Course- M.Sc. Part-II

Paper- X

Topic- MITOSIS (CYTOLOGY)

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MITOSIS

Mitosis is the somatic cell division for growth or a cell division that occurs for multiplication of lower organisms. A dividing parent cell has to divide equationally into two daughter cells to add to the growth of the body of the organism. Each of the daughter cells get same amount of DNA with same number of chromosomes. A diploid plant cell will give rise to two diploid daughter cells. All cells having the stimulus for division would divide by mitotic division repeatedly to increase the body size and volume till they loose the ability to do so.

The cycle of events undergoing in a cell that leads to the preparation of a cell for mitosis followed by the division forming daughter cells is known as Cell cycle.

The cell cycle comprises following phases -

1. G1 (gap1) phase
2. S phase (DNA synthesis phase)
3. G2 (gap2) phase, and
4. Mitosis

Till mitosis begins, we say that the cell is in Interphase. That long part of the cell cycle includes G1, S and G2 together. The term 'interphase' indicates the period between two successive divisions.

G1 comprises synthesis of mRNA and proteins The cell becomes larger because all other contents of the cell too get doubled.

If a cell is exiting the cell cycle being not committed to further division, it remains aloof and said to in G0. Later, it differentiates to form a permanent part of a stable tissue.

S phase is when DNA molecules of the cell replicate as they have to be later partitioned equally and equationally into two daughter cells. Histone proteins are also doubled along with it. The cell continues to grow bigger.

G2 comprises a system of control which has to oversee that the cell is really prepared to undergo mitosis. It is called G2 checkpoint. If the DNA has any

damaged segment, G2 checkpoint system would correct the errors.

The cell cycle is driven by special proteins known as cyclin dependent kinases.

Mitosis:

It is what occurs at the end of G2 if everything is alright. This divisional part comprises -

1. Karyokinesis, and
2. Cytokinesis

Karyokinesis is the division of nucleus that contains chromosomes. Each chromosome has doubled amount of DNA. Double copies of DNA are present in the two chromatids of each chromosome, one each. In this way, the cell at this point of time is tetraploid in terms of DNA amount though we call it diploid in terms of chromosome number.

In the beginning, each chromosome was a single thread with single DNA molecule. Now, each has two threads (chromatids) joined together at a point which we call centromere.

Karyokinesis can conveniently be divided into four parts or phases, though the process is continuous without any significant procedural marker.

The four phases are -

1. **Prophase** - It is practically the beginning of karyokinesis. The cell looks quite swollen and large. Nucleus is lager too. Nucleolus can be located in the nucleus. It may be one or more in different species. Chromosomes are seen as very thin threads in the beginning interwined a bit with each other. Gradually, they condense and look differentiated into double stranded threads.

   Each nucleolus is associated with a pair of homologous chromosomes called SAT chromosomes. Though, this association is difficult to observe during prophase.

   Nuclear membrane is seen sequentially disintegrating and

disappearing. The stage can be differentiated into Early, Mid and Late substages with time. It happens quick enough. Slides prepared of the dividing cells can show these in different squashes as still pictures.

2. **Metaphase** - Due to continuous condensation by coiling and recoiling at micro level, chromosomes by this time have become smaller in size and thicker so that they can now be counted easily. They are clearly seen having two chromatids. They are driven to the equatorial plate together in a coordinated manner. During mid metaphase, they look scattered in the cell along the equatorial region when seen in polar view. In side view, they naturally look arranged in one line along it. Nuclear membrane is nowhere to be seen. Nucleoli too are disorganised and not visible.

   Spindle apparatus is constituted originating from the two poles of the cell end to end and some of its microtubule fibres attach to the kinetochore of the centromeric part of the chromosomes. But other fibres are direct and run pole to pole. Microtubules are polymerized threads of tubulin protein. By the end of this stage, each chromosome is ready to partition from the centromere to segregate its chromatids that would separate and start moving to opposite poles of the cell.

3. Anaphase - The chromatids of all the chromosomes get detached with the help of the shrinking/condensing spindle fibres and start moving to their respective poles. By the end of the process, they finally segregate to their polar sides equationally having single DNA molecules in each of them.

   Nuclear membrane gradually appears to constitute nuclei at both the sides around the chromatids which are now better called chromosomes. Nucleoli reappear in both of the daughter nuclei. These nuclei are now having the same number of chromosomes as the patent cell had, and they have now the true level of DNA amount too as the original parent cell had before the process of mitosis started.

Cytokinesis: It is the division of the cytoplast of the parent cell. It occurs by cell

plate formation. Cell plate first appears in the centre and gradually extends towards the sides to form two separate cells that we call daughter

cells. The daughter cells are gradually separated to make them independent. That is the end of mitosis.

Each totipotently active cell with the capacity to divide would now experience the cell cycle events again to continue the whole scheme of cell division for addition to growth and development of the tissues and organs. Other cells will enter G0 phase.

Meristematic cells undergo mitosis in case of higher plants while apical cells do that in plants of lower group. In many of the plants of the lower group, each cell may have the ability to divide.

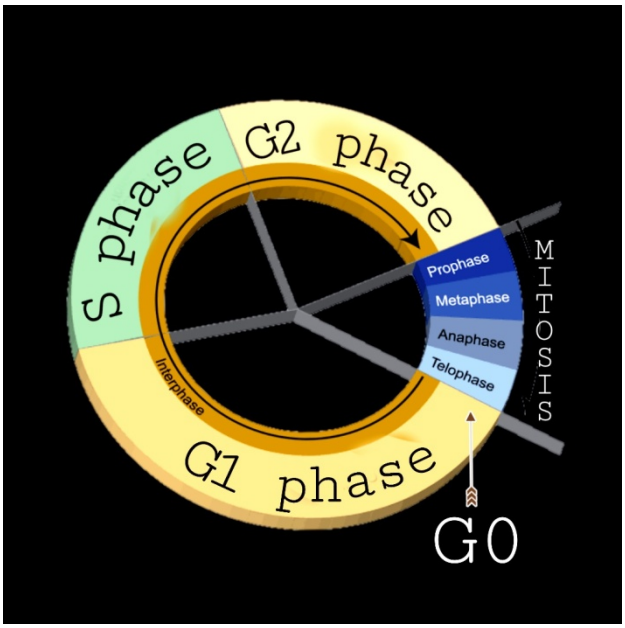
S phase
G2 phase
Prophase
Metaphase
Anaphase
Telophase
MITOSIS
Interphase
G1 phase
G0

Fig.(1)

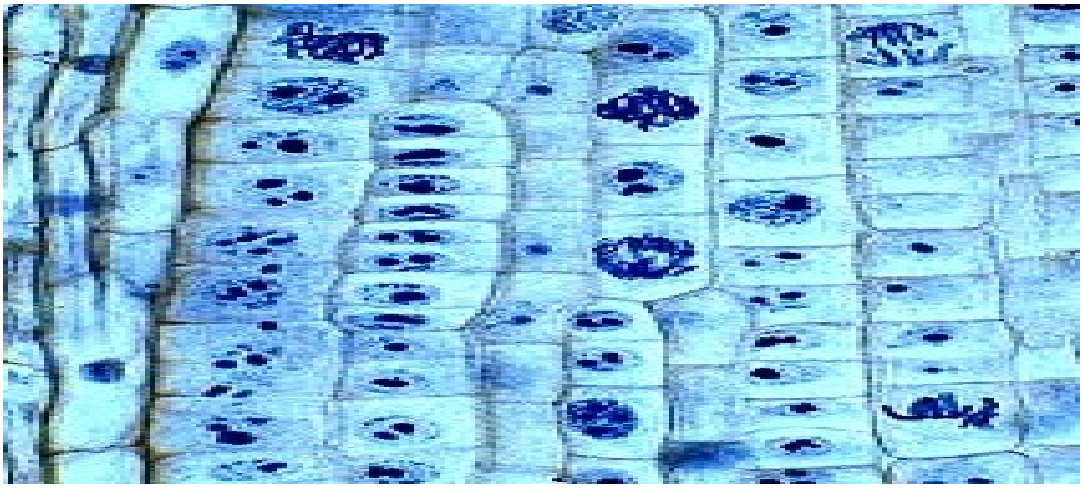

Fig. (2)

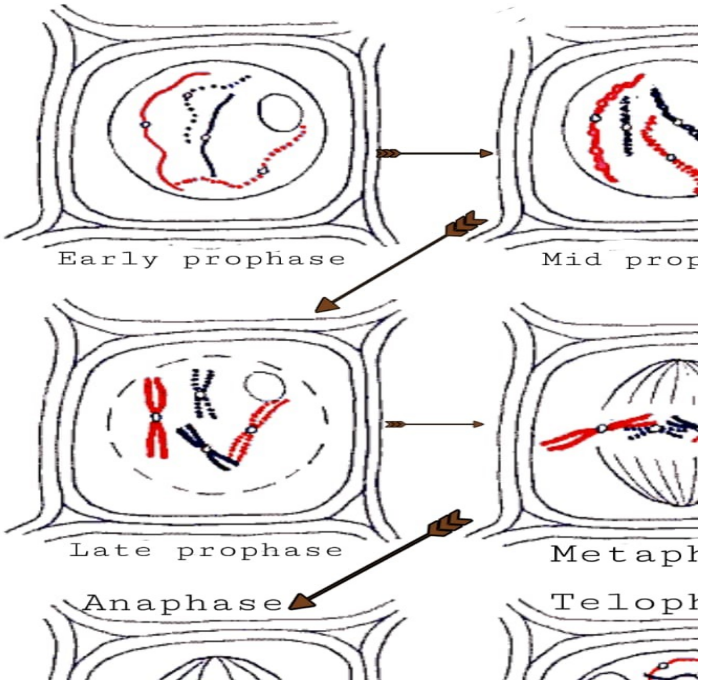

Fig. (3)

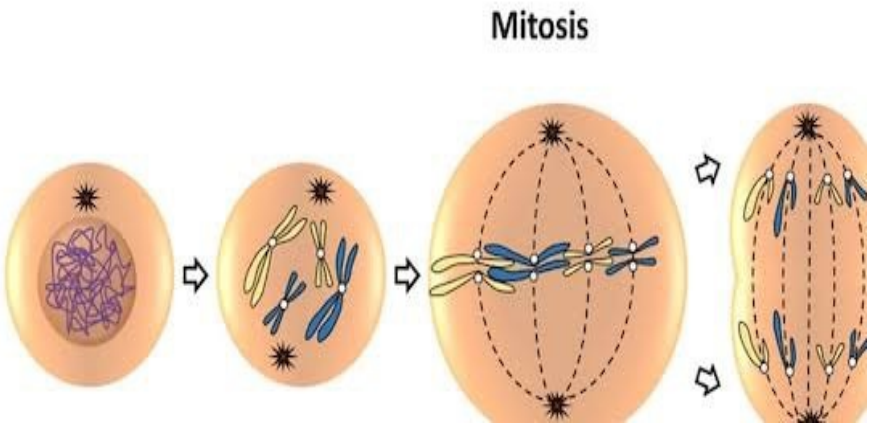

Fig. (4)

Figures show (1) Cell Cycle events , (2) Part of a Plant tissue with different cells in different stages of mitosis, (3) Stages of mitosis in a typical plant cell, and (4) Summary of mitotic stages in an animal cell for comparison.