MITOSIS

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MBOTCC-10
Unit-II

Introduction:

(i) Mitosis involves the exact replication of parent cell and its nucleus followed by its division into two daughter cells which are identical with each other as well as with the parent cell and contain the same number of chromosomes as found in the parent cell.

(ii) It is a necessity for the maintenance and perpetuation of life, and occurs almost uniformly in the somatic cells of nearly all forms of life.

(iii) This nuclear division was first observed by Strasburger (1870) in plant cells and Flemming (1882) in animal cells.

(iv) Mitotic division is a continuous process and its division into stages is done only for convenience of description.

(v) The replication and distribution of chromosomes and formation of two daughter nuclei is called karyokinesis while the division of cell cytoplasm and formation of two daughter cells is called cytokinesis.

(vi) The duration of individual stages of karyokinesis differs in various plant and animal cells.

Karyokinesis: This consists of the following stages:

(a) **Prophase:** (i) At prophase, the cell is still preparing for division, although DNA synthesis is already completed during interphase.

(ii) In the beginning of prophase, chromosomes appear as thin filamentous

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uncoiled structures.

(iii) Chromosomes become coiled, shortened and more distinct as the mitosis progresses through prophase, which is of longer duration than other stages.

(iv) Longitudinal splitting of each chromosome into two sister chromatids is an important characteristic of mitotic prophase.

- Longitudinally double structure of each chromosome is conspicuous at late prophase. Sister chromatids at this stage are attached only at the centromere.

(v) Nucleolus gradually diminishes in size and finally disappears at the end of prophase.

(vi) Nuclear membrane undergoes disintegration and finally disappears towards the end of prophase.

However, there are variations available with respect to the disappearance of nuclear membrane and nucleolus. In several primitive plant and animal species, the nuclear membrane does not dissolve.

(vii) Spindle apparatus starts its formation towards the end of prophase.

(viii) Complete disappearance of nuclear membrane and nucleolus usually marks the end of prophase.

(b) Metaphase: (i) Formation of spindle apparatus is completed.

(ii) Chromosomes become arranged on the equator of the spindle forming the equatorial plate.

- Spindle tubules get attached to chromosomes at their centromeres.

- Chromosomes orient

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themselves on the equator in such a fashion that their centromeres lie on the equator and are attached to the chromosomal fibres of the spindle, whereas the arms are oriented towards the poles.

(iii) Some spindle fibres run from pole to pole of the spindle apparatus and are called continuous fibres.

(iv) Each chromosome becomes more compact and short. Thus metaphasic chromosomes are the shortest and thickest entities during cell division.

(c) Anaphase: (i) Chromosomes split at centromeres due to contraction of chromosomal fibres attached with them. - Sister centromeres separate from each other, so that the two sister chromatids are separate structures and can now be called chromosomes.

(ii) The sister chromatids or daughter chromosomes now move towards opposite poles of the spindle apparatus.

(iii) The mechanism of movement of chromosomes at anaphase has been explained in different ways by different workers. It seems that there is repulsion between centrosomes and that there is contraction of spindle fibres which helps the movement.

(iv) Centromeres are pulled first towards the poles of the spindle and the arms of daughter chromosomes (chromatids) are dragged behind.

(v) At anaphase, arms of daughter chromosomes are directed towards the equator and centromeres towards the poles of the equator.

(vi) Depending on the centromeric position, different chromosomes assume characteristic V, J, L or I shapes during their anaphasic migration.

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(d) Telophase: (i) Chromosomes reach opposite poles of the spindle, and form two groups. (ii) Chromosomes begin to uncoil and become slender and longer chromatin threads. (iii) Nucleolus reappears and nuclear membrane is reconstructed around each group of chromosomes giving rise to one nucleus at each pole.

Cytokinesis:

Cytokinesis is the division of the cell cytoplasm into two separate cells. The process of cytokinesis differs in plant and animal cells. In plant cells, it occurs by cell plate formation while in animal cells it is brought about by simple furrowing.

Cytokinesis in animal cells:

(i) Occurs by simple furrowing.
(ii) A circular constriction appears at the equator of the cell membrane which converges on all sides thus eventually forming two daughter cells.

Cytokinesis in plant cells:

(i) A more rigid cell plate is usually initiated at the centre of the cell and is completed towards the periphery.
(ii) After the cell plate is laid down primary walls are deposited on either side of the cell plate. Cell plate is ultimately converted into middle lamella.
(iii) Phragmoplast is the earliest stage of cell plate formation. Remnants of the spindle fibres (residual fibres), lamellae and vesicles of the Golgi complex contribute to the formation of cell plate.

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Significance of Mitosis:

(i) Mitosis is primary required for the growth and development of multicellular organisms.

(ii) This division maintains cellular constancy in terms of chromosome number and genetic traits.

- It ensures a continuous succession of similarly endowed cells.

(iii) Mitotic divisions also help in replacing old and damaged tissues by new cells.

(iv) Secondary increase in thickness in perennial dicot shrubs and trees is accomplished by mitosis in cambium and cork cambium cells.

Energetics of Mitosis:

(i) O_2 consumption is minimum during mitosis and deficiency of O_2 or concentration of CO had no effect on the mitotic cell division.

(ii) Certain glycolytic enzymes (lactic acid dehydrogenase, triphosphate dehydrogenase, aldolase, etc.) are present in high concentration in the nucleus, whereas enzymes associated with respiration and oxidative phosphorylation in cytoplasm are absent from the nucleus.

(iii) Mitochondria are fragmented into granules which completely disappear during mitosis. Their reconstitution starts during terminal stages of mitosis.

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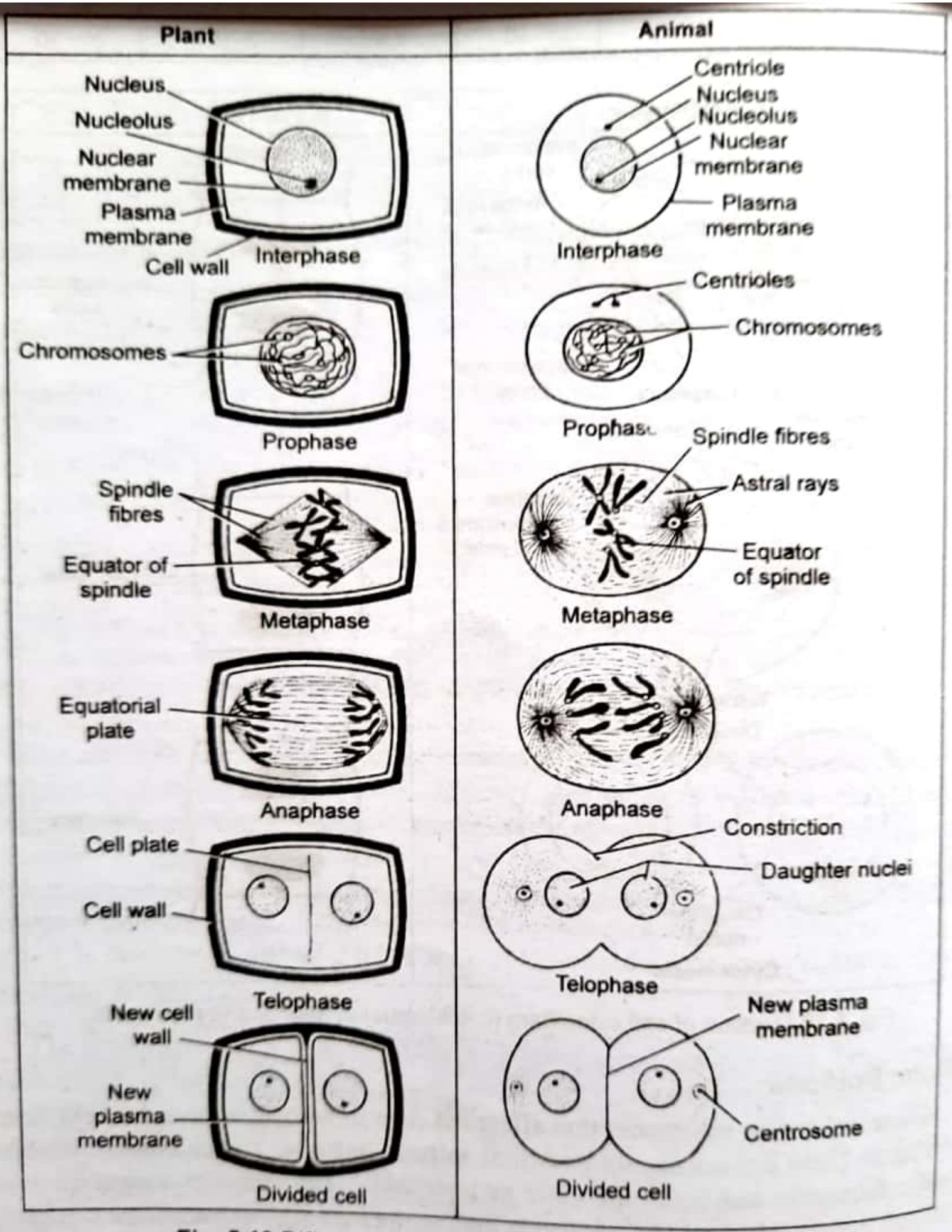

Fig. 5.19 Differences in mitosis in plant and animal cells.