it as **'mitosis'** in 1882.

It is the most common method of cell division in eukaryotes and takes place in somatic cells. Hence, it is also known as **somatic division**.

The duration of mitosis on an average is 30 minutes to 3 hours.

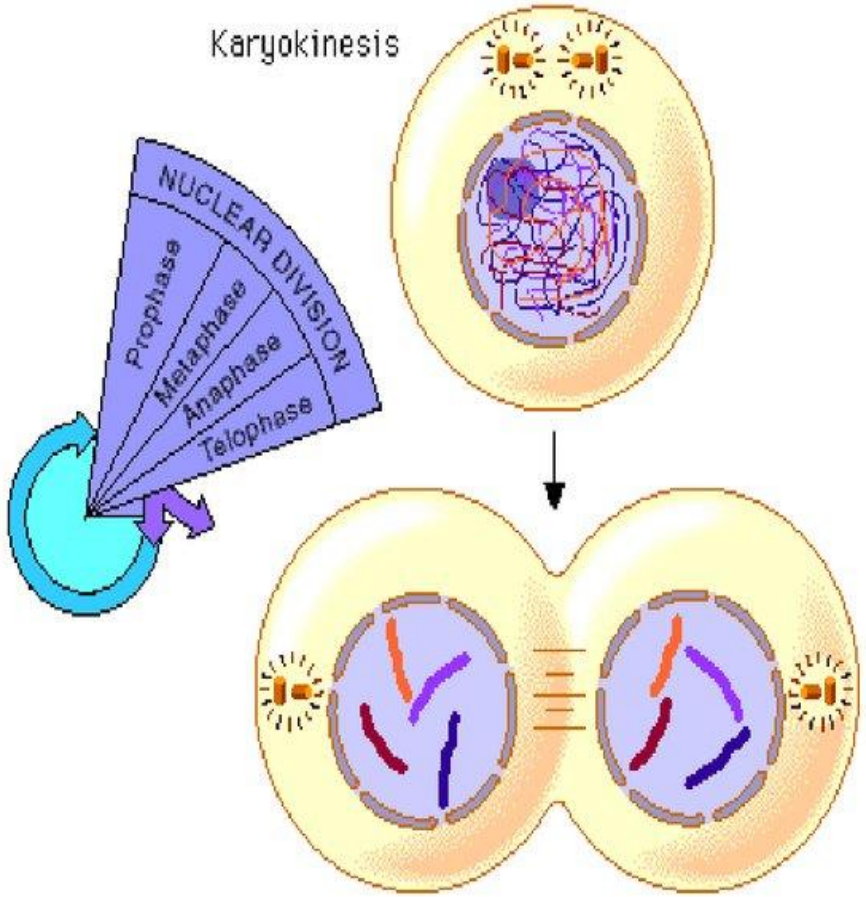
Mitosis is a form of eukaryotic cell division that produces two daughter cells with the same genetic component as the parent cell. Chromosomes replicated during the S phase are divided in such a way as to ensure that each daughter cell receives a copy of every chromosome.

Mitosis consists of two events-

- Karyokinesis
- Cytokinesis

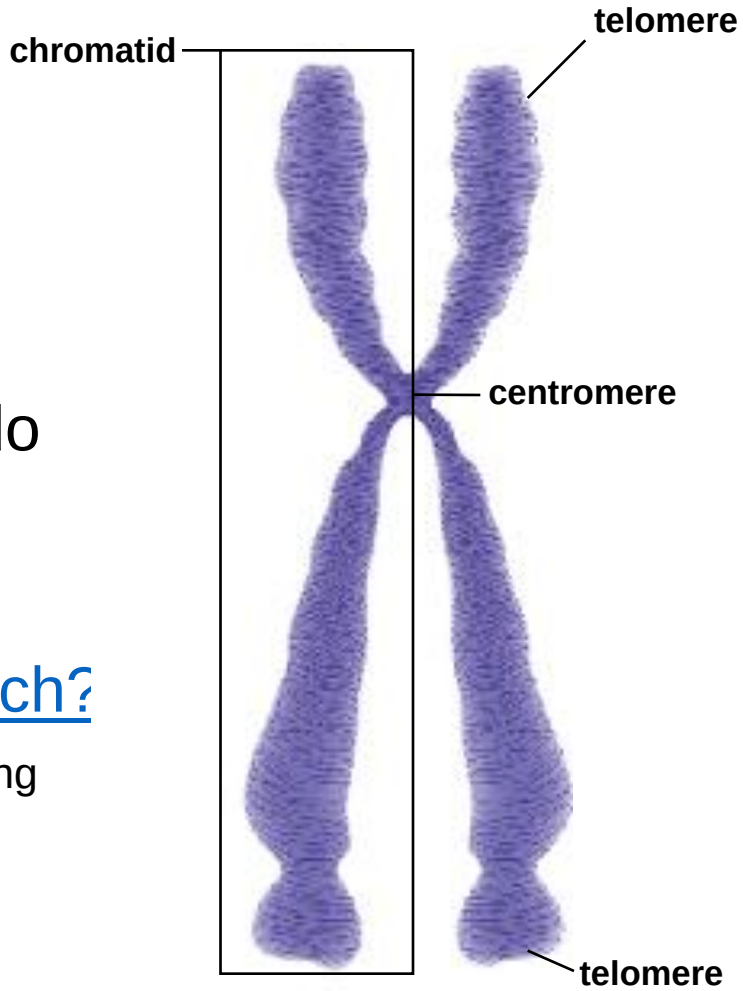
- **Karyokinesis:** The division of the nucleus into two daughter nuclei.

Karyokinesis



- Karyokinesis occurs in four distinct phases:
  - prophase
  - metaphase
  - anaphase
  - telophase

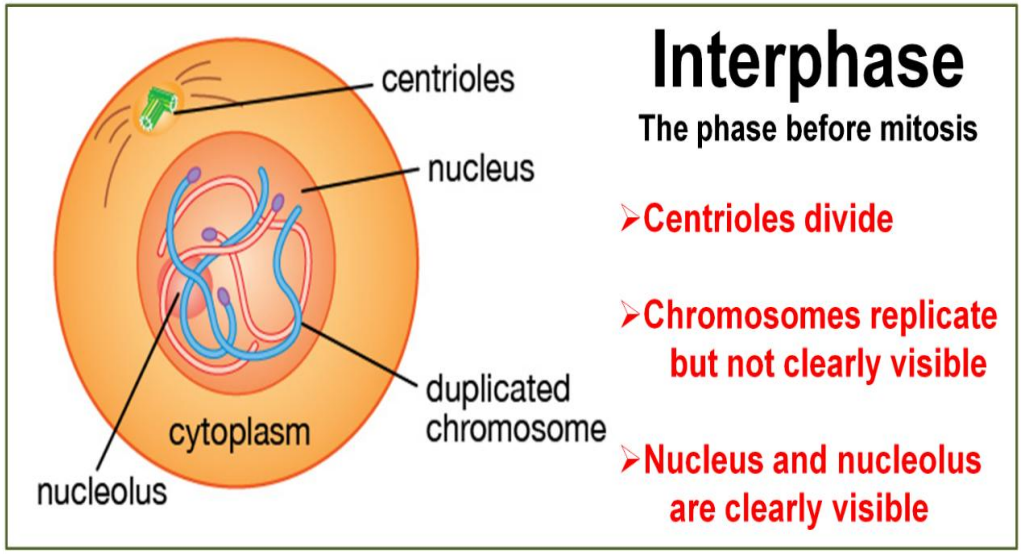
- DNA plus proteins is called chromatin.
  - One half of a duplicated chromosome is a chromatid.
  - Sister chromatids are held together at the centromere.
  - Telomeres protect DNA and do not include genes.
  - https://www.youtube.com/watch?=x1zw6uRxKYU telomeres and aging

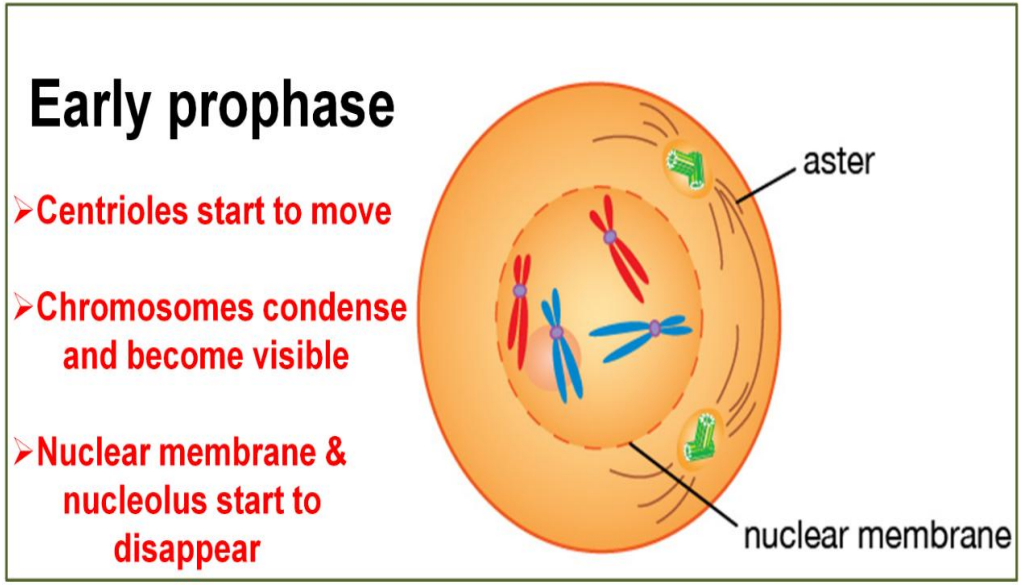


Condensed, duplicated chromosome

1. Prophase

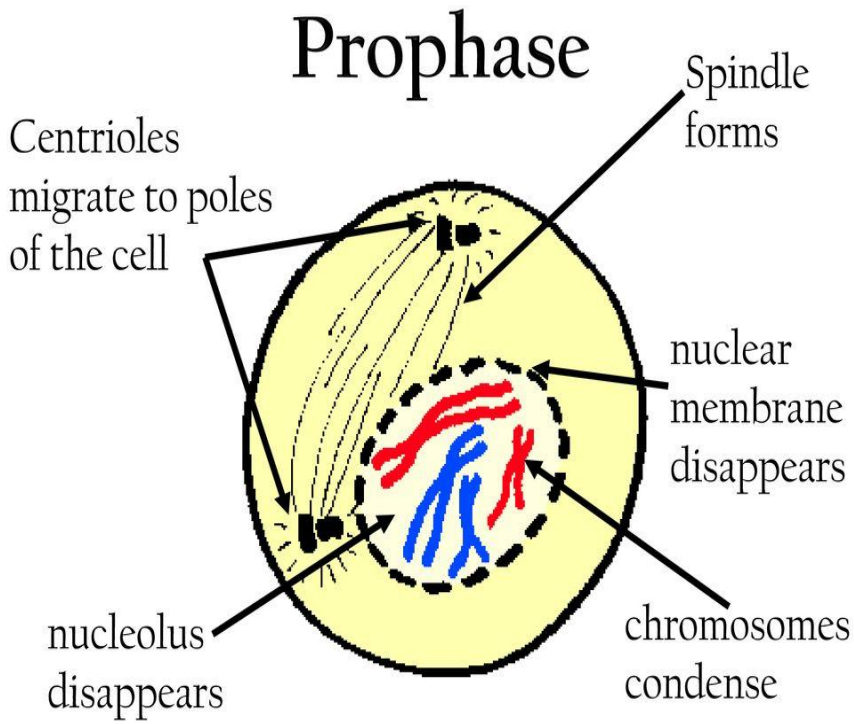
- Prophase which is the first stage of mitosis follows the S and G2 phases of interphase.
- In the S and G2 phases the new DNA molecules formed are not distinct but intertwined.
- Prophase is marked by the initiation of condensation of chromosomal material.
- The chromosomal material becomes untangled during the process of chromatin condensation.
- The centrosome, which had undergone duplication during S phase of interphase, now begins to move towards opposite poles of the cell.



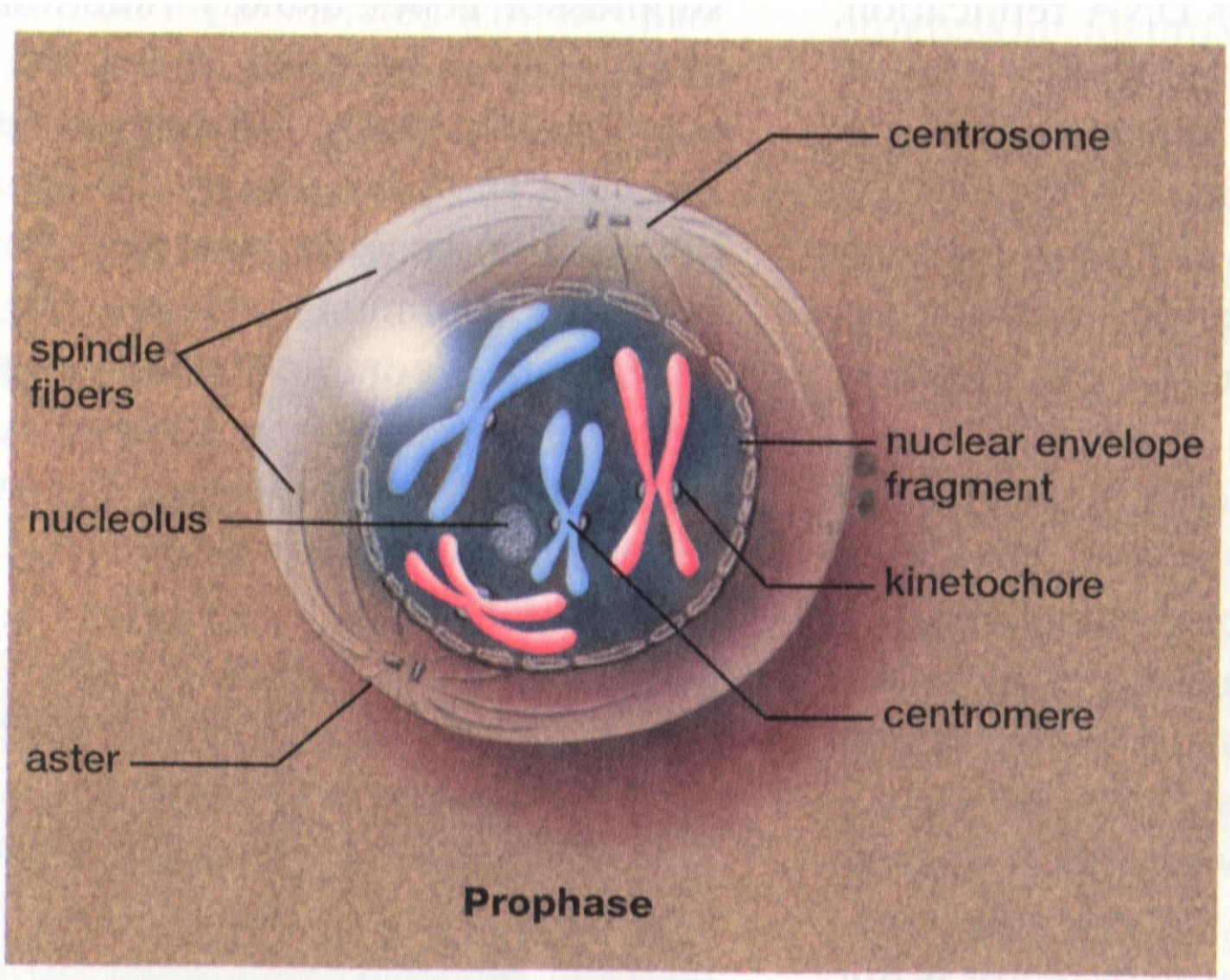


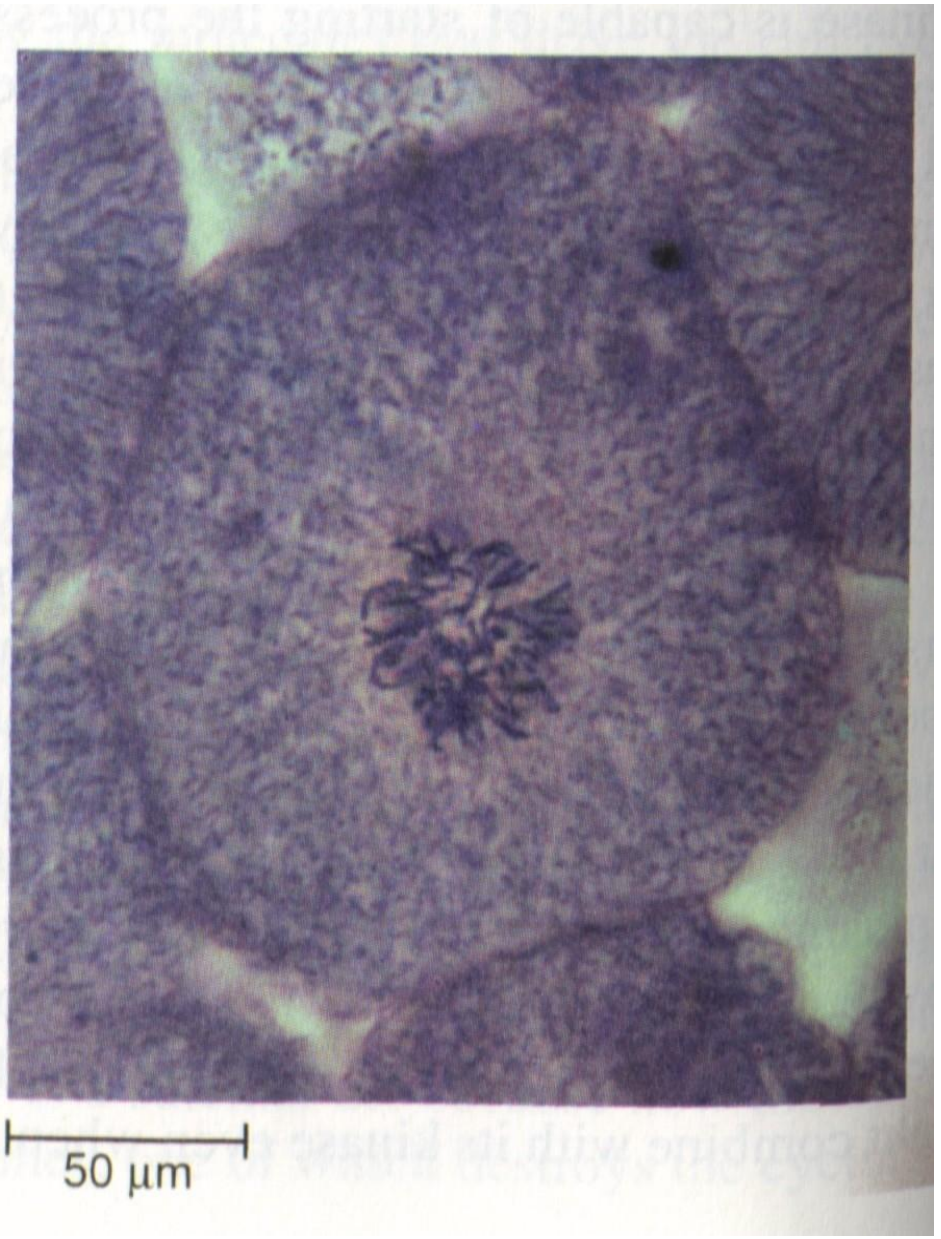
The completion of prophase can thus be marked by the following characteristic events:

- Chromosomal material condenses to form compact mitotic chromosomes. Chromosomes are seen to be composed of two chromatids attached together at the centromere.
- Centrosome which had undergone duplication during interphase, begins to move towards opposite poles of the cell.
- Each centrosome radiates out microtubules called asters. The two asters together with spindle fibres forms mitotic apparatus.
- Cells at the end of prophase, when viewed under the microscope, do not show golgi complexes, endoplasmic reticulum, nucleolus and the nuclear envelope.



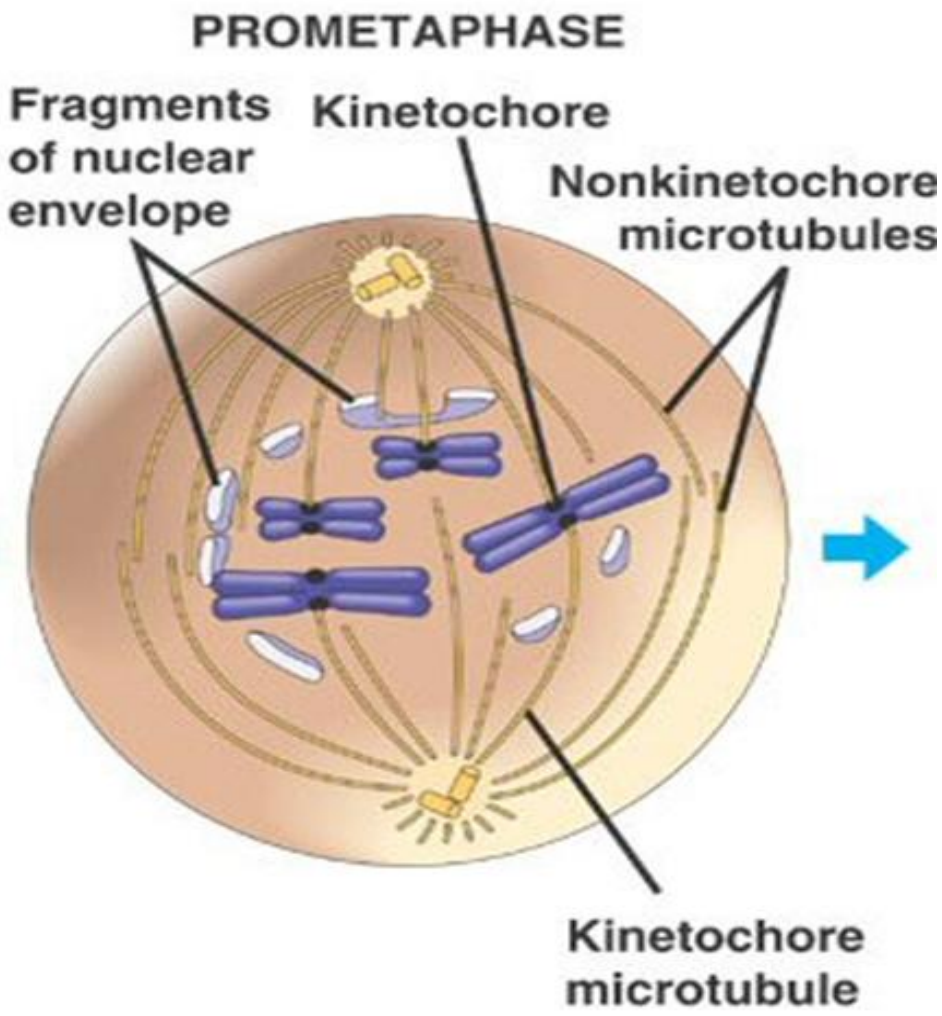
Prophase


centrosome
spindle fibers
nuclear envelope fragment
nucleolus
kinetochore
centromere
aster
Prophase


50 µm

Prometaphase:

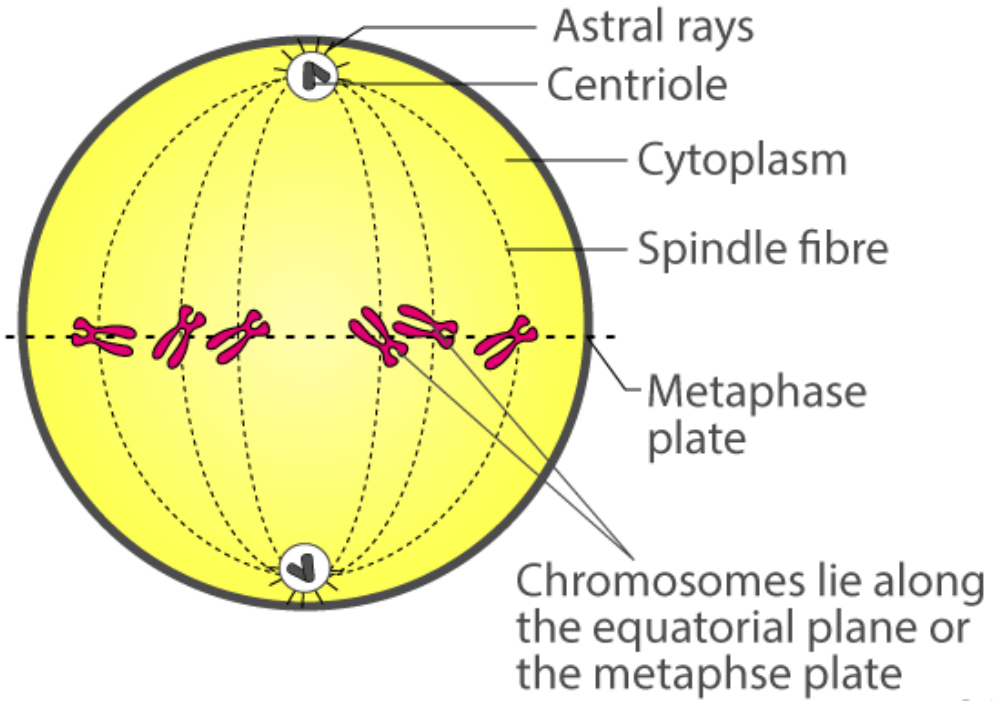
The chromosomes, led by their centromeres, migrate to the equatorial plane in the midline of cell - at right-angles to the axis formed by the centrosomes. This region of the mitotic spindle is known as the **metaphase plate**. The spindle fibres bind to a structure associated with the centromere of each chromosome called a kinetochore. Individual spindle fibres bind to a **kinetochore** structure on each side of the centromere.



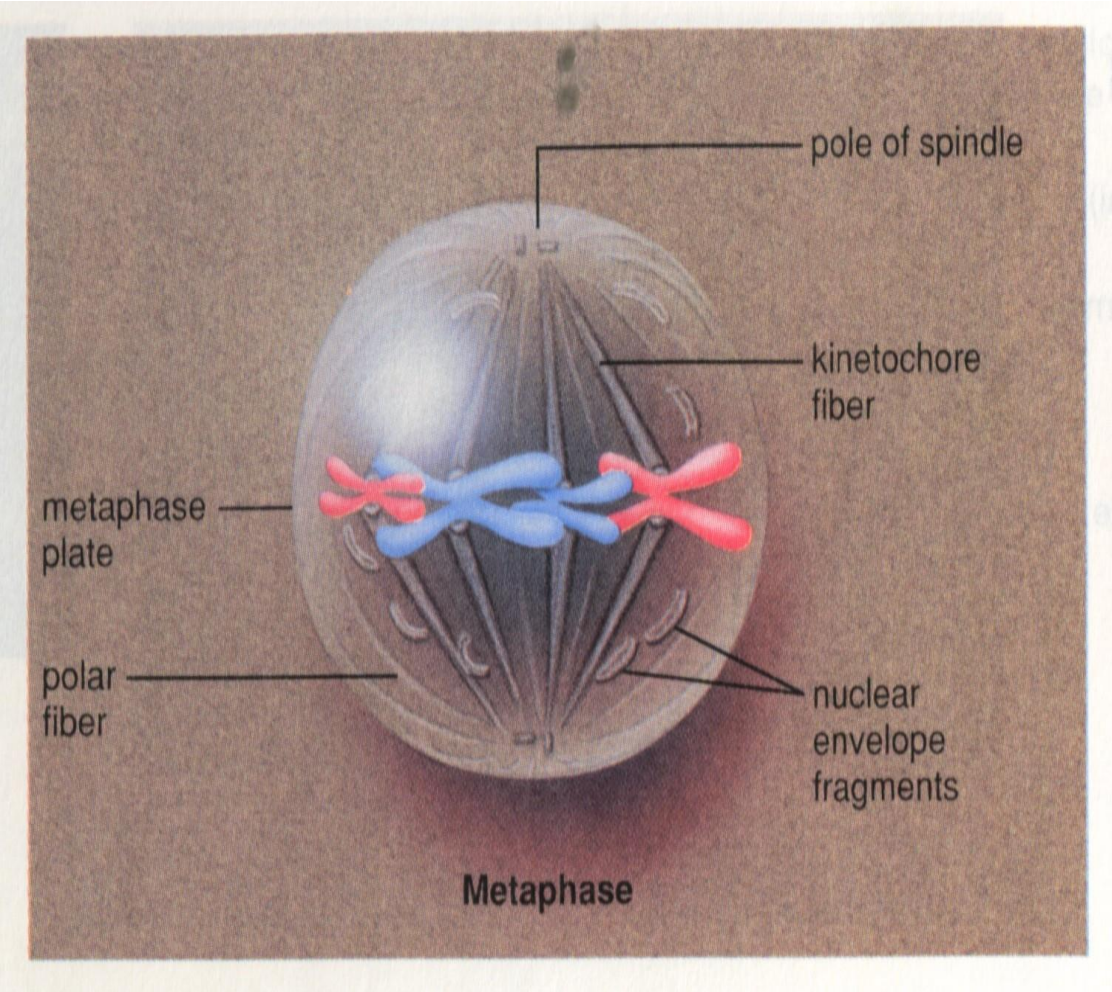
2. Metaphase

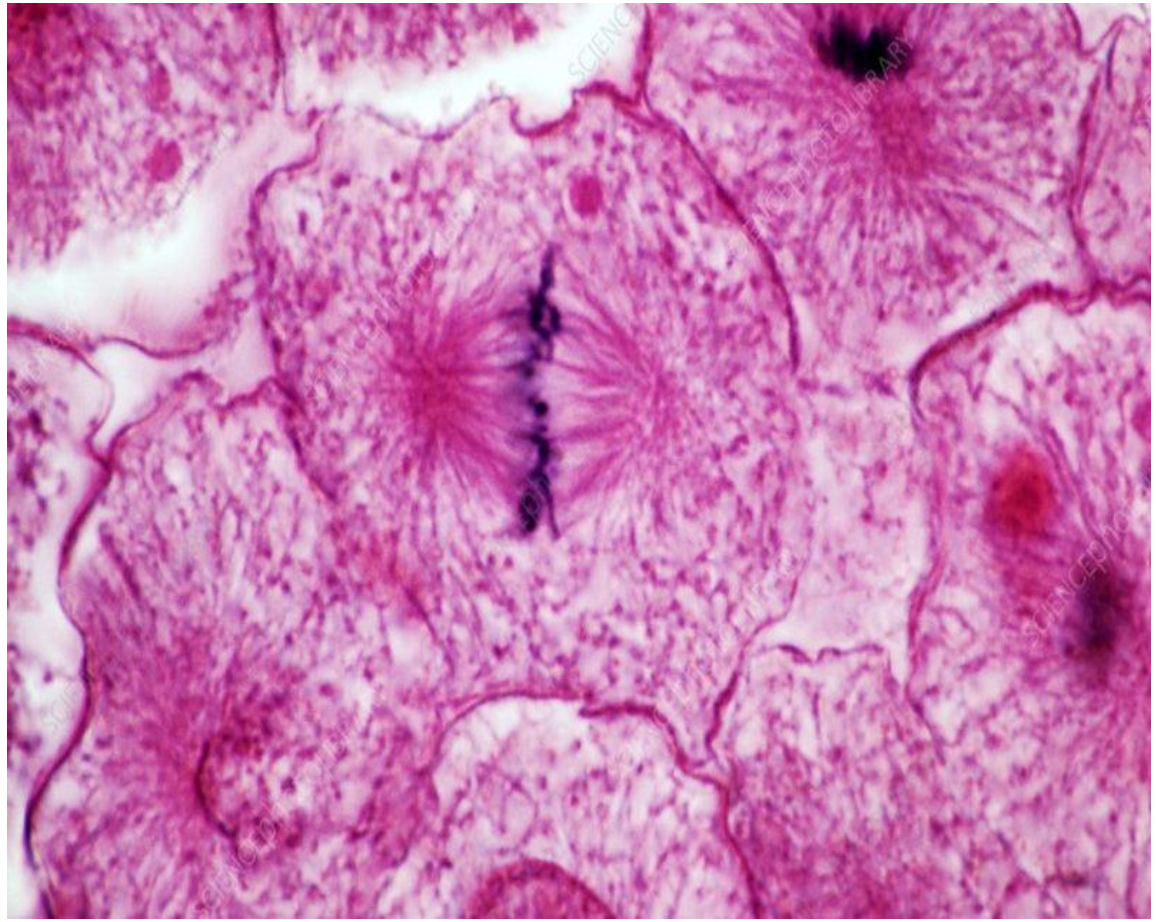
It is the short and simple phase which lasts for 2 to 10 minutes. It involves the following events:

- The chromosomes reach the central or equatorial portion of the spindle.
- They become radially oriented at the equator to form equatorial plate.
- The fibres of the spindle that connect to the chromosomes are called as chromosomal fibres.
- Those fibres that extend without interruption from one pole to other are called continuous fibres.
- The centrioles lie at the poles of spindle.
- Usually, the arms of the chromosomes lie on the equator of spindle. Sometimes, only the centromeres lie on the equatorial plane and arms are directed towards the poles.



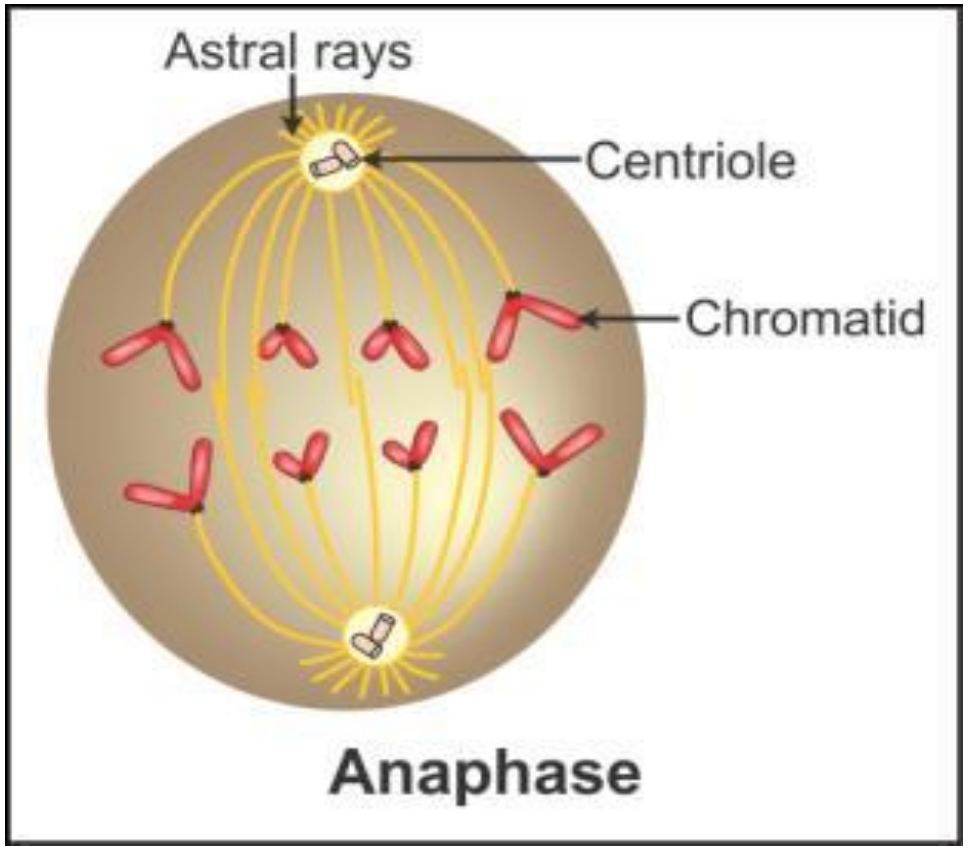
Metaphase


pole of spindle
kinetochore fiber
metaphase plate
polar fiber
nuclear envelope fragments
Metaphase

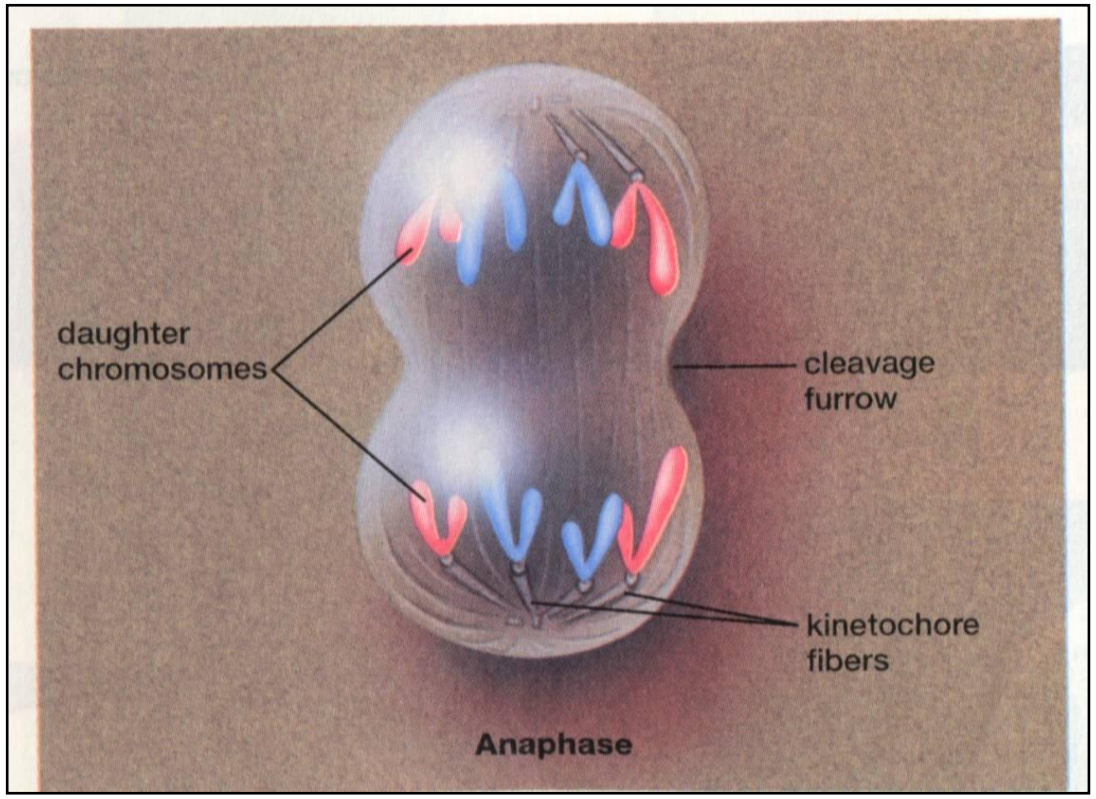


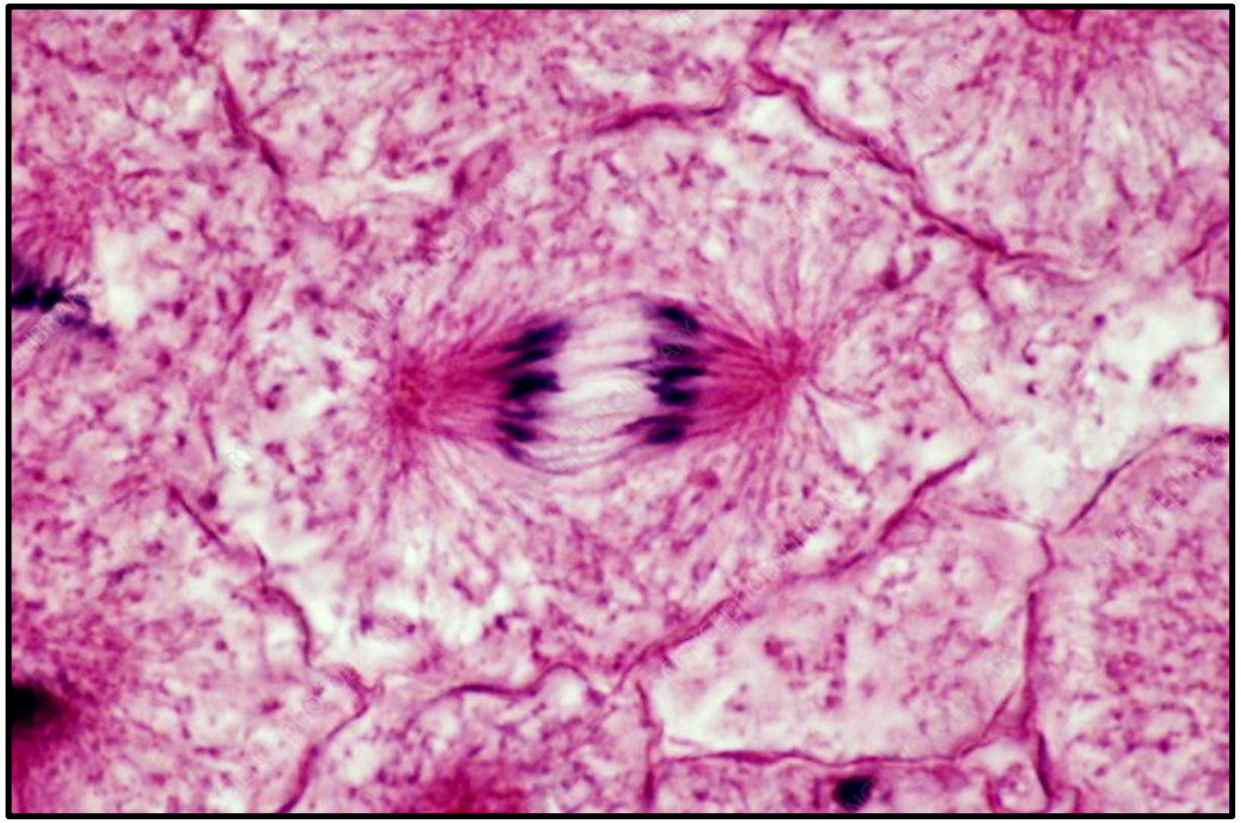
3. Anaphase

- Each chromosome arranged at the metaphase plate is split simultaneously.
- The two sister chromatids, now referred to as daughter chromosomes of the future daughter nuclei, begin their migration towards the two opposite poles.
- As each chromosome moves away from the equatorial plate, the centromere of each chromosome remains directed towards the pole and hence at the leading edge, with the arms of the chromosome trailing behind.



Anaphase

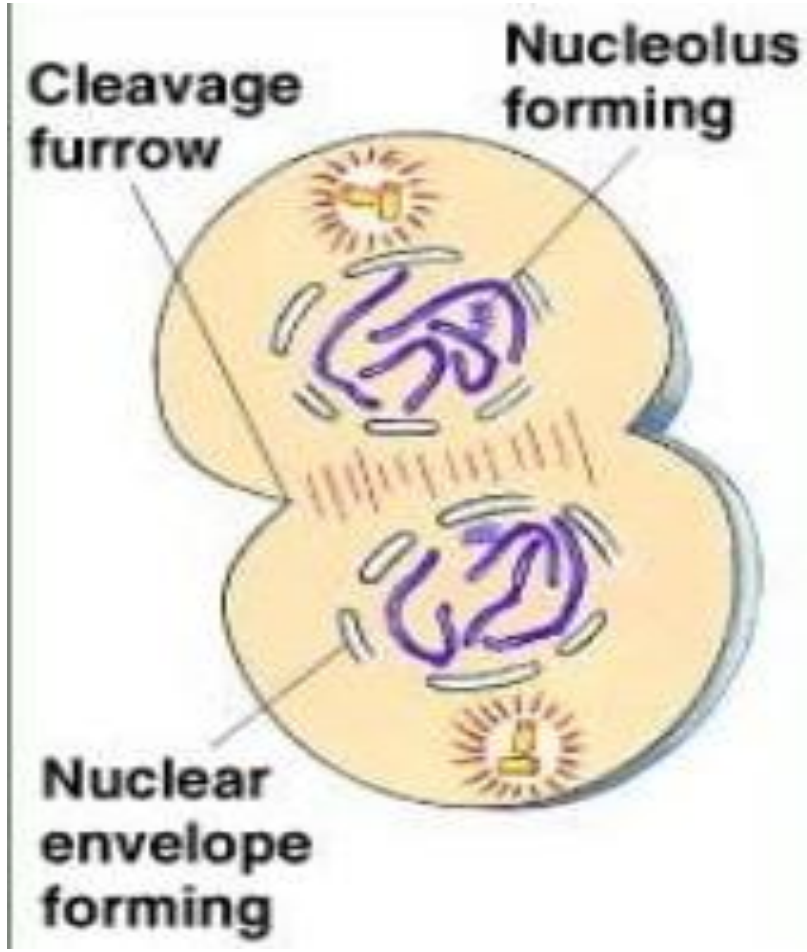

daughter
chromosomes
cleavage
furrow
kinetochore
fibers
Anaphase



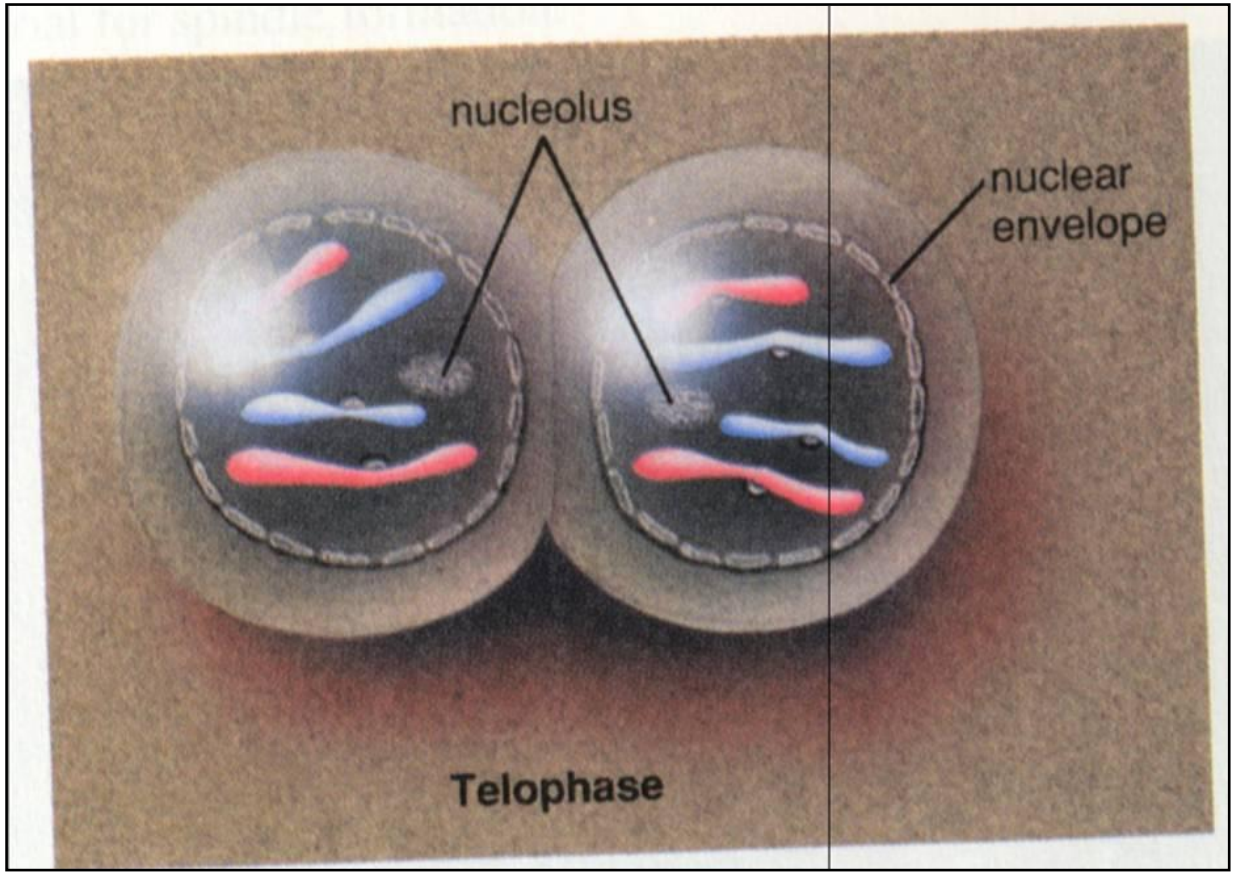
4. Telophase

The end of polar migration of daughter chromosomes marks the beginning of telophase (Telo= end).

- Chromosomes start to fold and become less and less condensed. Thus, it is the reverse prophase.
- The spindle fibres disappear.
- Chromosomes gather into masses of chromatin which become surrounded by segments of nuclear membrane made by ER. Such segments fuse to form two complete nuclear membranes of daughter nuclei.
- The nucleoli reappear at constrictions in one pair of chromosomes.



Telophase


nucleolus
nuclear envelope
Telophase

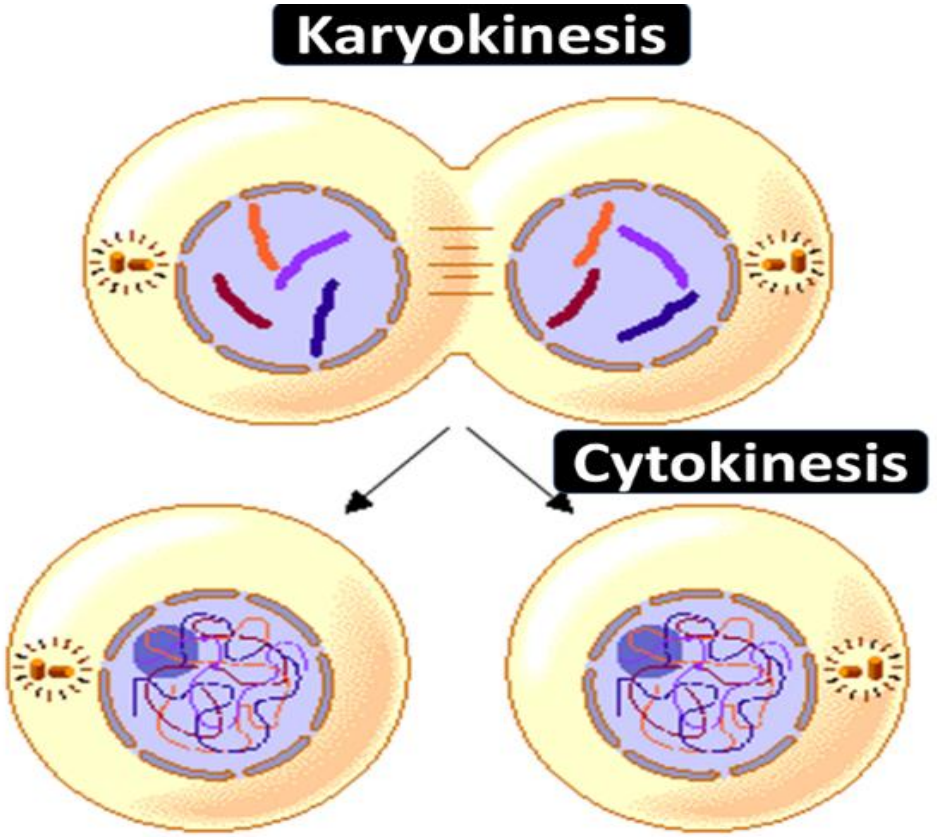

gettyimages
Ed Reschke
139803996

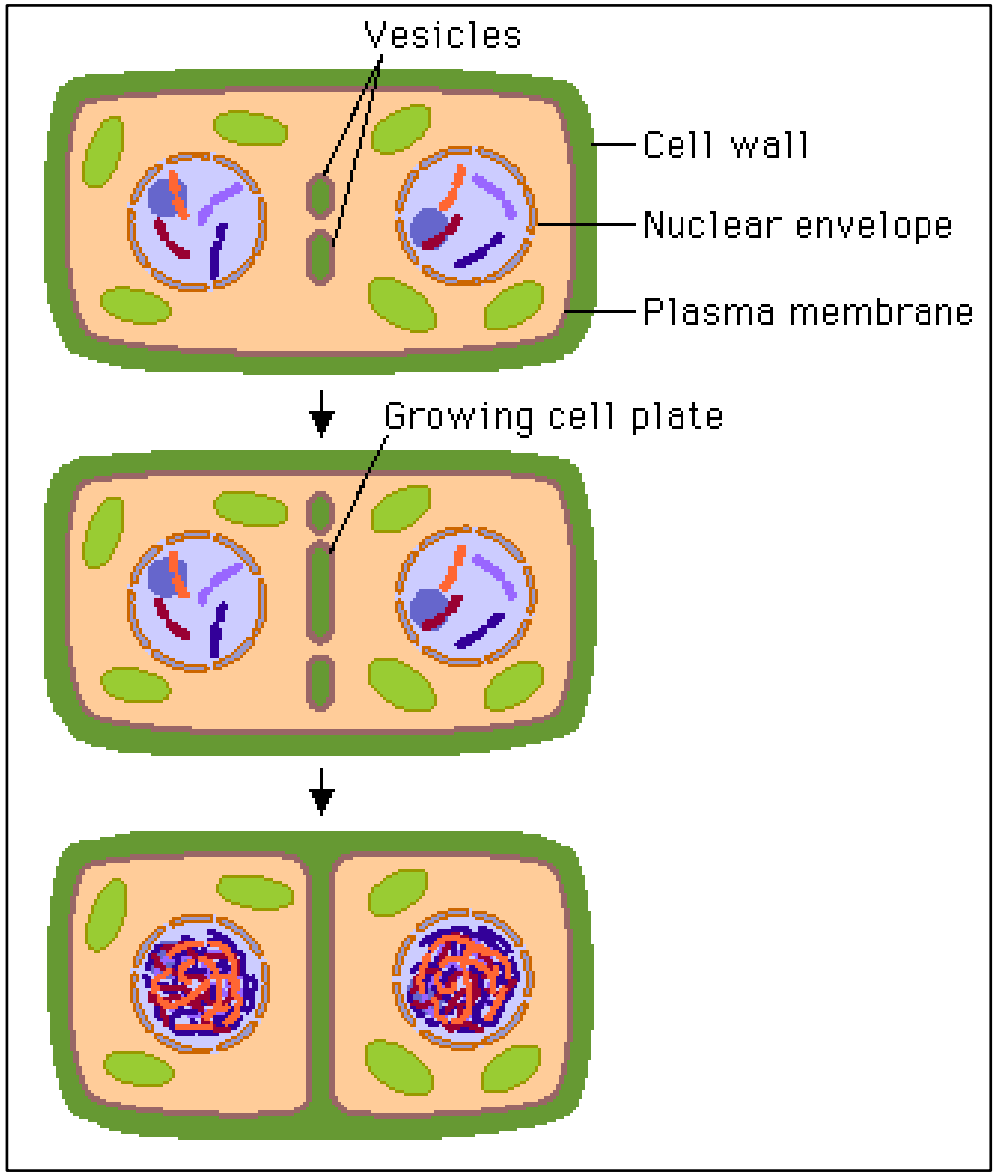
Cytokinesis:

- It is the division of the cytoplasm of a cell following the division of the nucleus. The cytoplasm divides by a process called as cleavage. It differs in plant and animal cells.
- Cytokinesis in animal cells occurs by forming a furrow at the equatorial region. The furrow is formed and deepened until the cell divides.
- In plant cells, there is formation of cell plate between two groups of chromosomes. This plate forms the membrane separating the two cells.

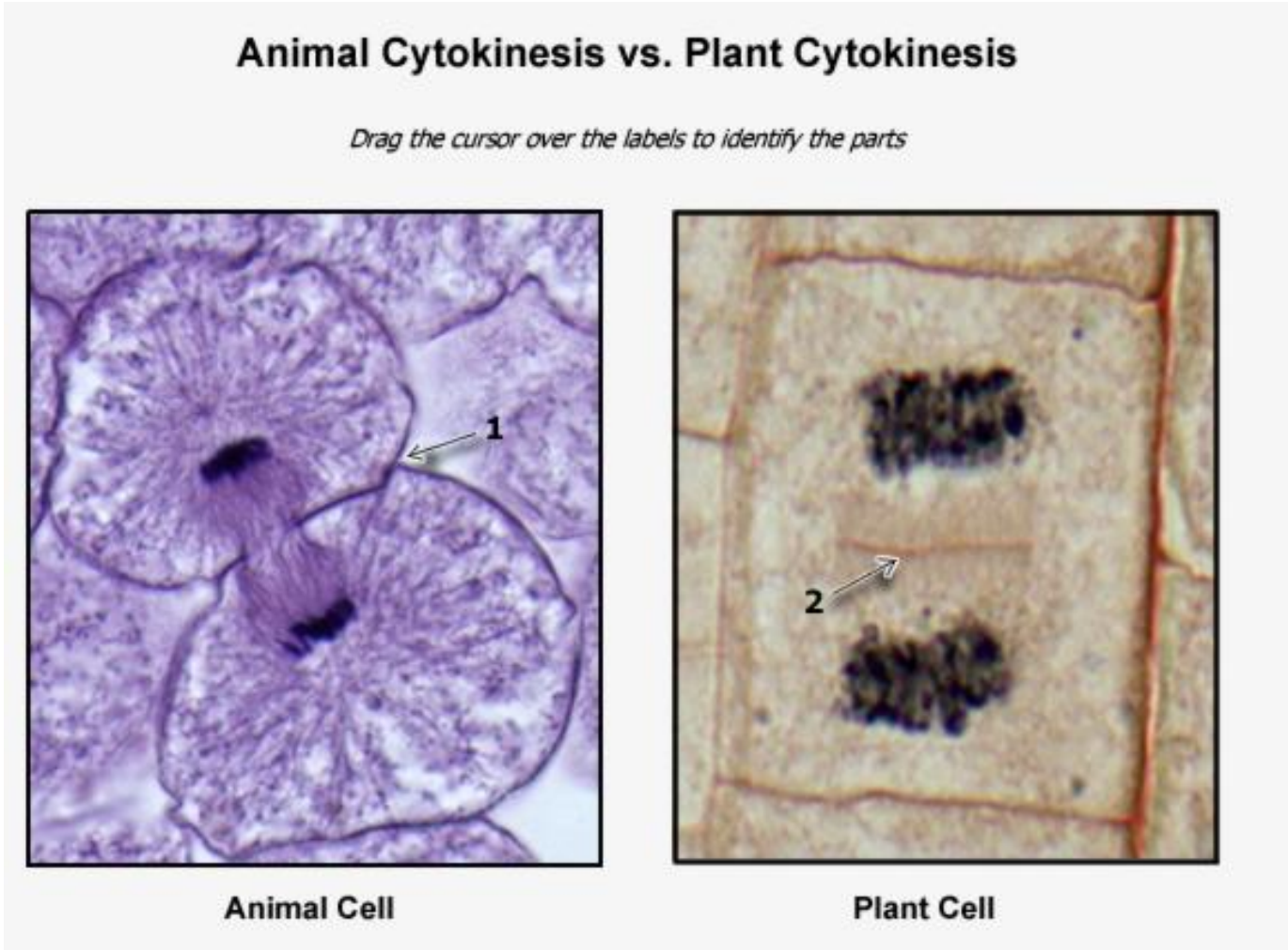
  During cytokinesis, the cytoplasmic components are distributed including the mitochondria and golgi complex.

- This is the end of cell division.

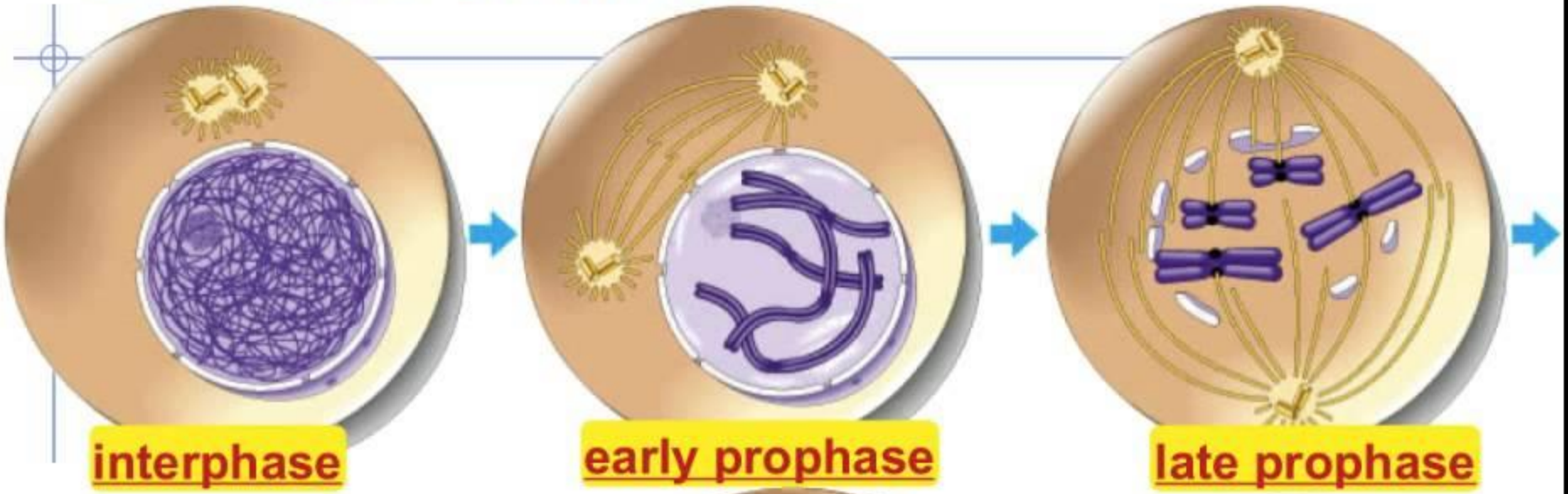


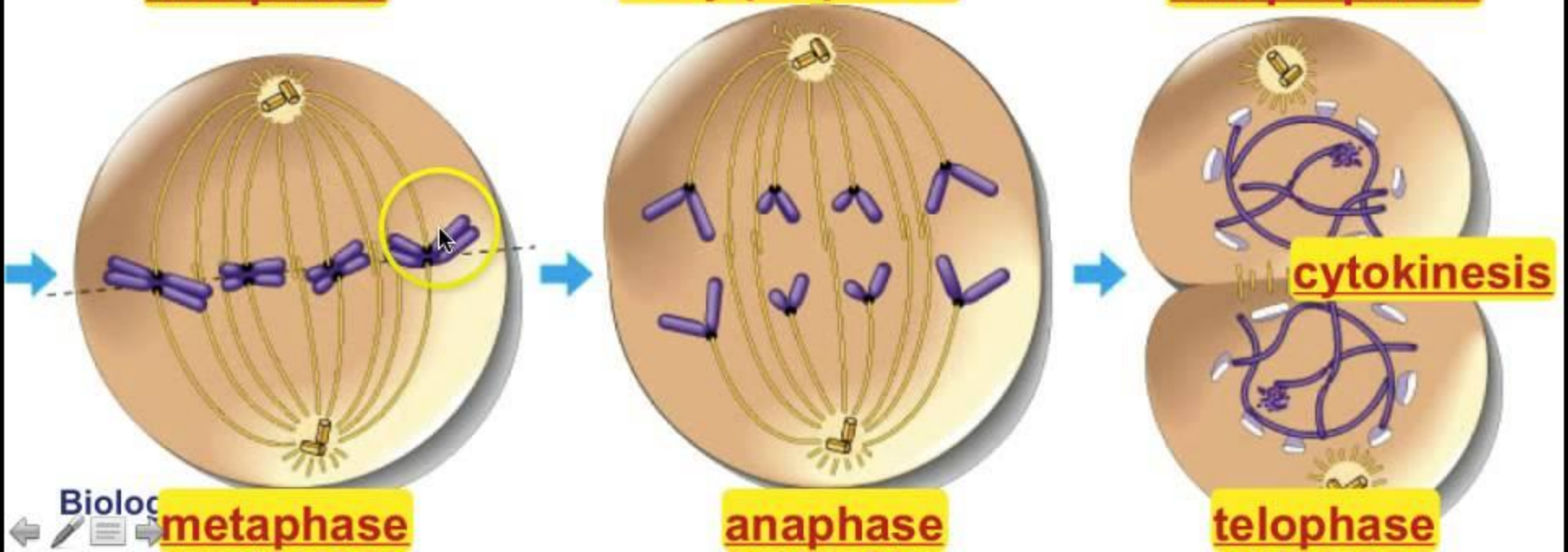


Cytokinesis in plant cells



Overview of mitosis





An Overview of Mitosis

Significance of Mitosis:

- **Equal distribution of chromosomes:**

  In mitosis, the chromosomes are equally distributed to the daughter cells. Thus constant number of chromosomes is maintained in all the cells of body.

- **Surface volume ratio:**

  As the cell increases in size, the available surface area in relation to increased volume becomes less. Due to mitosis the cell becomes small in size and surface volume ratio is restored.

- **Growth:**

  A fertilized egg develops into an embryo and finally into adult by repeated mitotic cell division.

- **Repair:**

  Repair of body takes place by addition of cells by mitosis. The old decaying and dead cells of body are replaced by mitosis.

- **Regeneration:**

  Some animals can regenerate parts of the body. Production of new cells in such cases is achieved by mitosis.


Thank you