Topic: Meiosis
B.Sc. Botany (Sub.) I
Group: C

By
Dr. Sanjeev Kumar Vidyarthi
Department of Botany
Dr. L.K.V.D. College, Tajpur, Samastipur
L.N. Mithila University, Darbhanga

Meiosis

The sexual cycle of a diploid organism involves the alternation of haploid and diploid states. Meiosis is the process by which haploid gametes or spores are produced by two successive divisions of diploid nucleus. During meiosis, homologous chromosomes pair, replicate once and undergo assortment so that each of the four meiotic products receives one representative of each chromosome. The two nuclear divisions are called first meiotic division (meiosis- I) and second meiotic division (meiosis- II).

First meiotic division (meiosis-l)

In meiosis I, the chromosome number is reduced from diploid to haploid. The mechanism consists of four important phases – prophase I, Metaphase I, Anaphase I and Telophase I.

Prophase I

The most complex phase of meiosis I is prophase I, it is longer in duration, and consists of five sub stages – leptotene, zygotene, pachytene, diplotene and diakinesis.

- Leptotene is marked by the appearance of the chromosomes as long threads.
- In zygotene homologous chromosomes pair side by side and gene by gene with each other. This process of lateral association of homologues is called synapsis. When the two homologous chromosomes consisting of four chromatids are paired, this structure is called a bivalent.
- In pachytene stage, shortening and thickening of chromosomes takes place. During this stage crossing over takes place resulting into exchange of portions of homologous chromosomes.
- In diplotene, homologous chromosomes begin to separate, particularly in the region surrounding the centromere. The sister chromatids remain attached at the centromeric region, at some points homologous chromosomes remain in close contact, these points are known as chiasmata.
- The last stage of Prophase I, diakinesis, is characterized by shortened chromosomes and the terminalization of chiasmata.

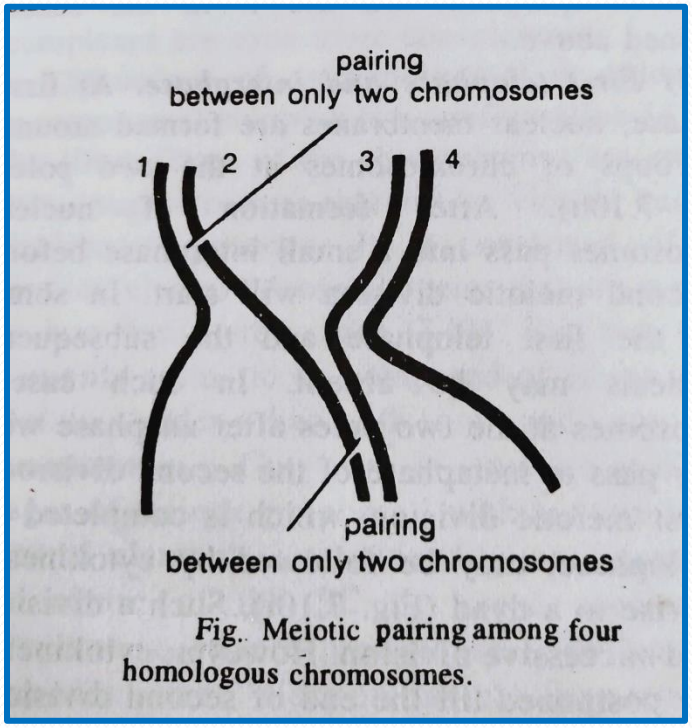

Fig. Meiotic pairing among four homologous chromosomes.

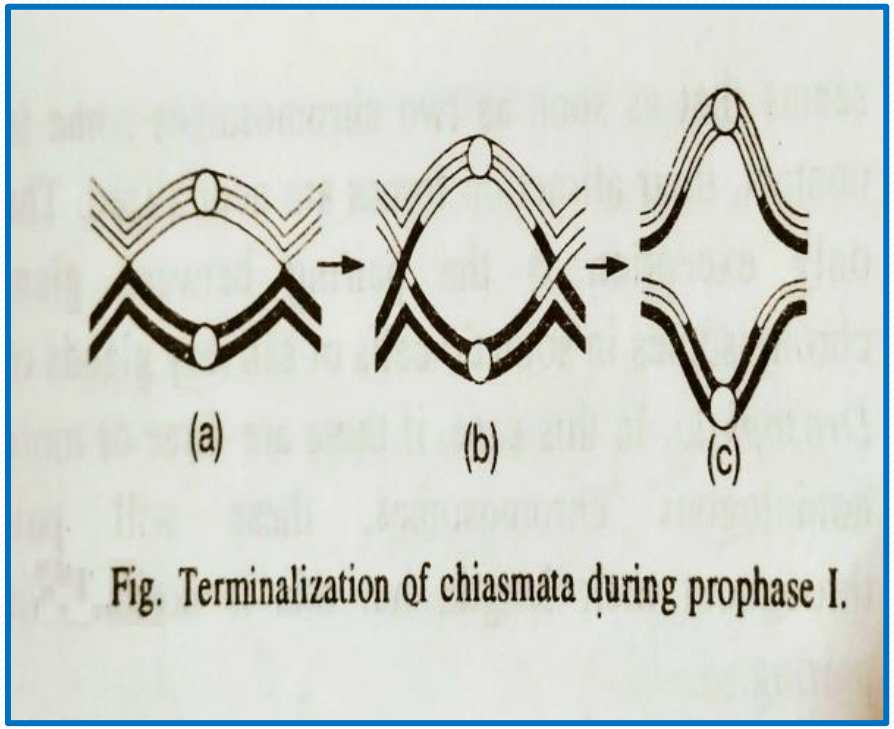

Fig. Terminalization of chiasmata during prophase I.

- **Metaphase I**

The homologous chromosomes which are joined through the chiasmata become oriented on the spindle, with the centromeres of each chromosomes lying towards poles but the ends of chromosomes towards the equatorial plate.

- **Anaphase I**

The chromosomes in each bivalent separate at this stage so that homologous pairs disjoin and migrate towards the opposite poles. As a result, the maternally and paternally derived homologues are segregated.

- **Telophase I**

It is a reorganization phase. Nuclear membrane and nucleolus reappear and thus at each pole a haploid nucleus is formed.

Second Meiotic division (meiosis -II)

It is similar to mitotic division; the sub stages are prophase II, metaphase II, anaphase II and telophase II. In prophase II, the chromosomes condense, and the centromeres

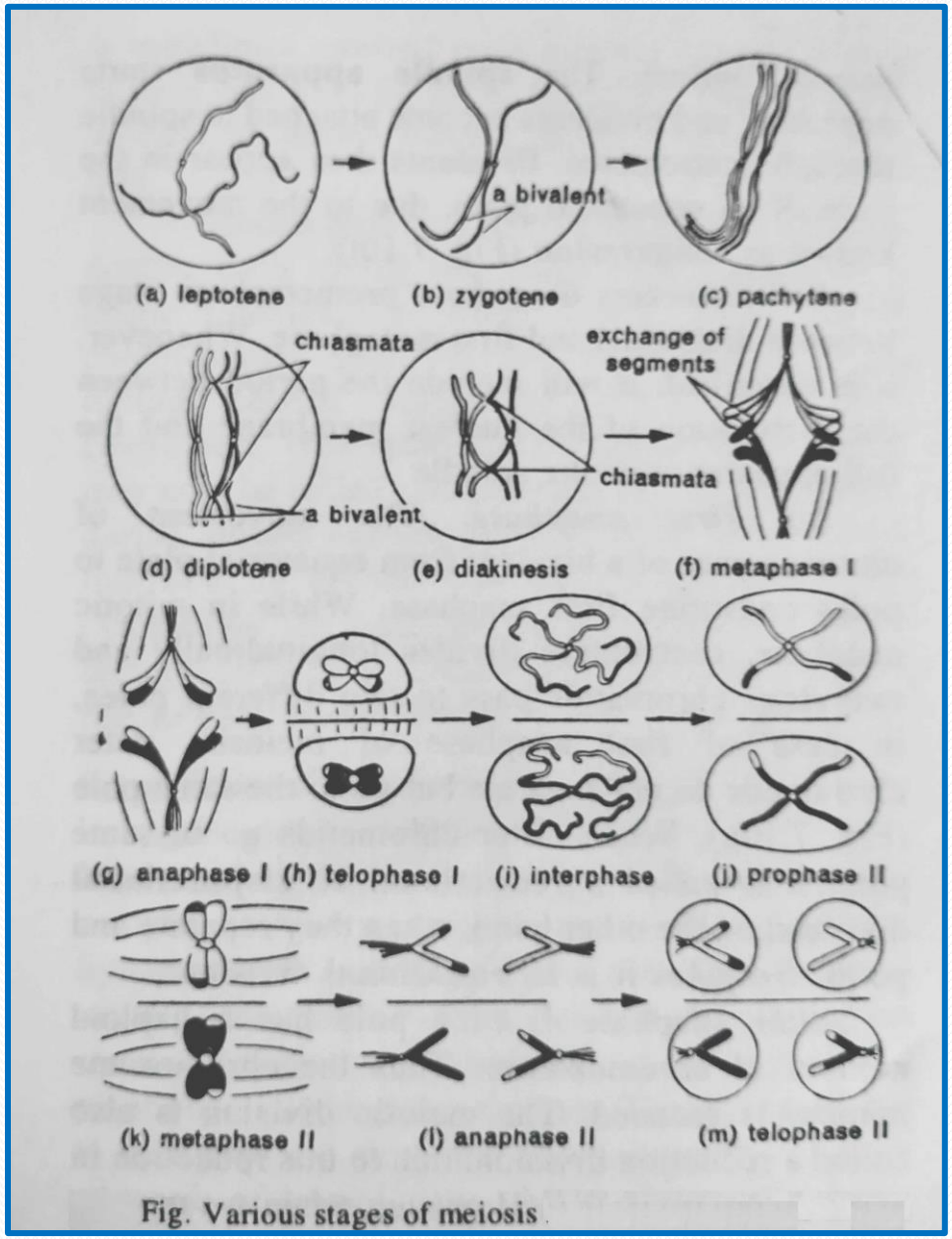

Fig. Various stages of meiosis.

divide.

In Metaphase II, a spindle apparatus is organized and the chromosomes become aligned at the equatorial plate.

In Anaphase II, the centromeres migrate to the opposite pole of the spindle, pulling the chromatids with them. Each of the two cells produced by the first division divides in telophase II, resulting into formation of four haploid cells. The chromosomes become less condensed and a nuclear membrane forms.

Significance

(i) Meiosis is necessary part of the life cycle of sexually reproducing animals and plants as it helps in restoring the definite number of chromosomes, the characteristic of a species.

(ii) The crossing over of genes between homologous chromosomes helps in exchange of genes leading to formation of new recombinants.

(iii) Meiosis is most essential for the completion of life cycle of a plant as it brings a change from diploid to haploid generation.