DEPARTMENT OF BOTANY

GOVERNMENT DEGREE COLLEGE FOR MEN

SRIKAKULAM

(AFFILIATED TO Dr. BRAU, SRIKAKULAM, AP)

(2022-2023)

Project work

ON

MITOSIS & MEIOSIS

Government Degree college for Men
Srikakulam

(Affiliated to Dr BR Ambedkar University, Srikakulam. AP)

DEPARTMENT OF BOTANY

CERTIFICATE

This is to certify that

Mr/Kumari_____of II BSc, Group_____has done the project work on **"MITOSIS & MEIOSIS"** with the Registered No _____of Sem-IV, Paper-V during the academic year 2022-2023.

Signature of the Lecturer

Signature of the HOD

Submitted for the exam on- _____

Signature of the Examiner

INDEX

MITOSIS

Mitosis is a type of cell division which results in the formation of two daughter cells. These cells are identical to the parent cells and have the same number of chromosomes. Mitosis occurs in vegetative cells. It can be best observed in onion root tip.

Aim: To study the mitosis by preparing squash of onion root tip.

Principle: The principle underlying this method consists of the spreading the cells in a single layer. Almost all the cells remain adhered to the slide. The cells are smeared at a stage when they are in the process of cell division. This permits the study of various stages of cell division and structure of chromosomes.

Requirements:

CHEMICALS: 1) 0.1 N HCl (1ml conc. HCl added in 119ml Distilled water).
2)70 % and 90 % ethanol.
3) Acetic-alcohol fixative (1: 3 Aceto methanol fixative).
Glacial acetic acid = 1 part; Ethyl/ methyl alcohol = 3 parts
4) 2 % acetocarmine stain 5) 45 % acetic acid.

MATERIALS: Slide, Cover slip, Watch glass, squashing needle, spirit lamp, blotting paper, Onion root tips.

PROCEDURE:

Fixation of Root tips: 1) Freshly cut onion root tips (1 cm long) are fixed in Aceto methanol fixative for overnight in a specimen tube.
2) Then, 90 % ethanol is added after decanting the fixative. Finally 70 % ethanol added after decanting. The root tips can be stored in 70 % ethanol for a long period of time in tightly closed container at room temperature.

Staining and making squash preparation:

1)Root tips are treated with 0.1%N HCl for 1 min. This will soften the cell wall.
2)Root tips are rinsed in water and transferred to acetocarmine stain for30m.
3)A drop of 45 % acetic acid is taken on a slide having one root tip and left for 1-2 min. If acetic acid drop becomes colored, it is decanted and a fresh drop is added.
4) A cover glass is placed on the root tip and squashed it using a rubber-end pencil under the folds of a blotting paper.
5) Then edges of the cover glass is sealed with molten was or with nail polish immediately to prevent drying of acetic acid film and entry of air bubbles.
6) Now the slide is observed under microscope.

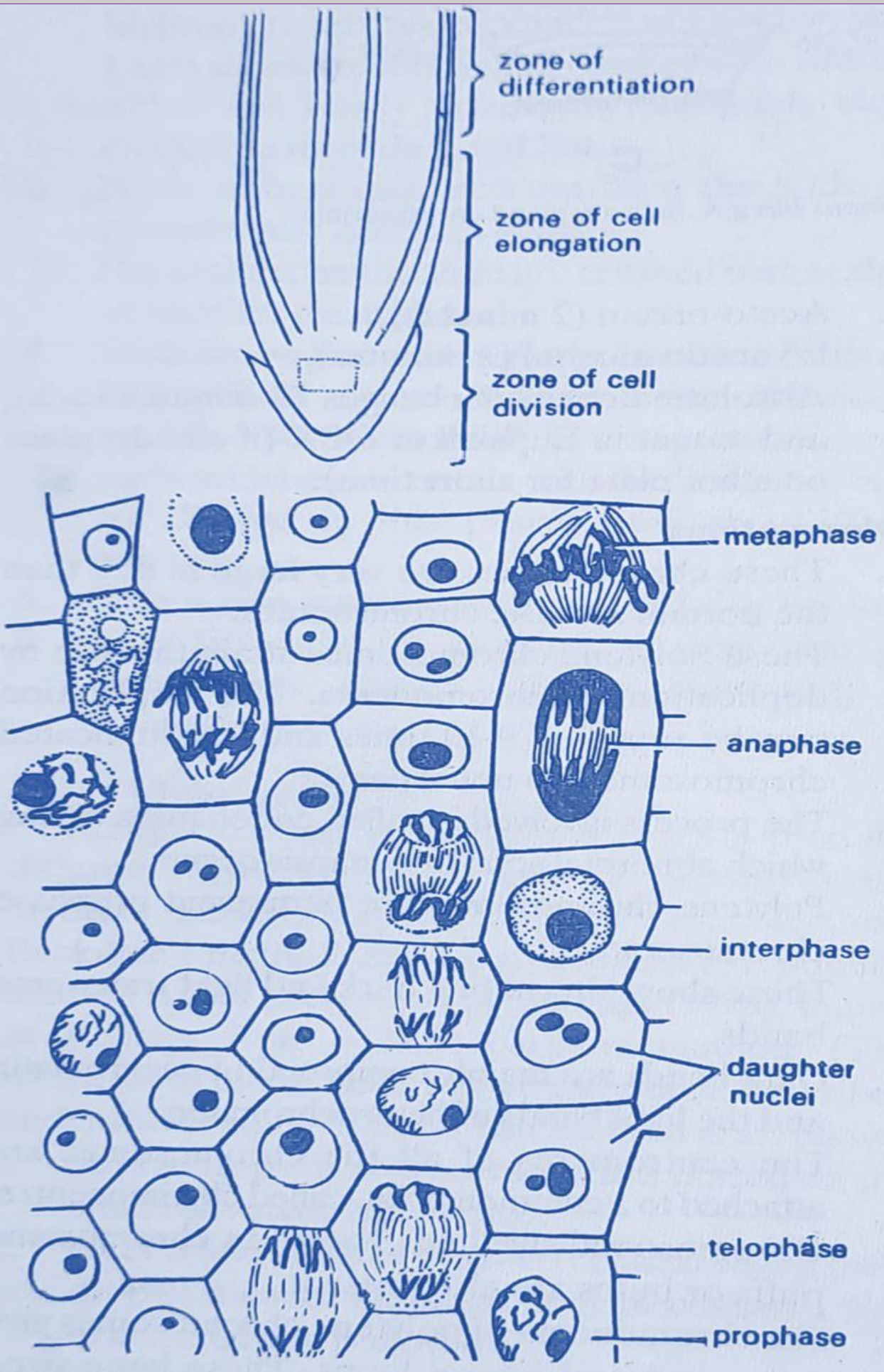

Fig. 8. L. s. onion root tip showing different stages of mitosis.

[I] Interphase

The following characteristics are seen-

1. This is a stage prior to actual mitotic cycle.
2. The cell appears to be inactive or in resting stage but is metabolically the most active. DNA replication occurs during this period.
3. Nuclear membrane and nucleolus are very distinct.
4. Chromosomes are in the form of chromatin network and individual chromosomes cannot be seen separately.
5. The chromosome appears double stranded i.e. made of two chromatids.

[II] Prophase

The following characteristics are seen-

1. The nuclear membrane and nucleolus have partially or completely disappeared.
2. Each chromosome now begins to show chromatids, primary constriction, secondary constriction and centromeres.
3. The equatorial region appears clearly in the center of the cell.
4. Chromosomes begin to move and gather near the equatorial plate.
5. Chromosomes are condensed and thus short and thick.
6. Spindle fibers also begin to appear.

[III] Metaphase

The following characteristics are seen.

1. Nuclear membrane and nucleolus are absent having disappeared.
2. Centromeres of the chromosomes are arranged on the equatorial plate and each is attached to the spindle fibers.
3. Centrioles are absent and hence aster is not formed in plant cells. This type of mitosis is known as anastral mitosis.
4. The spindle is made of fibers only. The absence of centrioles indicates that it is a plant cell.
5. The chromosomes at metaphase are very distinct. Thus, number and morphology of chromosome is studied at this stage. Each chromosome shows two chromatids, centromere, primary constriction, euchromatic and heterochromatic regions, chromomeres.

[I] Interphase

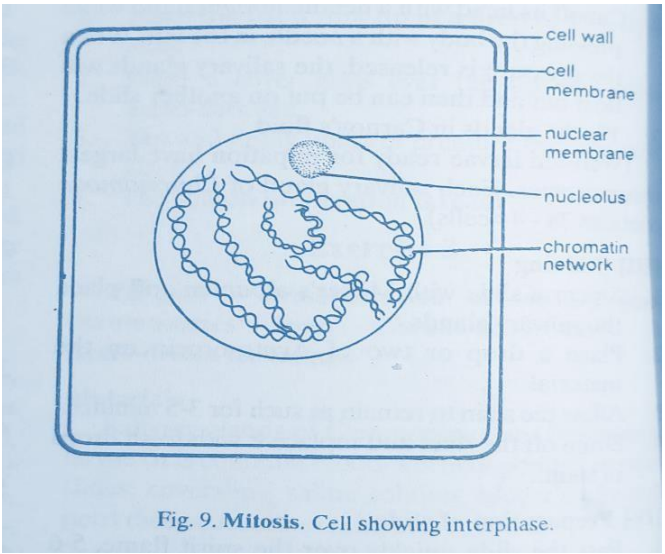

Fig. 9. **Mitosis**. Cell showing interphase.

[II] Prophase

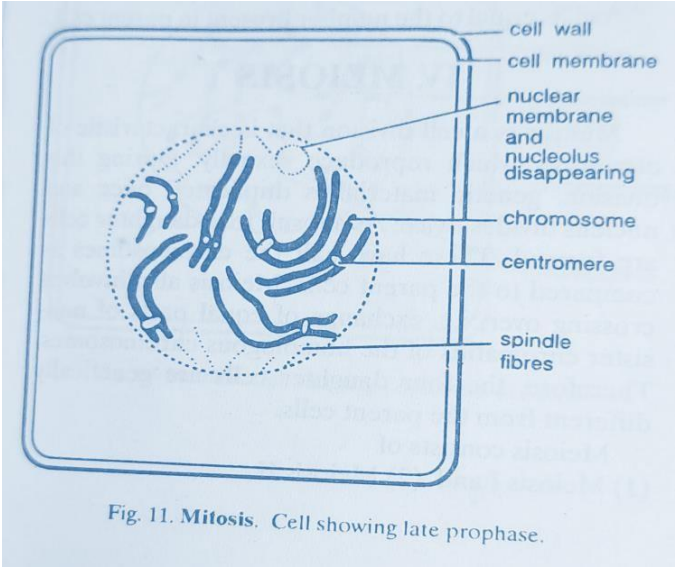

Fig. 11. **Mitosis**. Cell showing late prophase.

[III] Metaphase

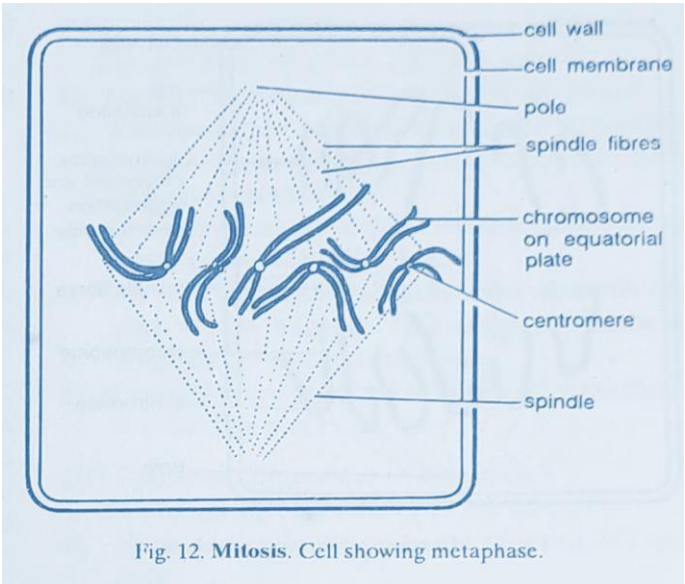

Fig. 12. **Mitosis**. Cell showing metaphase.

[IV] Anaphase

The following characteristics are seen-

1. This stage is completed in a very small period of time.
2. The centromere of each chromosome gets split into two.
3. The chromosome also gets divided into two chromatids. Each chromatid now bears one centromere each.
4. The chromosome becomes shorter and thicker.
5. The separated chromatids are now pulled towards the opposite poles due to contraction of spindle fibers.
6. During movement, each chromosome shows characteristic shape which is dependent on the position of centromere.

[V] Telophase

The following characteristics are seen-

1. The chromosomes are present at both the poles of a parent cell.
2. The chromosomes increase in length and become thread-like. All the chromosomes together form chromatin network and their individuality is now lost.
3. The groups of chromatin network at each are surrounded by nuclear membrane Nucleolus is also present.
4. Thus two fully formed nuclei, one at each pole are present in the parent cell.
5. Spindle fibers are absent.

[VI] Cytokinesis

The following characteristics are seen-

1. In this stage, cytoplasm divides into two. It results in the formation of two daughter cells.
2. Division of the cytoplasm is due to formation of a cell plate in the equatorial region.
3. Cell plate formation begins in the center of the cell and gradually progresses towards the periphery.
4. This results in the formation of two daughter cells. Organelles are also found.
5. The number of chromosomes in each daughter cell is equal to the number present in parent cell.

[IV] Anaphase

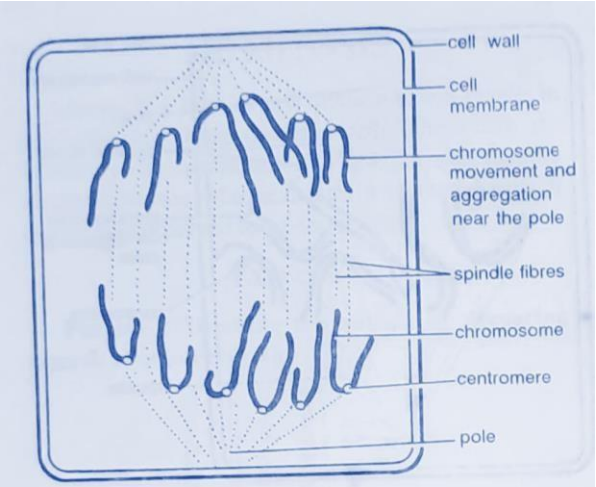

Fig. 13. **Mitosis**. Cell showing anaphase.

[V] Telophase

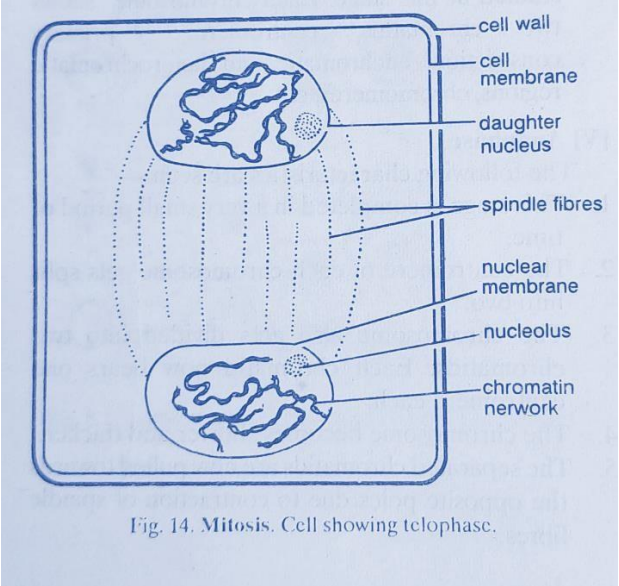

Fig. 14. **Mitosis**. Cell showing telophase.

[VI] Cytokinesis

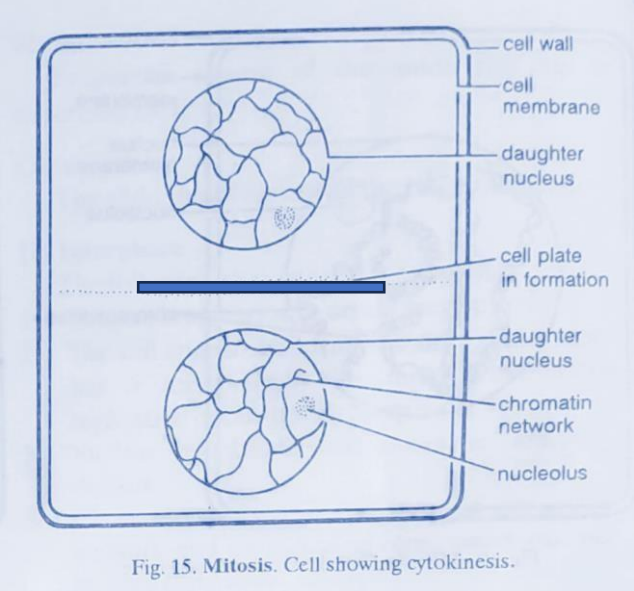

Fig. 15. **Mitosis**. Cell showing cytokinesis.

MEIOSIS

Meiosis is a cell division that is characteristic of organisms which reproduce sexually. During this division, genetic material is duplicated once and nucleus divides twice. As a result four daughter cells are formed. These have half the chromosomes as compared to the parent cells. Meiosis also involves crossing over, i.e. exchange of equal parts of non- sister chromatids of the homologous chromosomes. Therefore, the four daughter cells are genetically different from the parent cells.

Meiosis consists of **(1) Meiosis-I and (2) Meiosis-II.**

Meiosis-I involves some very characteristic and important stages such as-

1) Synapsis or pairing of homologous chromosomes,
2) Re-combinations due to crossing over
3) Segregation of homologous chromosomes.

The stages included in Meiosis I are Prophase-I, Metaphase-I, Anaphase-I and Telophase-I. At the end of meiosis-I, two daughter cells are formed. Each cell has half the number of chromosomes compared to parent cell.

Meiosis-II is similar to mitosis. It results in the formation of four daughter cells, each having the same chromosome number as was present at the end of Meiosis-I. Meiosis-II is also sub-divided into Prophase-II, Metaphase-II, Anaphase-II and Telophase-II.

Aim: To study meiosis by smear preparation from young anthers of Tradescantia.

Procedure: 1. Anthers are smeared on the cover glass.
2. It is then inverted on the slide in drop of acetocarmine.
3. Cover glass is sealed with melted wax.

Observations

Following stages can be seen in different slides of meiosis-

[I]Leptotene (Leptonema):

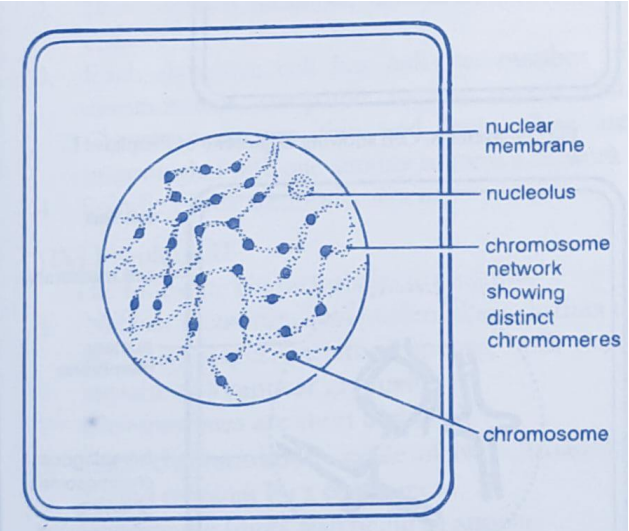

Fig. 16. **Meiosis**. Cell showing Leptotene of Prophase I.

[II] Zygotene (Zygonema):

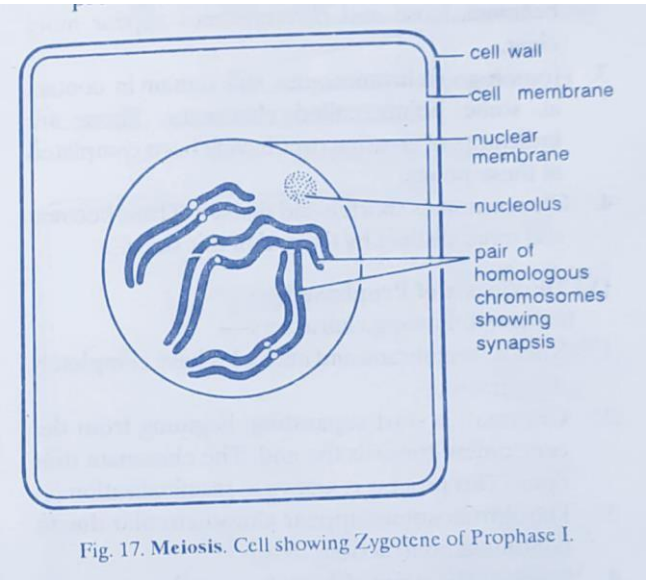

Fig. 17. **Meiosis**. Cell showing Zygotene of Prophase I.

[III] Pachytene (Pachynema):

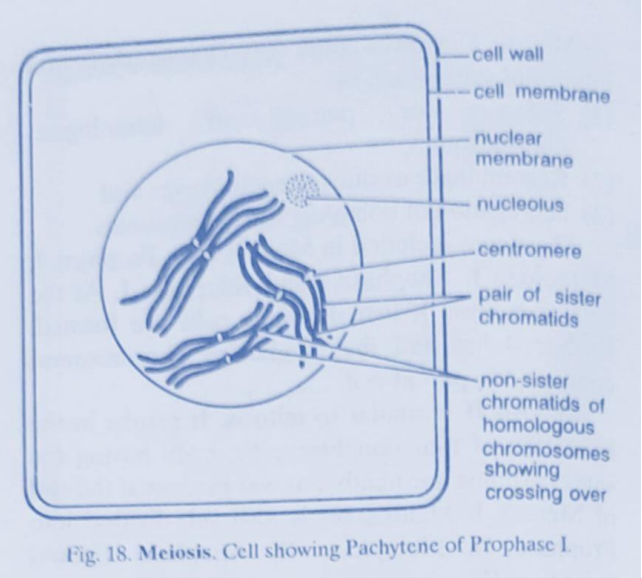

Fig. 18. **Meiosis**. Cell showing Pachytene of Prophase I.

[I]Leptotene (Leptonema): It shows following characters

1. Nuclear membrane and nucleolus are intact.
2. Chromosomes are long thread-like structures. All the chromosomes are intertwined to form chromatin network.
3. Chromosomes appear beaded due to chromomeres which are distinct at this stage.
4. All the chromosomes finally move towards one part of the nucleus. This stage is known as synizesis or bouquet formation.
5. Centrioles are not present. This indicates that it is a dividing plant cell.

[II] Zygotene (Zygonema): It shows following characters

1. Nuclear membrane and nucleolus are still very clear.
2. The major character of this stage is synapsis pairing of homologous chromosomes.
3. Synaptonemal complex is formed as a result of synapsis. This complex is made of two lateral elements and a central region which is bisected by a narrow central component.
4. Synapsis can occur at more than one points along the length of the chromosome.
5. At each place a pair showing two chromatids is present.

[III] Pachytene (Pachynema): The following are seen

1. Nucleolus and nuclear membrane are distinct.
2. Chromosomes are thickened, coiled and thread-like.
3. Chromosomes are very closely coiled. Each chromosome shows its two chromatids. A pair of homologous chromosomes which is intimately coiled upon one other show four chromatids together.
4. Pair of homologous chromosomes is called Bivalent. It is made of four chromatids and hence known as tetrad.
5. The stage is characterized by Crossing over. It is the exchange of equal parts of chromatids of two different but homologous chromosomes.

[IV] Diplotene (Diplonema):

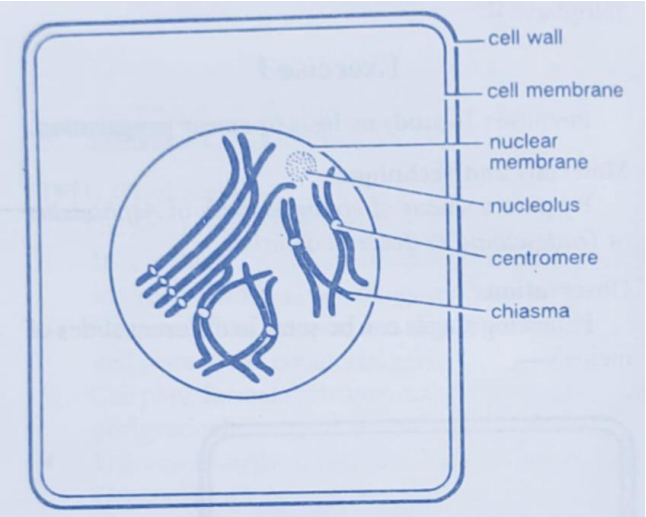

Fig. 19. **Meiosis**. Cell showing Diplotene of Prophase I.

[V] Diakinesis:

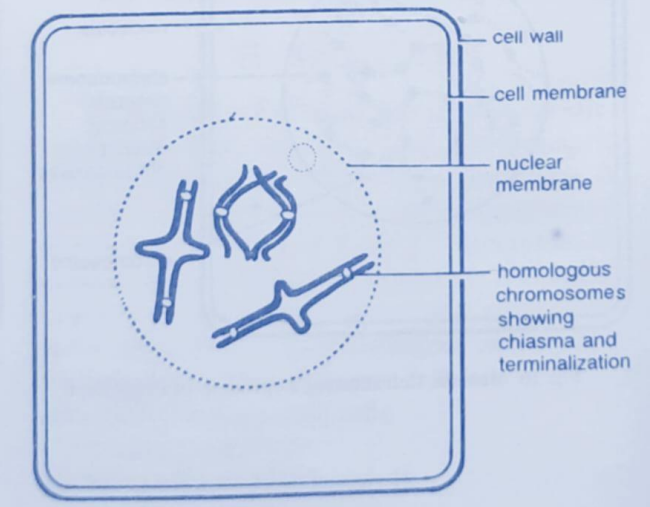

Fig. 20. **Meiosis**. Cell showing Diakinesis of Prophase I.

[VI] Metaphase-I:

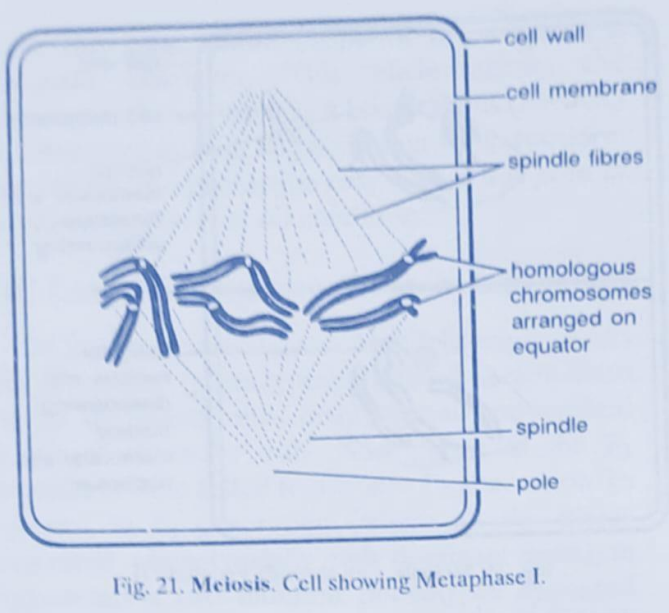

Fig. 21. **Meiosis**. Cell showing Metaphase I.

[IV] Diplotene (Diplonema): It shows following characters

1. The nucleolus is disappearing while nuclear membrane is still intact
2. The close and tight coiling of chromosomes becomes loose and chromosomes appear more clearly.
3. Homologous chromosomes still remain in contact at some points called Chiasmata. These are indicators of crossing over having beencompleted at these points.
4. Chromosomes shorten and thicken. These become still more distinct by the end of this stage.

[V] Diakinesis: It shows following characters-

1. Nuclear membrane and nucleolus have completely disappeared.
2. Chromatids start separating, beginning from the centromere towards the end. The chiasmata thus open. This process is known as Terminalization.
3. The chromosomes appear almost circular due to continued contraction.
4. Some of the pairs of homologous chromosomes still appear joined with one another.

[VI] Metaphase-I: It shows following characters

1. Nuclear membrane and nucleolus have completely disappeared.
2. Spindle formed by fibers is distinct.
3. Bivalents are arranged on the equatorial plate.
4. Each chromosome of a bivalent is attached to the spindle fibres by its centromere.
5. Centromeres are arranged on both the sides of the equatorial region, almost at equal distance.

[VII] Anaphase-I:

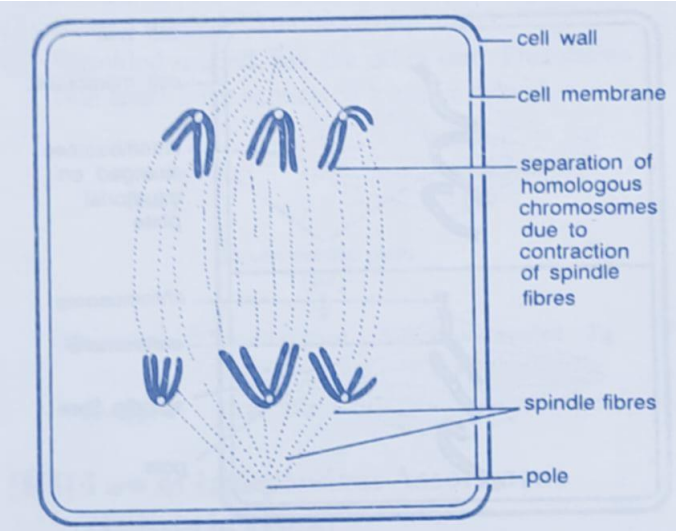

Fig. 22. **Meiosis**. Cell showing Anaphase I.

[VIII] Telophase-I:

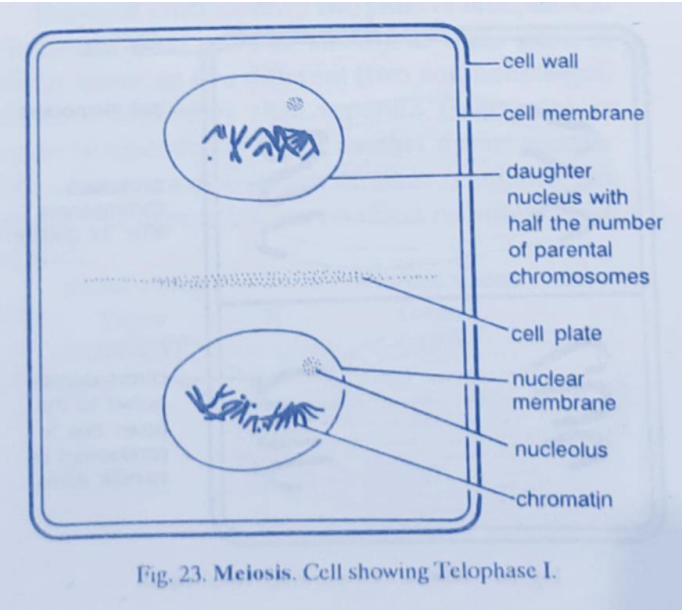

Fig. 23. **Meiosis**. Cell showing Telophase I.

[IX] Prophase-II:

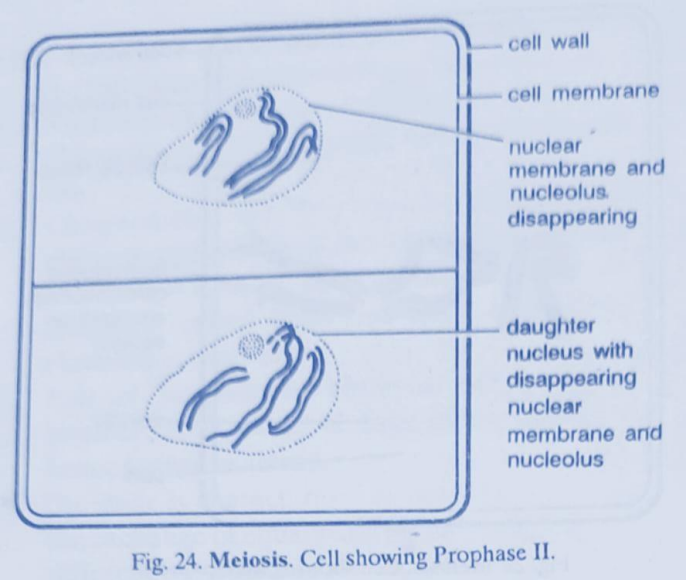

Fig. 24. **Meiosis**. Cell showing Prophase II.

[VII] Anaphase-I: The following are characteristics of this stage

1. Nuclear membrane and nucleolus are completely absent.
2. The chromosomes separate out of the pair of homologous chromosomes. (Segregation/Disjunction)
3. Spindle fibers contract and pull the centromere along with the chromosome to opposite poles.
4. This results in two haploid sets of chromosomes, one at each pole of the cell.
5. Each chromosome shows characteristic shape during movement.

[VIII] Telophase-I: The stage shows following characteristics-

1. Nuclear membrane and nucleolus have reappeared and are clearly seen.
2. There are two nuclei one each at the poles of the cell.
3. Each daughter cell has half the number of chromosomes compared to the parent cell. Chromosomes are thin and long. They are intermingled with one another to form a network.
4. Spindle fibers are totally absent.

[IX] Prophase-II: The following characteristics are seen-

1. Nuclear membrane and nucleolus are distinct in the early stages. In late prophase, both these structures disappear gradually.
2. Chromosomes are short and thick.
3. Each chromosome is made of two chromatids bound together by a centromere.
4. The spindle fibers also begin to appear.
5. Chromosomes move towards the equatorial plate which is generally formed at right angles to the plate formed during meiosis-I

[X] Metaphase-II:

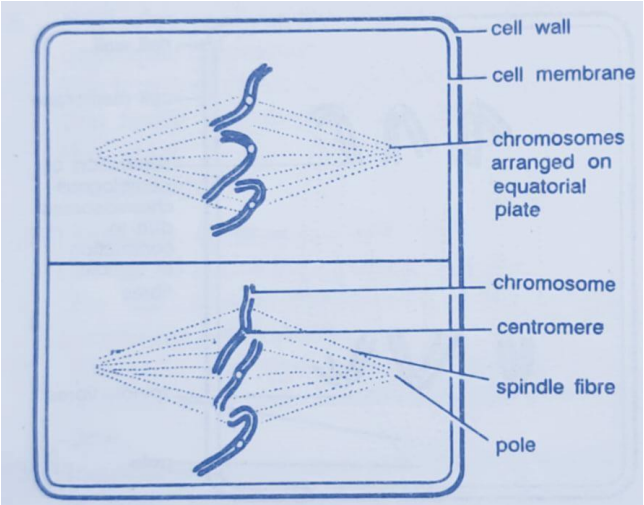

Fig. 25. **Meiosis**. Cell showing Metaphase II.

[XI] Anaphase-II:

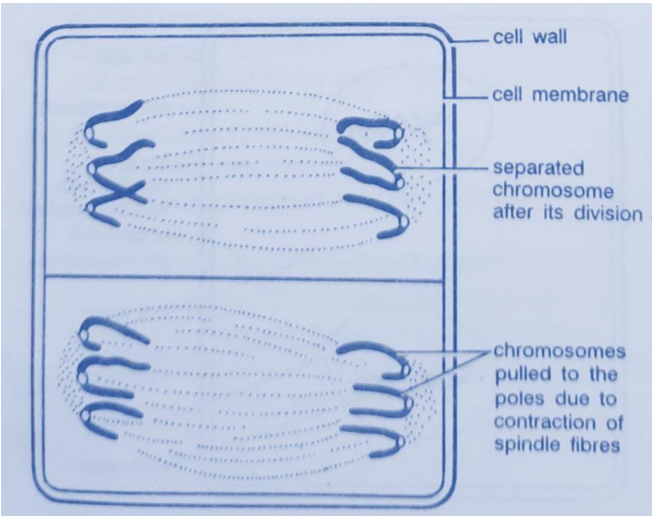

Fig. 26. **Meiosis**. Cell showing Anaphase II.

[XII] Telophase-II:

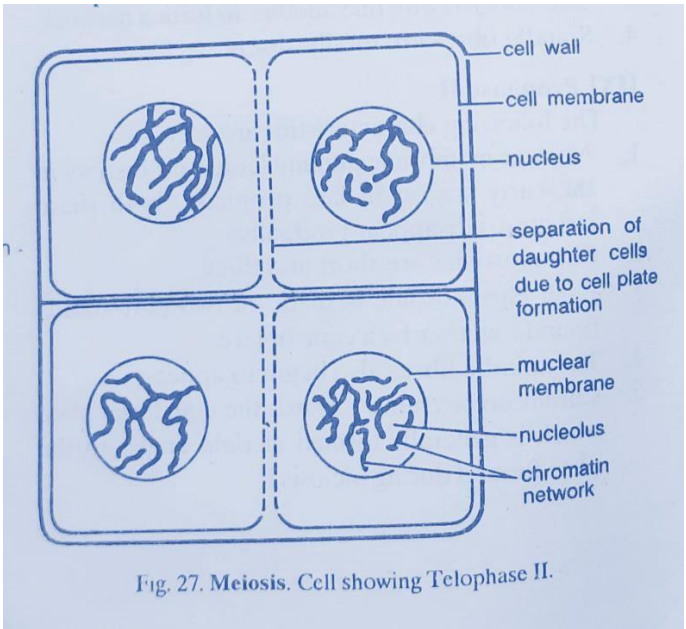

Fig. 27. **Meiosis**. Cell showing Telophase II.

[X] Metaphase-II: It shows following characteristics-

1. Nuclear membrane and nucleolus both are disappeared.
2. Spindle fibers are formed. These are organized into a spindle.
3. Spindle fibers are joined with centromeres of the chromosomes.
4. All the chromosomes are arranged on the equatorial plate.
5. Each chromosome is made of two chromatids held together by a centromere.

[XI] Anaphase-II: This stage is characterized by the following-

1. Nuclear membrane and nucleolus are absent.
2. Centromere that holds two chromatids split. Each chromatid now has an individual centromere.
3. Spindle fibers contract and each chromosome is now pulled to the opposite poles.
4. Chromatids (now called chromosomes) show characteristic shape during their movement.

[XII] Telophase-II: The following are characters are seen

1. Chromosomes are in the form of groups at each end of the parent cell.
2. Nuclear membrane reappears and surrounds the group of chromosomes. This results in the formation of daughter nuclei at the opposite poles of the cells.
3. Spindle fibers disappear completely.

[XIII] Cytokinesis: Division of cytoplasm can occur after each Nuclear division (Meiosis-I & Meiosis-II) or it may be delayed until the formation of four daughter nuclei. The process of cytokinesis is same as that of mitotic division.

THE END