PUC 1ST YEAR –SEMESTER-2

UNIT III: Cell cycle and cell division

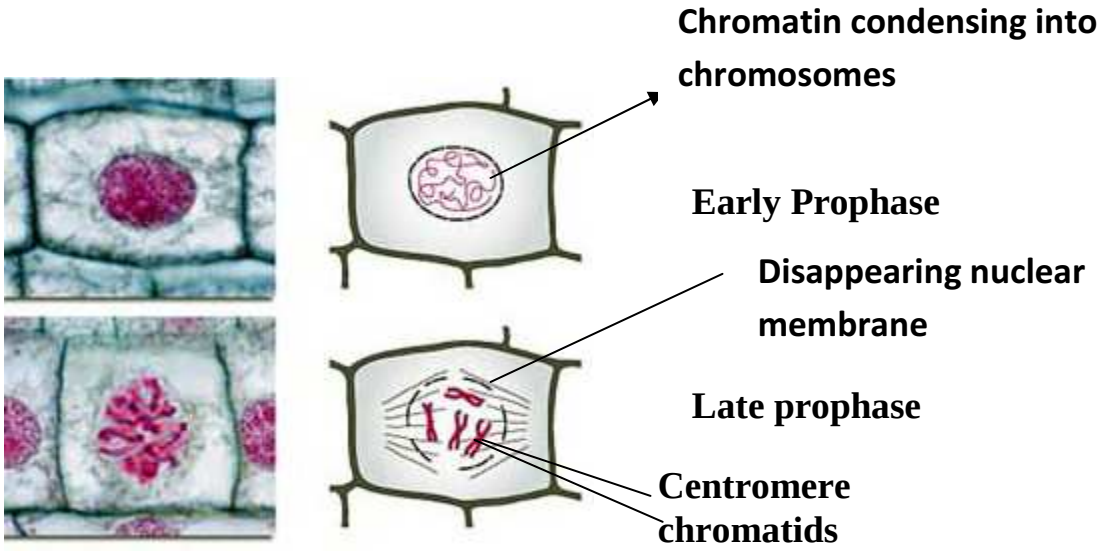
Module No: 16: Mitosis and its significance

Mitosis is a simple type of cell –division, in which new cells are formed in the growing regions of an organism. This type of division is found in all the animals and plants. This type of cell division occurs in all somatic cells, in which the same number and same type of chromosomes are maintained as in the parent cells.

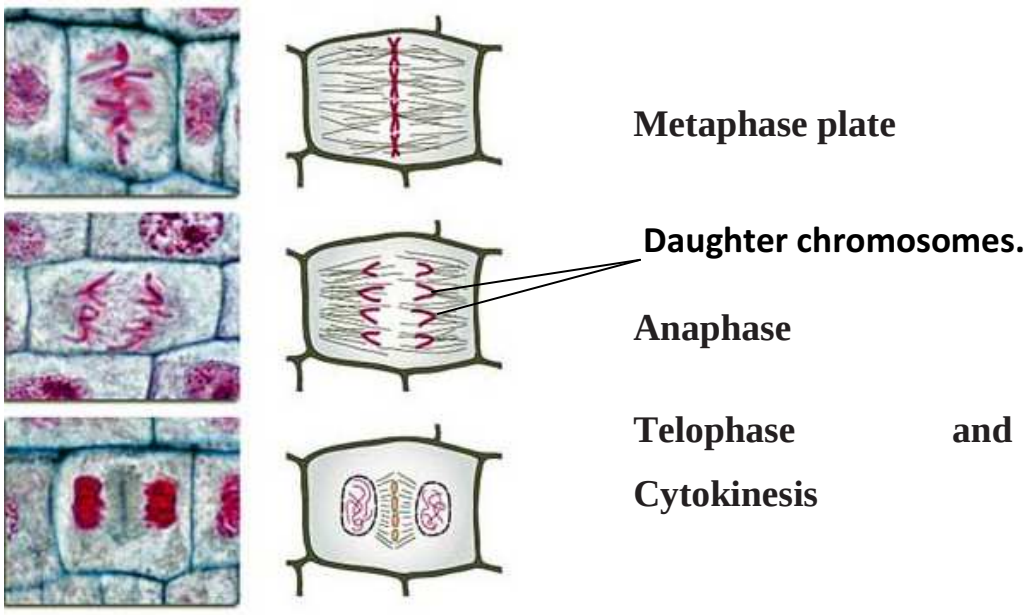
Mitosis has two steps, Karyokinesis and Cytokinesis.

Karyokinesis: It is the term used for nuclear division. It has been divided into four phases – Prophase, metaphase, anaphase and telophase.

1. **Prophase:** It is the first phase of karyokinesis and is of long duration, in which chromatin fibres condense to form chromosomes. Further condensation makes chromosomes shorter and thicker. Then each chromosome splits longitudinally consisting of two identical halves or chromatids. They are held together by centromere. The nucleolus disappears. Two centrioles continue their migration towards the poles. Finally nuclear membrane breaks down and disperses into cytoplasm as elements of endoplasmic reticulum.

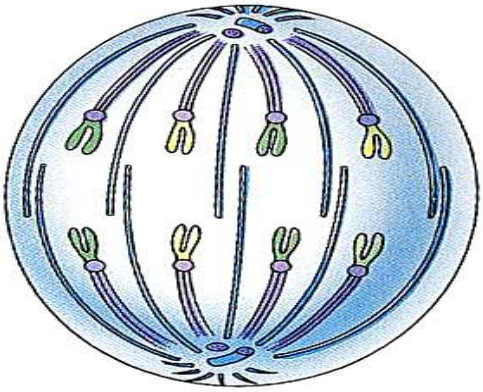


2. **Metaphase:** During this phase formation of spindle and orientation of chromosomes takes place. The cytoplasm around each centriole arranges as radiating fibres. This structure is called aster. Soon the cytoplasm between the asters differentiates into spindle fibres or microtubules. The middle part of the spindle is called equatorial plate or equator. The chromosomes arrange themselves in a regular manner at the equator in such a fashion that their centromeres lie on the equator and arms are oriented towards the poles. This is called as orientation. The chromosomes are attached to the spindle fibres at their contromeres. Each chromosomes becomes more compact and short and its two chromatids separate except at the centromere which has not yet divided.

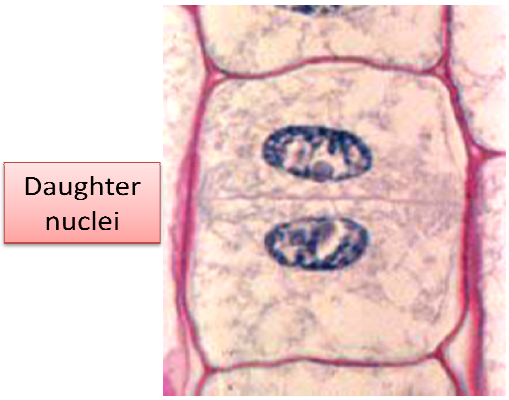


3. **Anaphase:** It is the shortest of all the stages in the mitotic cycle. During anaphase two things happens
    1. Centromere divides and
    2. Chromatids move to the opposite poles.

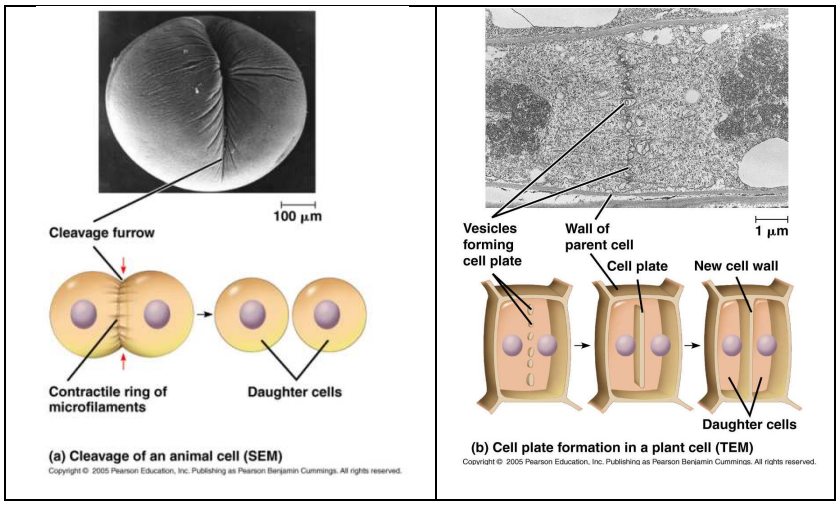
The centromere of each chromosome divides so that each chromatid contain a separate centromere and behaves as a chromosome. Chromatids begin to move towards the opposite poles and spindle fibres also move towards their respective poles. During their movement towards the poles the chromosomes look like U, V or J shape. Since the centromere is also divided each pole gets the same number of chromatids as present in the parent.



4. **Telophase:** This is the last phase in which two daughter cells are formed. Events occurred in prophase will be reversed in telophase. Chromosomes reach the opposite poles. Nuclear membrane develops around the chromosomes. Nucleolus reappears. Spindle fibres and asters begin to disappear. The chromosomes become long thread like structures which lose their identity. Each daughter nucleus gets the same number of chromosomes as present in the parent cell.



5. **Cytokinesis:** Division of cytoplasm is called cytokinesis. In this process a constriction or furrow appears in the middle of the cell on either side. It gradually deepens and divides the cell finally into two daughter cells. However in plant cells the cell wall formation starts in the center and grows outward to meet the existing lateral walls.



Significance of mitosis:

1. Mitosis is essential for growth and development of a multicellular organism.
2. The cells of some tissues are periodically worn out and these cells are replaced by new ones only by means of mitosis
3. Daughter cells formed by mitosis are identical to the mother cells. The hereditary characters are transmitted to the daughter cells.
   Mitosis in unicellular organisms help in reproduction
4. Mitosis help in healing of wounds.
5. It is useful in regeneration of lost parts and grafting in vegetative reproduction.

Check points

- Mitosis occurs in all somatic cells
- Nuclear division is called karyokinesis whereas division of cytoplasm is called cytokinesis.
- Mitosis is divided into 4 phases. 1. Prophase 2. Metaphase 3. Anaphase and 4. Telophase

- In prophase chromatin fibres condense to form chromosomes. Nuclear membrane and nucleolus disappears.
- During metaphase spindle formation and orientation of chromosomes takes place
- During anaphase stage centromere divides and chromatids move to the opposite poles.
- In telophase events occurred in prophase will be reversed.

Object Type Questions:

1. What is mitosis?
   A. **The replication of nuclear material and division of the cell and cytoplasm into half.**
   B. Division of cytoplasm only
   C. The process of nuclear division that reduces the number of chromosomes in the resulting cells by half
   D. Replication of nuclear material only without cell division
2. In which phase of mitosis the chromosome move towards the poles?
   A. Prophase B. Metaphase C. Telophase **D. Anaphase**
3. In which of the following phases of mitosis does chromosome separation occur?
   A. Telophase B. Prophase **C. Anaphase** D. Metaphase
4. The first stage of mitosis when chromosomes start becoming visible in the microscope is called:
   A.Anaphase **B. Prophase** C. Telophase D. Metaphase
5. Cytokinesis in a plant cell is characterized by:
   A. The equal division of homologous chromosomes.
   B. Pinching off of the cell membrane to divide the cell.
   C. The formation of a cell plate in the cytoplasm.

D. The movement of the chromosomes from the metaphase plate.

6. What is the structure in animal cells that divides the cytoplasm into two cells

   A. Mitotic spindle B. Centriole **C. Cleavage furrow** D. Cell plate

7. What occurs during anaphase?

   A. The mitotic spindle beings to form.

   B. The chromosomes align on a plane in the center of the cell.

   C. The sister chromatids separate.

   D. The mitotic apparatus disassembles.

8. Which of the following features of cell division are very different for animal and plant cells?

   A. Prophase

   B. Metaphase

   C. Anaphase

   D. **cytokinesis**

Short answer Questions:

1. What is the significance of Mitosis?
2. Mention the various phases of a mitotic cycle.
3. Give an account of the events that take place during metaphase of mitosis.
4. Give an account of spindle fibers and their role in cell division.
5. What is karyokinesis and cytokinesis?
6. What is the significance of anaphase?
7. What kind of change do chromatin fibers undergo during prophase and telophase?

Long answer Questions:

1 What are the changes found during the prophase and metaphase? Explain with neat labeled diagrams.
2 What are the changes found during the anaphase and telophase? Explain with neat labeled diagrams
3 Explain mitosis in detail?