


Chapter-10

CELL CYCLE AND CELL DIVISION

POINTS TO REMEMBER

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

Phases of cell cycle :  Interphase
M Phase (Mitosis phase)

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 synthesised 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 : (i) Replicated chromosomes, each consisting of 2 chromatids, condense and become visible.

(ii) Microtubules are assembled into mitotic spindle.

(iii) Nucleolus and nuclear envelope disappear.

(iv) Centriole moves to opposite poles.

Metaphase : (i) Spindle fibres attached to kinetochores (small disc-shaped structures at the surface of centromeres) of chromosomes.

(ii) Chromosomes line up at the equator of the spindle to form metaphase plate.

Anaphase : (i) Centromeres split and chromatids separate.

(ii) Chromatids move to opposite poles.

Telophase : (i) Chromosomes cluster at opposite poles.

(ii) Nuclear envelope assembles around chromosome cluster.

(iii) 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 :

1. Growth – addition of cells.
2. Maintenance of surface/volume ratio.
3. Maintenance of chromosome number.
4. Regeneration.
5. Reproduction in unicellular organisms.
6. Repair and wound healing.

Meiosis :

- Specialised 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 appearance 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 disappear 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

1. **Formation of gametes** : In sexually reproducing organisms.

2. **Genetic variability**

3. **Maintenance of chromosomal number** : By reducing the chromosome number in gametes. Chromosomal number is restored by fertilisation of gametes.

QUESTIONS

Very Short Answer Questions (1 mark each)

1. What are kinetochores ?
2. What is interkinesis ?
3. Why is mitosis called equational division ?
4. Name the stage of meiosis during which synaptonemal complex is formed.
5. What is G_0 phase of cell cycle ?
6. Where does mitosis take place in plants and animals?

Short Answer Questions-II (2 marks each)

7. Differentiate between cytokinesis of plant and animal cell.
8. What is chiasmata ? State its significance.

10. Give the terms for the following :

- The period between 2 successive mitotic divisions
- Cell division in which chromosome number is halved.
- Phase in cell cycle where DNA is synthesised
- Division of nuclear material.

11. What happens during S phase of interphase ?

12. Distinguish between metaphase of mitosis and metaphase I of meiosis.

13. What will be the DNA content of a cell at G_1 , after S and G_2 if the content after M phase is $2C$.

Short Answer Questions-I (3 marks each)

14. Differentiate between mitosis and meiosis.

15. List the significance of mitosis.

16. Describe the following :

- Synapase
- Bivalent
- Leptotene

Long Answer Questions (5 marks each)

17. With the help of labelled diagram, explain the following :

- Diplotene
- Anaphase of mitosis
- Prophase I

18. What is cell cycle ? Explain the events occurring in this cycle.

ANSWERS

Very Short Answers (1 mark each)

- Small disc-shaped structure at the surface of the centromeres.
- The stage between two meiotic divisions.
- The chromosome number in daughter cells is equal to that of the parent cell.
- Zygotene.
- Cells which enter a stage where they are metabolically active but no longer proliferate.

6. Plants – Meristematic tissue; Animals - somatic cells.

Short Answers-II (2 marks each)

7. Refer 'Points to Remember'.

8. Refer 'Points to Remember'.

9. Chromatin

a) Diffuse, deep staining hereditary material

b) Metabolically inert

Chromatid

longitudinally split half of a chromosome, light staining hereditary material

Metabolically active

10. a) Interphase

b) Meiosis

c) S phase

d) Karyokinesis

11. Refer 'Points to Remember'.

12.

| Metaphase | Metaphase I |
|--|---|
| (a) Chromosome align along the equator of the cell. | a) Bivalent chromosomes arrange along the equatorial plane |
| (b) Figure 10.2 (b) page 165, Text Book of Biology for Class XI. | b) Figure 10.3, meta phase I page 169, NCERT Text Book of Biology for Class XI. |

Short Answers-I (3 marks each)

13. $G_1 - 2C$, $S_1 - 4C$, $G_2 - 4C$

14. Refer 'Points to Remember'.

15. Refer 'Points to Remember'.

16. Refer 'Points to Remember'.

Long Answers (5 marks each)

17. Refer 'Points to Remember'.

18. Refer 'Points to Remember'.