

CELL CYCLE AND CELL DIVISION

Points To Remember :

- **Cell cycle** : The sequence of events by which a cell duplicates its genome, synthesis the other constituents of the cell and eventually divides into two daughter cells.

Phases of cell cycle :

Interphase :

- **G₁ Phase**: Cell metabolically active and grows continuously.
- **S Phase**: DNA synthesis occurs, DNA content increases from 2C to 4C. but the number of chromosomes remains same (2N).
- **G₂ Phase**: Proteins are synthesized in preparation for mitosis while cell growth continues.
- **M Phase (Mitosis Phase)**: Starts with nuclear division, corresponding to separation of daughter chromosomes (karyokinesis) and usually ends with division of cytoplasm (cytokinesis).
- **Quiescent stage (G₀)**: Cells that do not divide and exit G₁ phase to enter an inactive stage called G₀. Cells at this stage remain metabolically active but do not proliferate.

MITOSIS :

- **Prophase** :
 - Replicated chromosomes, each consisting of 2 chromatids, condense and become visible.
 - Microtubules are assembled into mitotic spindle.
 - Nucleolus and nuclear envelope disappear.
 - Centriole moves to opposite poles.
- **Metaphase** :
 - Spindle fibres attached to kinetochores (small disc-shaped structures at the surface of centromeres) of chromosomes.
 - Chromosomes line up at the equator of the spindle to form metaphase plate.
- **Anaphase** :
 - Centromeres split and chromatids separate.
 - Chromatids move to opposite poles.
- **Telophase** :
 - Chromosomes cluster at opposite poles.
 - Nuclear envelope assembles around chromosome cluster.
 - Nucleolus, Golgi complex, ER reform.

- **Cytokinesis** : Is the division of protoplast of a cell into two daughter cells after Karyokinesis (nuclear division).
- **Animal cytokinesis** : Appearance of furrow in plasma membrane which deepens and joins in the centre dividing cell cytoplasm into two.
- **Plant cytokinesis** : Formation of new cell wall begins with the formation of a simple precursor – cell plate which represents the middle lamella between the walls of two adjacent cells.

Significance of Mitosis :

- Growth – addition of cells.
- Maintenance of surface/volume ratio.
- Maintenance of chromosome number.
- Regeneration.
- Reproduction in unicellular organism.
- Repair and wound healing.

MEIOSIS :

- Specialized kind of cell division that reduces the chromosome number by half, resulting in formation of 4 haploid daughter cells.
- Occurs during gametogenesis in plants and animals.
- Involves two sequential cycles of nuclear and cell division called Meiosis I and Meiosis II.
- Interphase occurs prior to meiosis which is similar to interphase of mitosis except the S phase is prolonged.
- 4 haploid daughter cells are formed.

Meiosis I -

Prophase I : Subdivided into 5 phases.

Leptotene :

- Chromosomes make their as single stranded structures.
- Compaction of chromosomes continues.

Zygotene :

- Homologous chromosomes start pairing and this process of association is called **synapsis**.
- Chromosomal synapsis is accompanied by formation of **synaptonemal complex**.
- Complex formed by a pair of synapsed homologous chromosomes is called **bivalent** or **tetrad**.

Pachytene :

- Crossing over occurs between non-sister chromatids of homologous chromosomes.

Diplotene :

- Dissolution of synaptonemal complex occurs and the recombined chromosomes separate from each other except at the sites of crossing over. These X-shaped structures are called **chiasmata**.

Diakinesis :

- Terminalisation of chiasmata.
- Chromosomes are fully condensed and meiotic spindles assembled.
- Nucleolus disappears and nuclear envelope breaks down.

Metaphase I :

- Bivalent chromosomes align on the equatorial plate.
- Microtubules from opposite poles of the spindle attach to the pair of homologous chromosomes.

Anaphase I:

- Homologous chromosomes separate while chromatids remain associated at their centromeres.

Telophase I :

- Nuclear membrane and nucleolus reappear.
- Cytokinesis follows (diad of cells).

Interkinesis : Stage between two meiotic divisions. (Meiosis I and meiosis II)

Meiosis II -

Prophase II

- Nuclear membrane disappears.
- Chromosomes become compact.

Metaphase II

- Chromosomes align at the equator.
- Microtubules from opposite poles of spindle get attached to kinetochores of sister chromatids.

Anaphase II

- Simultaneous splitting of the centromere of each chromosome, allowing them to move towards opposite poles of the cell.

Telophase II

- Two groups of chromosomes get enclosed by a nuclear envelope.
- Cytokinesis follows resulting in the formation of tetrad of cells i.e., 4 haploid cells.

Significance of Meiosis

- Formation of gametes: In sexually reproducing organisms.
- Genetic variability
- Maintenance of chromosomal number: By reducing the chromosome number in gametes. Chromosomal number is restored by fertilisation of gametes.

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