

CELL CYCLE AND DIVISION

Day - 3

CONTENT

PROCESS OF MEIOSIS

In meiosis two complete cell divisions follow in close sequence with or without a short interphase between them. The first meiotic division is known as reduction division or heterotypic division. The second division is known as homotypic division and is a simple mitotic division in which the two haploid cells formed as a result of heterotypic division, divide again forming four daughter cells.

Meiosis I

First prophase: This is the longest phase of meiosis, it is divided into five stages –

(a) Leptotene

- Chromosomes are long thread like with chromomeres on it.
- Volume of nucleus increases.
- Chromatin network has half chromosomes from male and half from female parent.
- Chromosome with similar structure are known as homologous chromosomes.
- Leptonemal chromosomes have a definite polarization and form loops whose ends are attached to the nuclear envelope at points near the centrioles, contained within an aster. Such peculiar arrangement is termed as bouquet.
- E.M. (Electron microscope) reveals that chromosomes are composed of paired chromatids. A dense proteinaceous filament or axial core lies within the groove between the sister chromatids of each chromosome.

(b) Zygotene

- Chromosomes condense and get shortened.
- Homologous chromosomes make pairs.
- The pairing is called synapsis.
- The main component of synaptonemal complex is protein. This synaptonemal complex was discovered by Moses.

(c) Pachytene

- Chromosomes become thick and short.
- Each chromosome pair splits longitudinally into 4 chromatids. This is called a bivalent or tetrad.
- Each tetrad has four kinetochores (two sister and two homologous).
- Non sister chromatids of bivalent show exchange or segments at molecular level.
- Synaptonemal complex helps in keeping the pairs stable.,
- Exchange of segments is called crossing over.
- Electron-Microscopy (EM) reveals a number of electron dense bodies about 100 nm in diameter at irregular intervals within the centre of the synaptonemal complex. These structures are called recombination nodules.

(d) Diplotene

CELL CYCLE AND DIVISION

- At this stage the paired chromosomes begin to separate.
- Cross is formed at the place of crossing over between non-sister chromatids.
- Homologous chromosomes move apart they remain attached to one another at specific points called chiasmata.
- At least one chiasma is formed in each bivalent.
- Chromosomes are attached only at the place of chiasmata.
- Chromatin bridges are formed in place of synaptonemal complex on chiasmata.
- This stage remains as such for long time.
- In some spermatocytes and oocytes the diplotene chromosome disperse in a particular configuration.

(e) **Diakinesis**

- Chiasmata moves towards the ends of chromosomes. This is called terminalization.
- Chromatids remain attached at the place of chiasma only.
- Nuclear membrane and nucleolus degenerates.
- Chromosome recondense and tetrad moves to the metaphase plate.

Metaphase I

- Chromosomes come on the equator.
- Due to repulsive force the chromosome segments get exchanged at the chiasmata.
- At this stage the arms are directed towards the equator and centromeres towards the poles.

Anaphase I

- Homologous chromosomes move towards different poles after exchanging some segments due to crossing over.
- Each chromosome has two chromatids undivided and attached at the centromere.

Telophase I

- Two daughter nuclei are formed but the chromosome number is half than the chromosome number of mother cell.
- Nuclear membrane reappears.
- After telophase I cytokinesis may or may not occur.
- At the end of Meiosis I either two daughter cells will be formed or a cell may have two daughter nuclei.
- Meiosis I is also termed as reduction division.
- After meiosis I, the cells in animals are reformed as secondary spermatocytes or secondary oocytes; with haploid number of chromosomes but diploid amount DNA.

Meiosis II

- Meiosis II starts just after the end of Telophase I.
- Each daughter cell (nucleus) undergoes mitotic division.
- Meiosis II is similar to mitosis.

CELL CYCLE AND DIVISION

- The various stages of meiosis II are prophase II, Metaphase II, Anaphase II and Telophase II.
- At the end of Meiosis II cytokinesis takes place.
- Four daughter cells are formed after the completion of one meiotic division.
- The chromosome number of daughter cells is haploid.
- Meiosis II is termed as equational division.
- In Meiosis I the kinetochores of homologous chromosomes are separated while in Meiosis II the sister kinetochores of one chromosome are separated.
- The four daughter cells receive one chromatid each of the tetravalent.

Significance of Meiosis

- Gametes have half the number of chromosomes than the mother cell.
- This stage is important for sexual reproduction as two gametes fuse to form a zygote.
- If the chromosome number is not reduced than after every fusion the number of chromosomes doubled in a zygote. So it is necessary that before the formation of zygote the reduction division should take place to form the gametes.
- Sexual reproduction includes one meiosis and one fusion.
- Exchange of segments give rise to new varieties.
- This process introduce genetic variations.
- The four daughter cells will have different types of chromatids.

MEIOSIS

- Meiosis
- It occurs in the germ cells during the formation of the gametes.
- Term meiosis was given by Farmer and Moore.
- It is divided into two main phases.

Meiosis I

- Heterotypic division or reduction division.
- It leads to reduction in chromosome numbers. Division of chromosome does not occurs in meiosis-I and only segregation of homologous chromosomes takes place.

Meiosis II

- Homotypic division or equational division.
- It does not leads to any change in chromosome number.
- Meiosis II is just like mitosis. Division of centromere occur in meiosis II.
- In Meiosis, division of nucleus takes place twice but division of chromosome occurs only once.
- Meiosis (Scheme)

Meiosis I

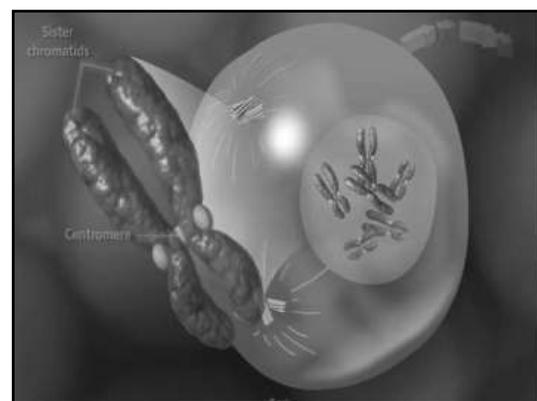
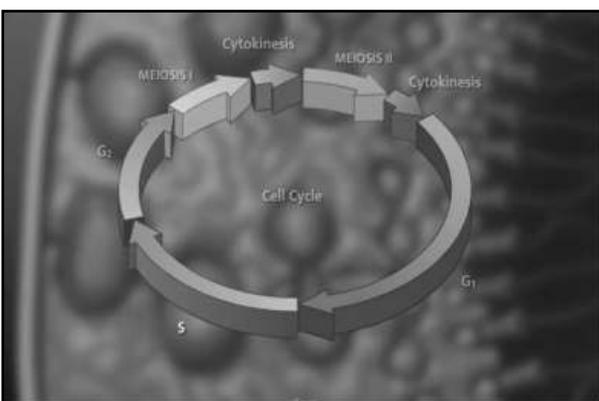
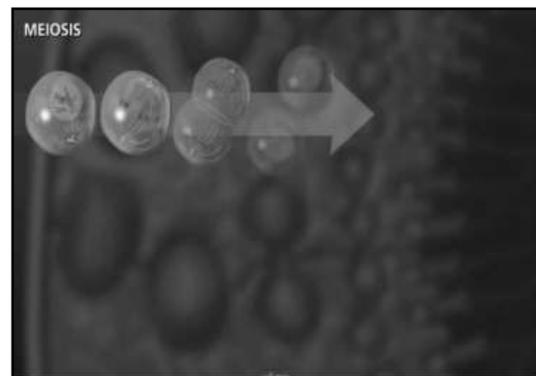
- Karyokinesis I
- Prophase I
- Leptotene
- Zygotene

CELL CYCLE AND DIVISION

- Pachytene
- Diplotene
- Diakinesis
- Metaphase I
- Anaphase I
- Telophase I
- Cytokinesis I
- Interkinesis

Meiosis II

- Karyokinesis II
- Prophase II
- Metaphase II
- Anaphase II
- Telophase II
- Cytokinesis II



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