EXPERIMENT

AIM

To study the meiosis in onion bud or grasshopper testis using permanent slides.

THEORY

Meiosis

Meiosis as a cell division occurs in reproductive cells of an organism located in the reproductive organg such as testis and ovary of sexually reproducing organisms in order to produce gametes (i.e. Sperm and ova). The number of chromosomes in daughter cells is reduced to half in this, hence, it is also called the reductional division.

It comprises of mainly two phases, i.e. meiosis-I and meiosis-II.

Meiosis-I

Meisosis-l is the reductional division in which the chromosomes of homologous pairs separate from each other. Two important events occur in meiosis-l, which are as follows:

(i) Synaptonemal complex formation This is homologous chromosome coming close together to undergo synapsis.

(ii) Crossing over This is considered as a very important event of meiosis-l as it brings about variation in the offsprings produced thus helping in evolution. Process of crossing over occurs due to the exchange of genetic material between non-sister chromatids of homologous chromosomes. As a result of this, new recombinant chromosomes differ from the parental ones and are inherited by the next generation through gametes.

Meiosis-II

Meiosis-II is an equational division resulting in the formation of four daughter cells. In this division, chromosome number remains same as produced in meiosis-I. It is initiated immediately atter cytokinesis. Meiosis can be observed in a cytological preparation of the cells of testis tubules or in the pollen mother cells of the anthers of flower buds.

REQUIREMENTS

Permanent slides of all the stages of meiotic division and compound microscope.

PROCEDURE

1. Focus the slide under low power (10x) of a compound microscope.
2. Observe the dividing cells carefully.
3. Look for the nucleus, chromosome, etc. in each cells,
4. Use pointer in the objective lens to point out a specific stage of meiotic cell division to be seen in high power.
5. Observe the stage of the cell pointed by pointer under high power (45x).

MEIOSIS-I (First Nuclear Division)

1. Prophase I

It is a complex phase characterised by number of events It is divided into five main sub-stages

(i) Leptotene (leptos - slender, tene - band or thread)

a) Nuclear membrane and nucleolus are not clearly visible

b) Fine network of thin chromatin threads is seen. These are chromatin fibres in condensed form called chromosomes.

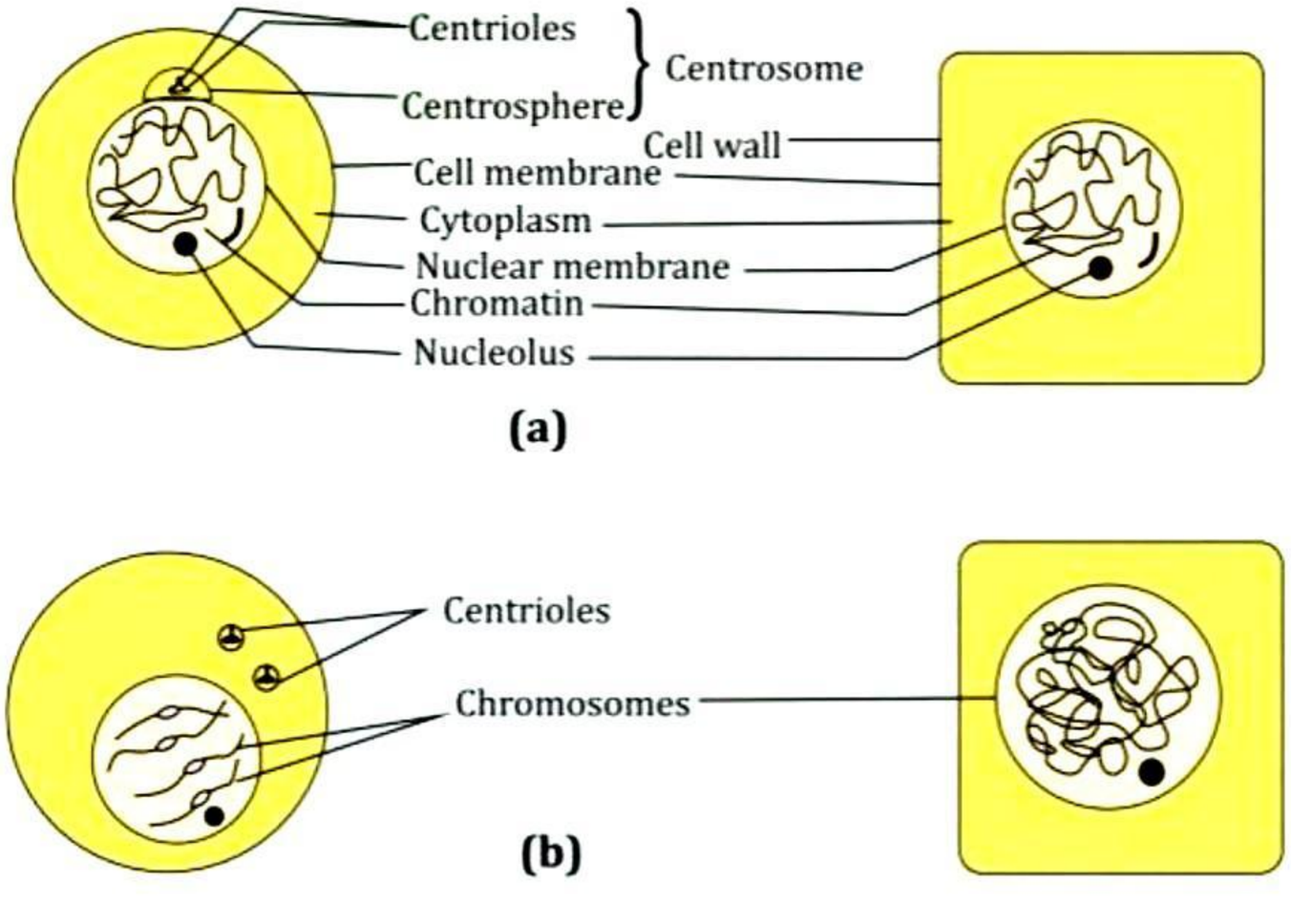


Fig. (a) Interphase (b) Leptotene

(ii) Zygotene (zygon - paired)

a) Pairing of homologous chromosomes occurs in this stage and they form bivalents.

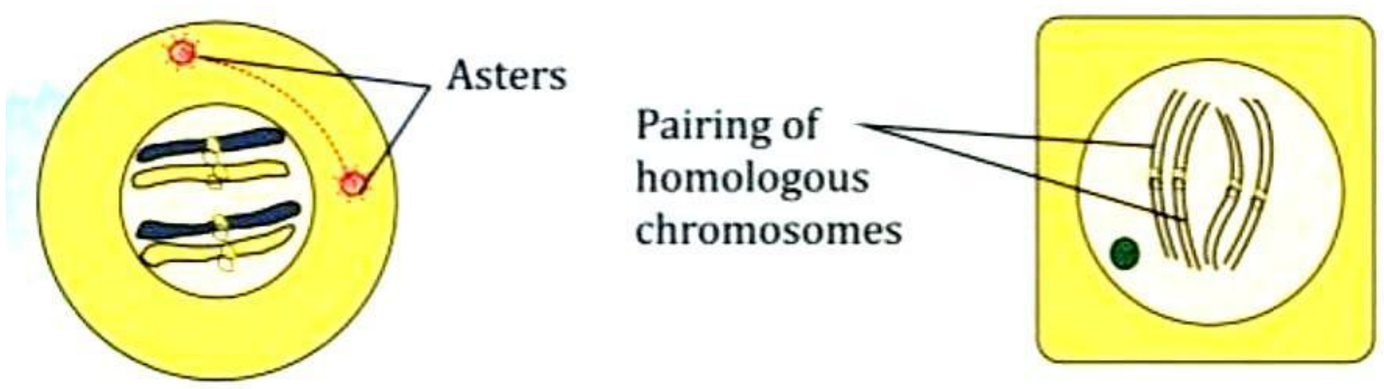


Fig. Zygotene

b) Each pair has two chromosomes similar in their length and their centromere position.

c) Chromosomes become more distinct as they become much shorter than before.

(iii) Pachytene (pachy - thick)

a) The homologous pairs are clearly visible.

b) Each chromosome has two chromatids and thus each bivalent consists of Hence, the chromosomes exhibit tetrad configuration.

c) Crossing over, i.e. exchange of chromatid segments takes place between non-sister chromatids of homologous chromosomes.

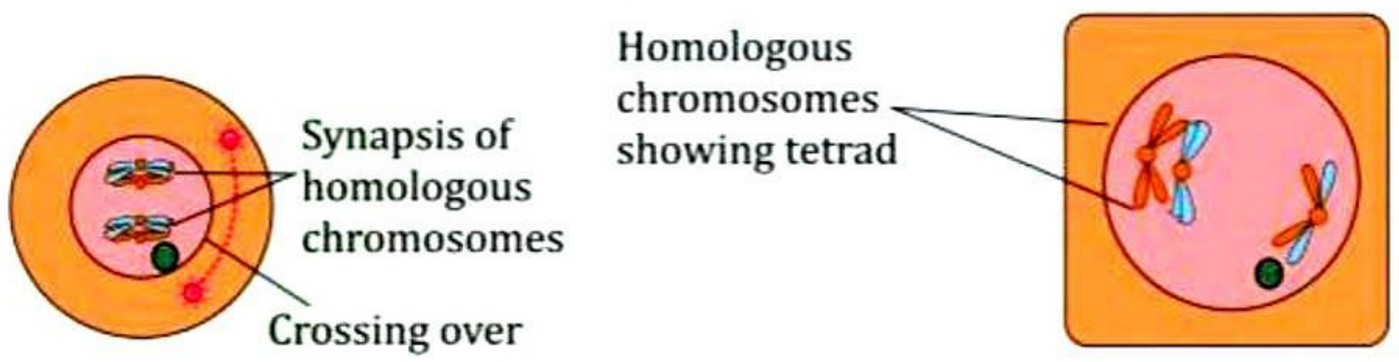


Fig. Pachytene

(iv) Diplotene (diplos-double)

a) Diplos means double, so each homologous chromosome has two chromatids that show distinct separation from each other except at some points.

b) The attachment points of two homologous chromosomes are called chiasmata (sing chiasma).

c) These chiasmata represent the site of crossing over.

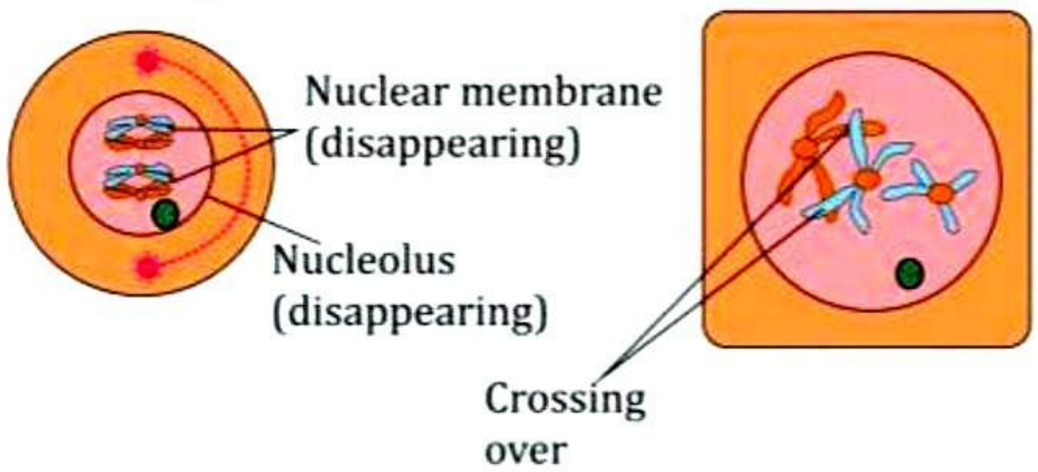


Fig. Diplotene

(v) Diakinesis (dia - opposite; kinesis - separation or movement)

a) Bivalents condense further during this stage and appear to be more shortened, thick and prominent than before.

b) Chiasmata are clearly visible.

c) All homologous pairs appear in a scattered form within the cell.

d) Nuclear membrane and nucleolus have disappeared completely.

e) Spindle formation can be seen in its early stages.

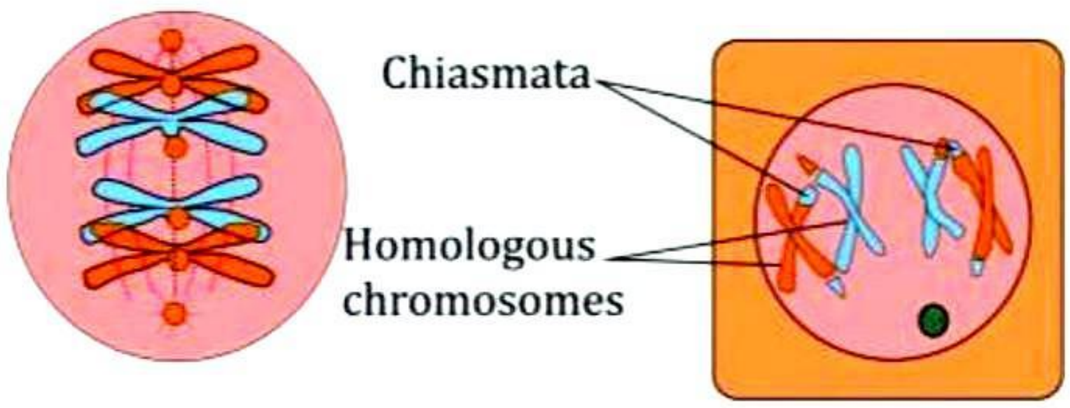


Fig. Diakinesis

2. Metaphase-I

(i) The homologous chromosomes are still in pairs and are arranged along the equatorial plane of the cell.

(ii) At this stage, number of bivalents can be counted.

(iii) Chiasmata may still be seen in few bivalents.

(iv) The spindle fibres attach themselves to the centromosome of each chromosome pair.

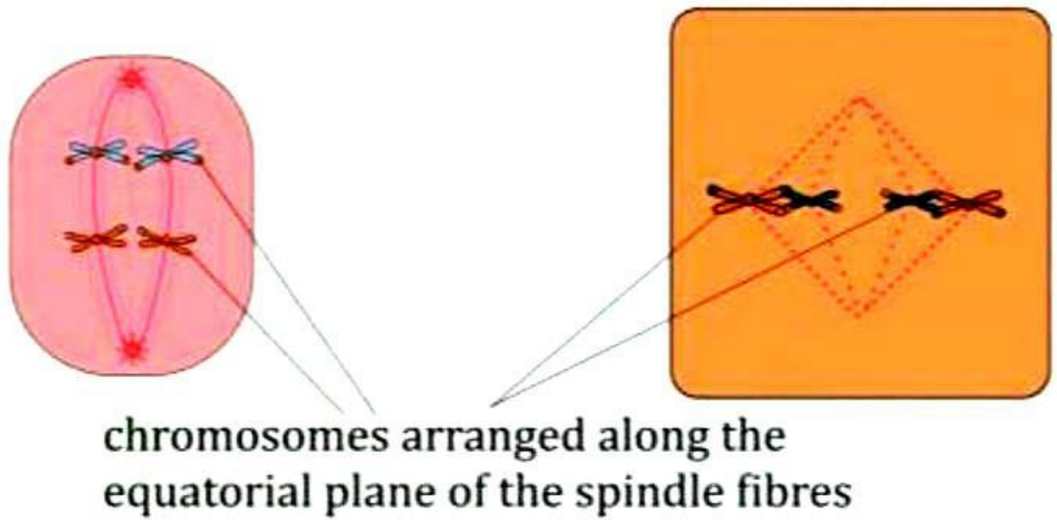


Fig. Metaphase -I

3. Anaphase-I

(i) As a result of shortening of spindle fibres, the paired chromosomes start separating.

(ii) At the end of anaphase-I, the chromosomes assemble at two poles.

(iii) This result into the reduction of chromosomes number to half.

(iv) Each chromosome has two chromatids at this stage.

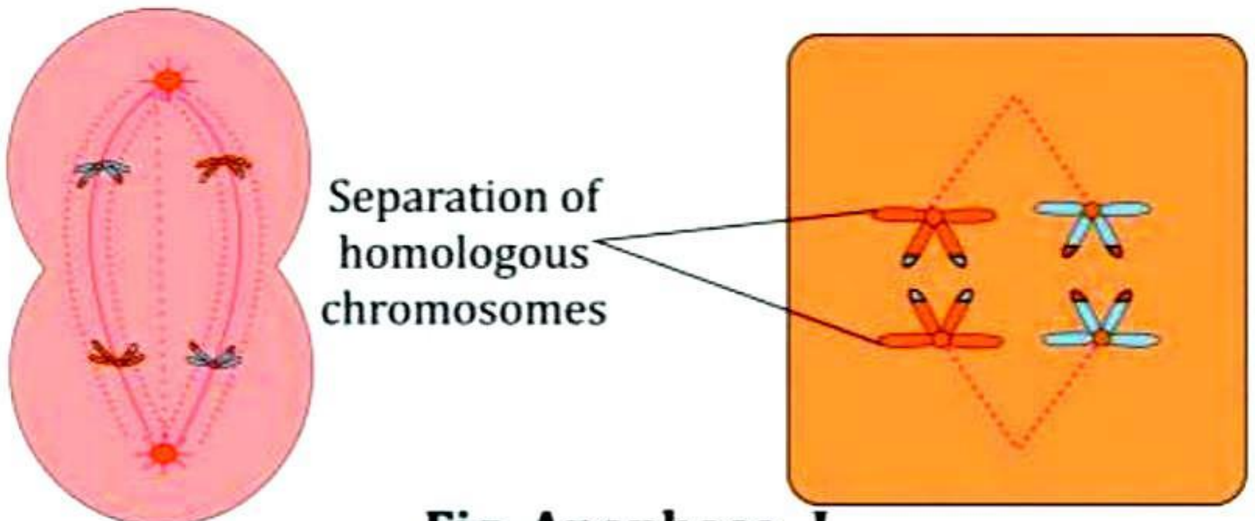


Fig. Anaphase- I

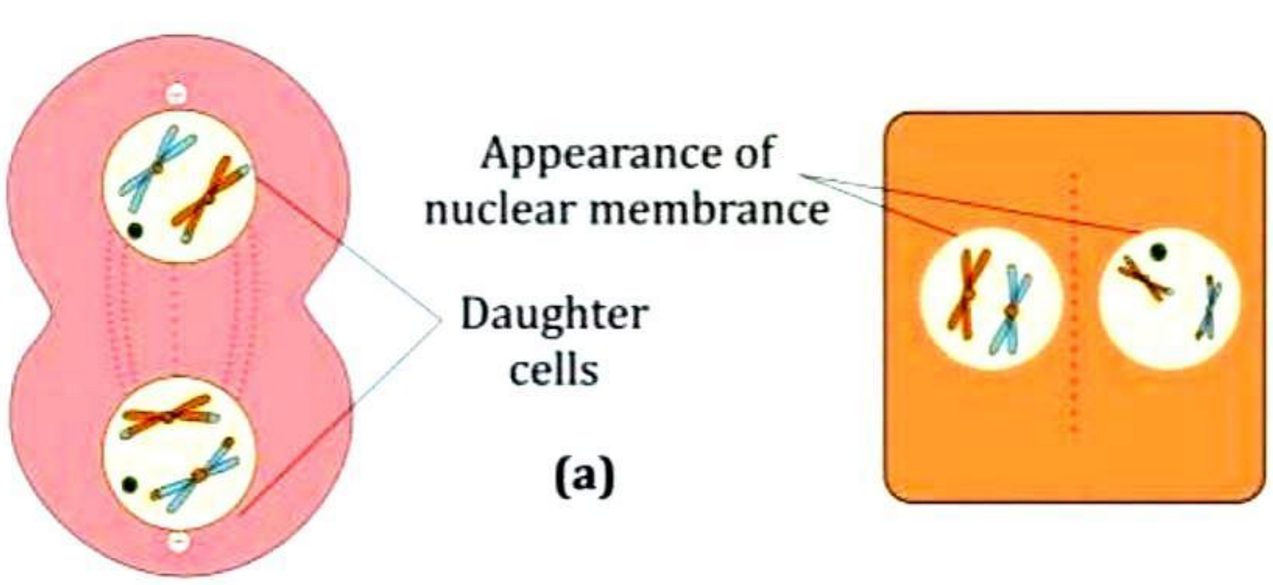
4. Telophase-I

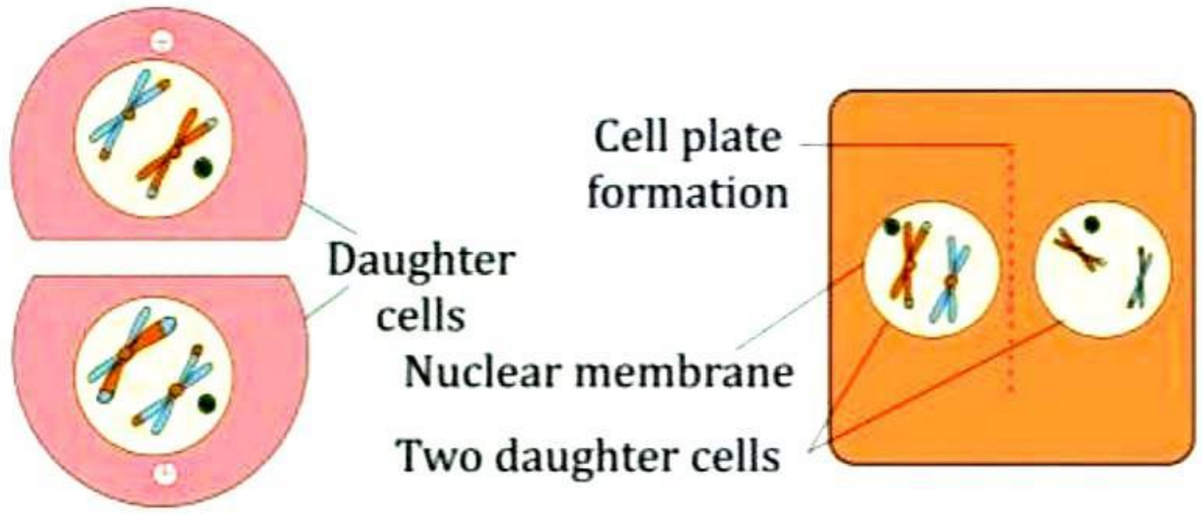
(i) Chromosomes present at the two poles appear decondensed.

(ii) The nuclear membrane is formed around the two new daughter nuclei.

(iii) Nucleolus also reappears.

(iv) Thus, each nucleus formed has half number of chromosomes as compared to the nucleus of the parent cell.





(b)

Fig. (a) Telophase - I (b) Cytokinesis

Note: It is not necessary that cytokinesis takes place after telophase-I. Cells can thereafter enter into the second meiotic division after meiosis-I.

MEIOSIS-II (Second Nuclear Division)

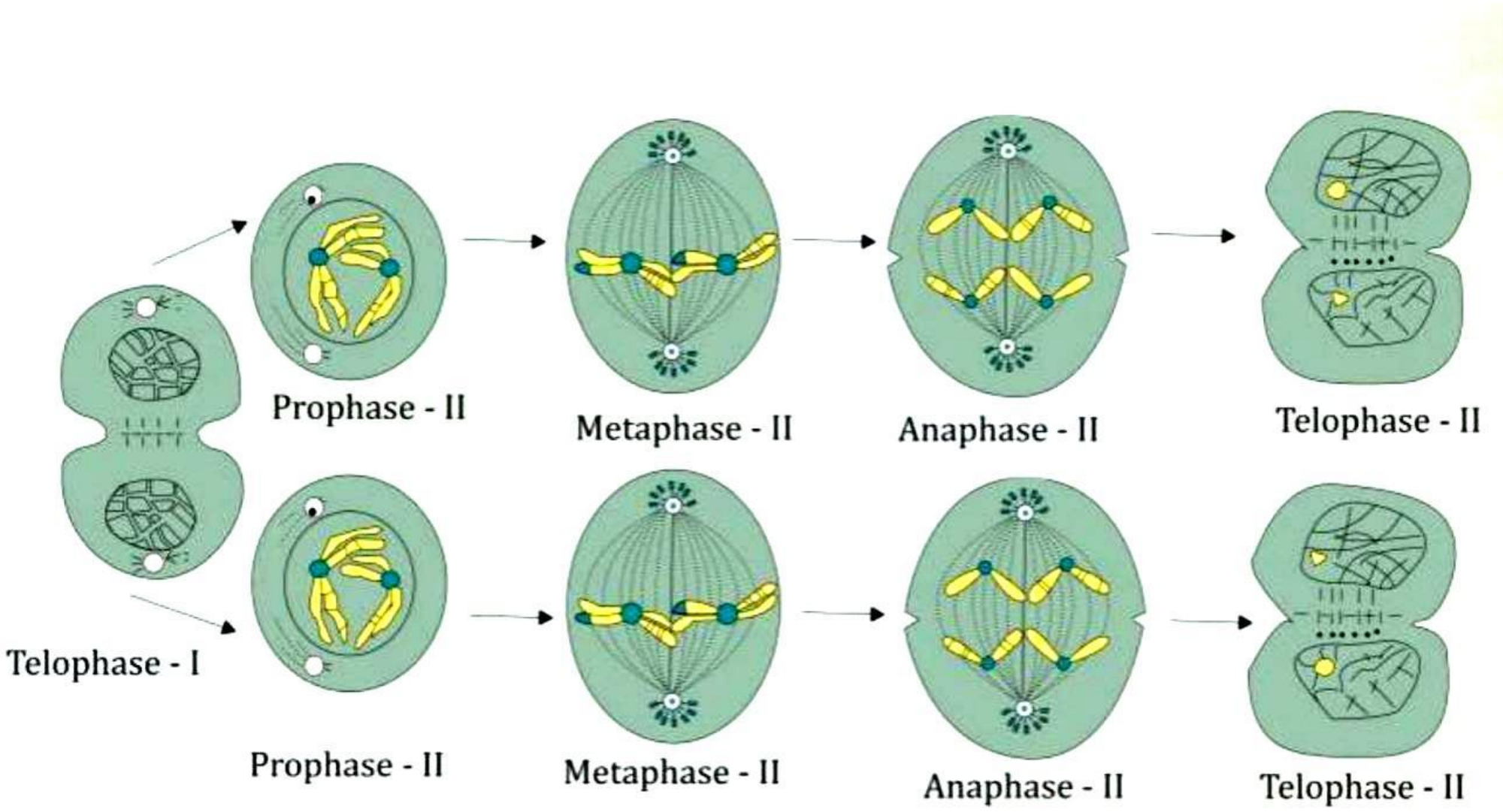
Meiosis-II is similar to mitosis without duplication of DNA. It is divided into following stages:

1. **Prophase-II**
   - **(i)** The chromosomes reappear as distinct rod-shaped or thread-like chromatin fibres.
   - **(ii)** Each chromosome has two chromatids.
   - **(iii)** Nuclear membrane and nucleolus start disappearing.
   - **(iv)** The chromosomes become short by coiling and condensation.
2. **Metaphase-II**
   - **(i)** This phase is similar to that of mitotic division.
   - **(ii)** The chromosomes having two chromatids attached at the centromere are observed arranged of the equatorial plane of the cell.

Note Metophase-ll can be differentiated from metaphase-l by the following features:

- Every chromosome of metaphase-ll has two chromatids while in metaphase-I, paired homologous chromosomes each having two chromatids form tetrad.
- In metaphase-I a few chiasmata are observed, while no chiasma are observed during metaphase-II.

3. **Anaphase-II**
   - **(i)** The centromere of each chromosome divides into two, so that each chromatid gets its centromere.
   - **(ii)** Shortening of the spindle fibres occurs so that chromatids are pulled apart towards their respective poles.
   - **(iii)** The two chromatids of each chromosome after separation appear to lie at the two poles of the cell.
4. **Telophase-II**
   - **(i)** The chromatids (now chromosome) on their respective poles, now uncoil and form the chromatt network again.
   - **(ii)** Nuclear membrane and nucleolus are reformed.
   - **(iii)** Four haploid nuclei are seen in each cell (male or female gamete).



Note Anaphase-II can be differentiated from anaphase-I on the basis of chromatids. In anaphase-I, eact chromosome has distnct chromatids but in anaphase-II each chromosome is represented by ane chromatid only.

RESULT

The slides under observation revealed all the characteristic features of the meiotic cell division occurring in the onion bud or grasshopper testis.

PRECAUTIONS

- Handle the permanent slides cautiously so that they do not break.
- Focus each slide first under 10 × magnification of light microscope and then under 40 × magnification to get the better view of dividing cells.

VIVA VOCE

Q1. Why is meiosis called as reduction division and mitosis as equational division?

Ans. Because in meiosis chromosome number in daughter cells is reduced to half and by mitosis the number of chromosomes remain the same as in parent cell.

Q2. Can a haploid cell divide by meiosis?

Ans. No, a haploid cell cannot divide by meiosis.

Q3. Where do meiosis takes place?

Ans. Meiosis takes place in reproductive organs to form gametes.

Q4. Where does mitosis take place?

Ans. In somatic cells.

Q5. Which is essential - Mitosis or Meiosis?

Ans. Both are necessary, mitosis is required for growth and development of body, repair of tissues whereas meiosis is required for the production of gametes which is the main step of sexual

reproduction.

Q6. What are the important events of meiosis?

Ans. (i) Crossing over
(ii) Reduction of chromosome number to half.

Q7. What is the importance of crossing over?

Ans. Crossing over leads to genetic variation and thus helps in evolution by creating new combination of genes.

Q8. Name the stage where the chromosome number is reduced to half.

Ans. Anaphase I.

Q9. Differentiate between karyokinesis and cytokinesis.

Ans. Karyokinesis is the division of nucleus whereas cytokinesis is the division of cytoplasm.

Q10. How will you identify whether a dividing cell is a plant cell or animal cell?

Ans. Plant cell has a definite shape with cell wall around the cell membrane and centriole is absent. Whereas an animal cell is round in shape with plasma membrane as the covering and centrioles are seen at opposite poles giving rise to spindle fibres.

Q11. Name the stages where the nuclear membrane is not visible.

Ans. Metaphase I, Anaphase I, Metaphase II and Anaphase II.

Q12. How many meiosis are required to form 16 pollen grains?

Ans. 1 Meiosis gives rise to 4 cells 16/4=4 meiosis are required to produce 16 pollen grains.