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 (\mathbf{G}_0) : Cells that do not divide and exit \mathbf{G}_1 phase to enter an inactive stage called \mathbf{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 pole		
Telophase : (i) Chr		omosomes 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.	Bivalent chromosomes arrange along the equatorial plane Figure 10.3, meta phase I
	(b)	Figure 10.2 (b)	page 169, NCERT Text Book of Biology for
		page 165, Text Book of	Class XI.
		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'.