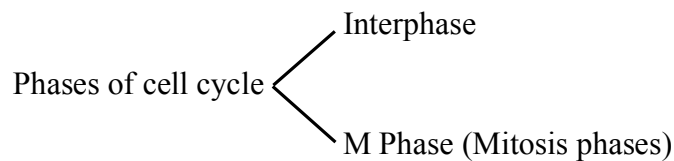


## Chapter - 10

# 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.



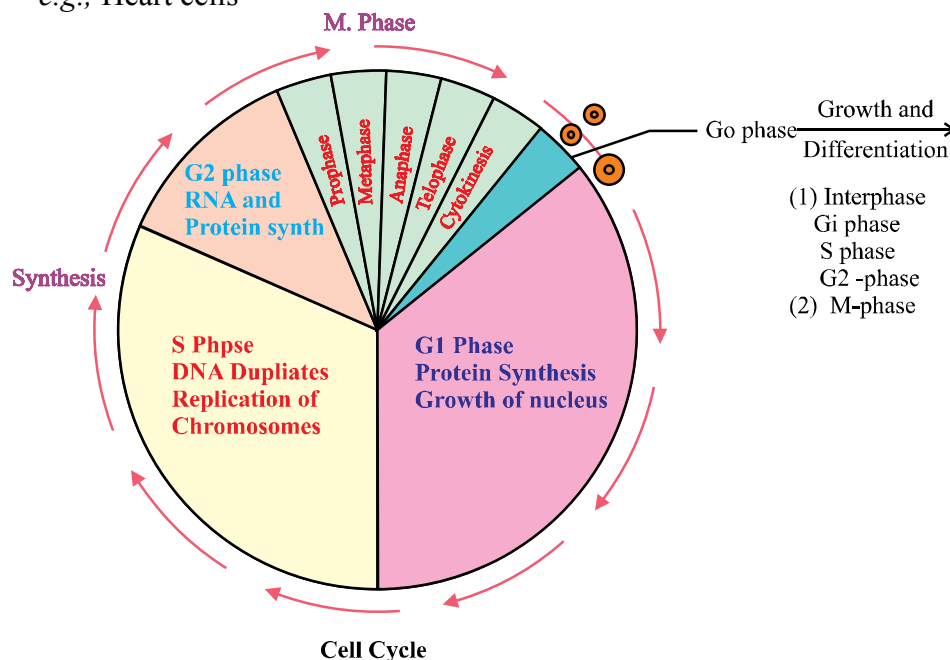
### Interphase : (Resting Phase)

- **G<sub>1</sub> Phase :** Cell metabolically active and grows continuously but does not replicate DNA
- **S Phase :** DNA synthesis occurs, DNA content increases from 2C to 4C, but the number of chromosomes remains same *i.e.*,  $2n$ .
- **G<sub>2</sub> 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<sub>0</sub>)** In adult animals cells that do not divide and exit G<sub>1</sub> phase to enter an inactive stage called G<sub>0</sub>. Cells at this stage remain metabolically active but do not proliferate.

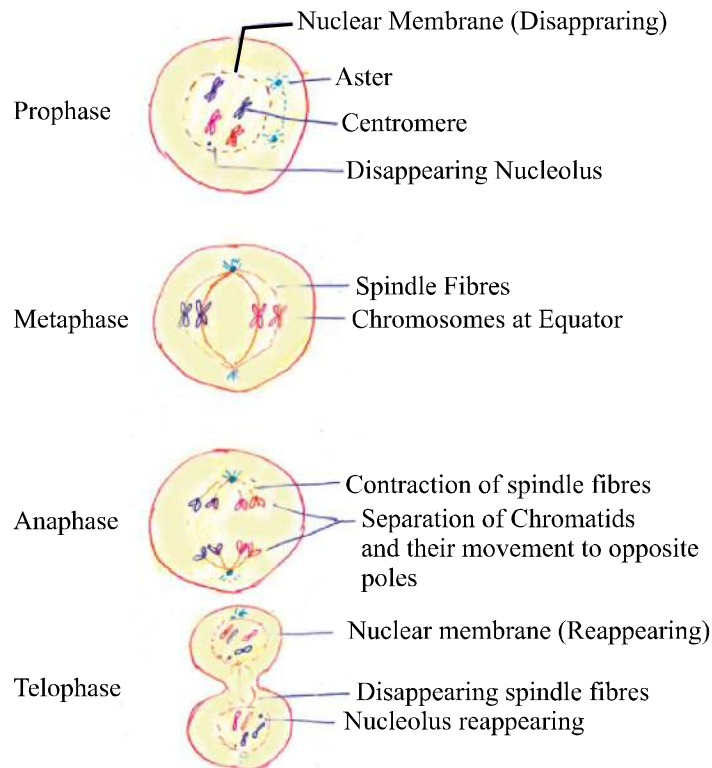
e.g., Heart cells



## Mitosis

Since the number of chromosomes in the parent and progeny cells is the same, it is called as equational division. Mitosis is divided into four sub stages.

- 1. Prophase :** (i) Replicated chromosomes, each consisting of 2 chromatids, condense and become visible.
  - (i) Microtubules are assembled into mitotic spindle.
  - (iii) Nucleolus and nuclear envelope disappear.
  - (iv) Centriole moves to opposite poles.
- 2. Metaphase :** (i) Spindle fibres attached to kinetochores (small disc-shaped structures at the surface of centromere) of chromosomes.
  - (ii) Chromosomes line up at the equator of the spindle to form metaphase plate.
- 3. Anaphase :** (i) Centromeres split and chromatids separate.
  - (ii) Chromatids move to opposite poles due to shortening of spindal fibres.
- 4. Telophase :** (i) Chromosomes cluster at opposite poles.
  - (ii) Nuclear envelope assembles around chromosomes clusters'.
  - (iii) Nucleolus, Golgi Complex, E.R. reforms.



#### Stages of Mitosis

**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.

- When karyokinesis is not followed by cytokinesis, a multinucleated condition arises. This is called **syncytium**.

#### Significance of Mitosis :

1. Growth-addition of cells.
2. Maintenance of surface/volume ratio. Maintain Nucleo—cytoplasmic ratio.
3. Maintenance of chromosomes number.
4. Regeneration.

5. Reproduction in unicellular organisms, lower plants and some insects.
6. Repair and wound healing.
7. Vegetative reproduction in plants takes place by mitosis.

## Meiosis :

- Specialised kind of cell division that reduces the chromosomes number by half. hence it is called reductional division.
- Occurs during gametogenesis in plants and animals.
- Involves two sequential cycles of nuclear and cell division called Meiosis I and Meiosis II.
- It results in 4 haploid daughter cells.
- Interphase occurs prior to meiosis which is similar to interphase of mitosis except the S phase is prolonged.

## Meiosis I

**Prophase I** : Subdivided into 5 phases.

### (i) Leptotene :

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

### (ii) 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.

**(iii) Pachytene** : Crossing over occurs between non-sister chromatids of homologous chromosomes. The enzymes involved in the process is 'recombinase'. Recombination between homologous chromosomes is completed. Exchange of genetic material.

**(iv) 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**. In oocytes of some vertebrates diplotene can last for month or years.

(v) **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 nucleus reappear.
- Cytokinesis follows (diad of cells).

**Interkinesis** : Stage between two meiotic divisions, (meiosis I and meiosis II) generally short lived.

**Meiosis II:** (It resembles the normal mitosis).

### **Prophase II**

- Nuclear membrane disappears.
- Chromosomes again 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** : Variations are very important for evolution.
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. Name the term used for the stage between two meiotic divisions.
3. Why is mitosis called equational division ?
4. Name the stage of meiosis during which synaptonemal complex is formed.
5. What is G<sub>0</sub> phase of cell cycle ?
6. Where does mitosis take place in plants and animals ?

### Short Answer Questions-I

(2 marks each)

7. Differentiate between cytokinesis of plant and animal cell.
8. What is chiasmata ? State its significance.
9. Differentiate between chromatin and chromatid.
10. Give the terms for the following :
  - (a) The period between 2 successive mitotic divisions.
  - (b) Cell division in which chromosome number is halved.
  - (c) Phase in cell cycle where DNA is synthesised.
  - (d) 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<sub>1</sub> after S and G<sub>2</sub> if the content after M phase is 2C.

### Short Answer Questions-II

(3 marks each)

14. Differentiate between mitosis and meiosis.
15. List the significance of mitosis.
16. Describe the following :
  - (a) Synapse
  - (b) Bivalent
  - (c) Leptotene

### Long Answer Questions

(5 marks each)

17. With the help of labelled diagram, explain the following :
  - (a) Diplotene
  - (b) Anaphase of mitosis
  - (c) Prophase I of meiosis

18. What is cell cycle ? Explain the events occurring in this cycle.
19. With the help of labelled diagrams, explain various stages of mitosis cell division.
20. (a) Write a note on significance of meiosis.  
 (b) Differentiate between anaphase I of meiosis and Anaphase of mitosis.  
 (c) In which phase of interphase duplication of DNA will occur ?

## Answers

### Very Short Answers

(1 mark each)

1. Small disc-shaped structure at the surface of the centromeres.
2. Interkinesis.
3. The chromosomes number in daughter cells is equal to that of the parent.
4. Zygotene.
5. Cells which enter a stage where they are Metabolically active but no longer proliferate.
6. Plant – Meristematic tissue; Animals – somatic cells.

### Short Answers-I

(2 marks each)

7. Refer 'Points to Remember'.
8. Refer 'Points to Remember'.
9. **Chromatin Chromatid :**
  - (a) Diffuse, deep staining hereditary material longitudinally split half of a chromosome, light staining hereditary material.
  - (b) Metabolically inert Metabolically active.
10. (a) Interphase  
 (b) Meiosis  
 (c) S phase  
 (d) Karyokinesis
11. Refer 'Points to Remember' :

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-II

(3 marks each)

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

14.	Mitosis	Meiosis
(a)	Occurs in Somatic cells	(a) Occurs in germ cells
(b)	Number of chromosomes remain same in daughter cells	(b) Number of chromosomes reduces to half in daughter cells.
(c)	No exchange of genetic material	(c) Exchange of genetic material occurs due to crossing over
(d)	Involve single division	(d) Involve two successive division

15. Refer 'Points to Remember'.

16. Refer 'Points to Remember'.

### Long Answer

(5 mark each)

17. Refer 'Points of Remember'.

18. Refer 'Points of Remember'.

19. Refer 'Points of Remember'.

20. (a) Refer 'Points of Remember'  
(b) Refer 'Points of Remember'.  
(c) During A phase or synthesis phase.

