Chapter-10

CELL CYCLE AND CELL DIVISION

POINTS TO REMEMBER

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

Phases of cell cycle :

Interphase :

- **G_1 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 some (2N).
- **G_2 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 (G_0) : Cells that do not divide and exit G_1 phase to enter an inactive stage called G_0. 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 centromers) 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 divison 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 organism.
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 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 **chaismata.**

Diakinesis : • Terminalisation of chaismata.

- 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 ?

Short Answer Questions-II (2 marks each)

6. Differentiate between cytokinesis of plant and animal cell.

7. What is chaismata ? State its significance.

8. What happens during S phase of interphase ?

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

Short Answer Questions-I (3 marks each)

10. Differentiate between mitosis and meiosis.

11. List the significance of mitosis.

12. Describe the following :

(a) Synapase

(b) Bivalent

(c) Leptotene

Long Answer Questions (5 marks each)

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

(a) Diplotene

(b) Anaphase of mitosis

(c) Prophase I

14. What is cell cycle ? Explain the events occuring in this cycle.

ANSWERS

Very Short Answers (1 mark)

1. Small disc-shaped structure at the surface of the centromeres.

2. The stage between two meiotic divisions.

3. The chromosome number in daughter cells is equal to that of the parent cell.

4. Zygotene.

5. Cells which enter a stage where they are metabolically active but no longer proliferate.

Short Answers-II (2 marks)

6. Refer ‘Points to Remember’.

7. Refer 'Points to Remember'.

8. Refer 'Points to Remember'.

9.

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

Short Answers-II (2 marks)

10. Refer 'Points to Remember'.

11. Refer 'Points to Remember'.

12. Refer 'Points to Remember'.

Short Answers-II (2 marks)

13. Refer 'Points to Remember'.

14. Refer 'Points to Remember'.