Chapter 10

Cell cycle and cell division

1. What is the average cell cycle span for a mammalian cell?

Ans. The average cell cycle span for a mammalian cell is approximately 24 hours.

2. Distinguish cytokinesis from karyokinesis.

Ans. The division of cytoplasm along with cell organelles into daughter cells is called cytokinesis, while the segregation of duplicated chromosomes into daughter nuclei is called karyokinesis.

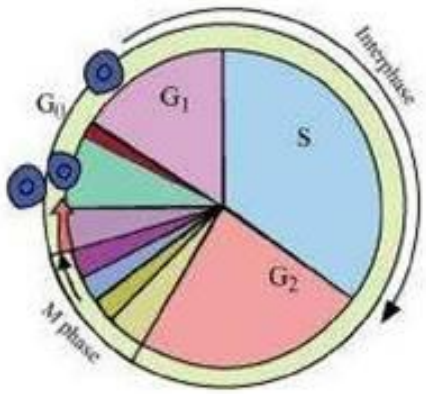
3. Describe the events taking place during interphase.

Ans. Interphase involves a series of changes that prepare a cell for division. It is the period during which the cell experiences growth and DNA replication in an orderly manner. Interphase is divided into three phases.

G_1 phase – It is the stage during which the cell grows and prepares its DNA for replication. In this phase, the cell is metabolically active.

S phase – It is the stage during which DNA synthesis occurs. In this phase, the amount of DNA (per cell) doubles, but the chromosome number remains the same.

G_2 phase – In this phase, the cell continues to grow and prepares itself for division. The proteins and RNA required for mitosis are synthesised during this stage.



4. What is G_0 (quiescent phase) of cell cycle?

Ans. G_0 or quiescent phase is the stage wherein cells remain metabolically active, but do not proliferate unless called to do so. Such cells are used for replacing the cells lost during injury.

5. Why is mitosis called equational division?

Ans. Mitosis is the process of cell division wherein the chromosomes replicate and get equally distributed into two daughter cells. The chromosome number in each daughter cell is equal to that in the parent cell, i.e., diploid. Hence, mitosis is known as equational division.

6. Name the stage of cell cycle at which one of the following events occur:

(i) Chromosomes are moved to spindle equator

(ii) Centromere splits and chromatids separate

(iii) Pairing between homologous chromosomes takes place

(iv) Crossing over between homologous chromosomes takes place

Ans. (i) Metaphase

(ii) Anaphase

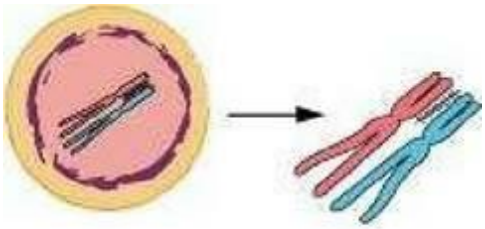
(iii) Zygotene of meiosis I

(iv) Pachytene of meiosis I

7. Describe the following:

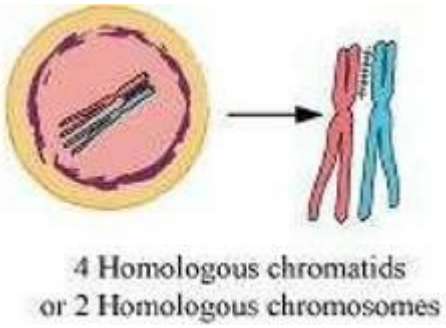
(a) synapsis (b) bivalent (c) chiasmata Draw a diagram to illustrate your answer.

Ans. (a) Synapsis: The pairing of homologous chromosomes is called synapsis. This occurs during the second stage of prophase I or zygotene.

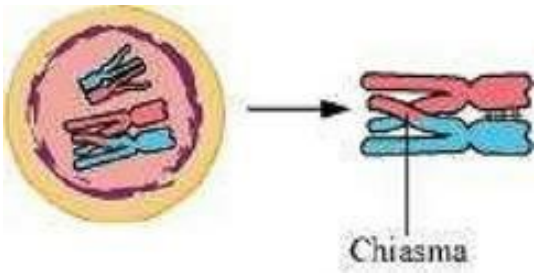


Synapsis: pairing of homologous chromosomes

(b) Bivalent: Bivalent or tetrad is a pair of synapsed homologous chromosomes. They are formed during the zygotene stage of prophase I of meiosis.



(c) Chiasmata: Chiasmata is the site where two sister chromatids have crossed over. It represents the site of cross-over. It is formed during the diplotene stage of prophase I of meiosis.



8. How does cytokinesis in plant cells differ from that in animal cells?

Ans. Differences between plant cytokinesis and animal cytokinesis

Plant Cytokinesis	Animal Cytokinesis
i.It occurs by cell plate formation. ii.The cell plate appears at the centre and extends outwards. iii.Fusion of vesicles begins cell plate formation. iv.A midbody is not formed.	i.It occurs by cleavage. ii.Cleavage begins at the periphery and proceeds inwards. iii.Cleavage is started by contraction of a peripheral ring of microfilaments. iv.A midbody of dense material is formed at the middle of the cell.

9. Find examples where the four daughter cells from meiosis are equal in size and where they are found unequal in size.

Ans. (a) Spermatogenesis or the formation of sperms in human beings occurs by the process

of meiosis. It results in the formation of four equal-sized daughter cells.

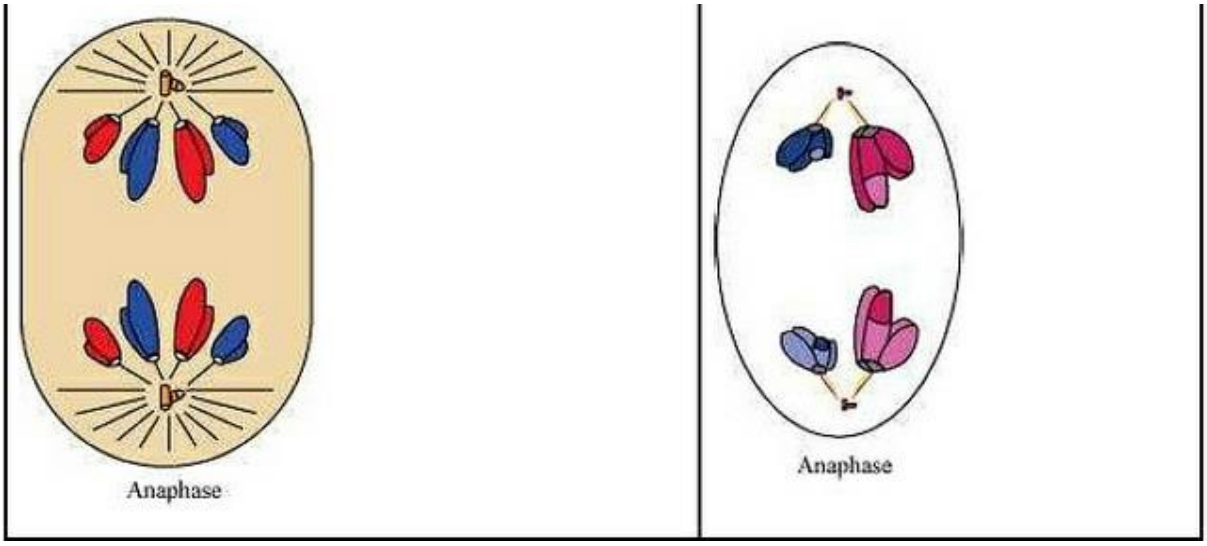
(b) Oogenesis or the formation of ovum in human beings occurs by the process of meiosis. It results in the formation of four daughter cells which are unequal in size.

10. Distinguish anaphase of mitosis from anaphase I of meiosis.

Ans. Anaphase I of Meiosis

During anaphase of mitosis, the centromere splits and the chromatids separate.

During anaphase I of meiosis, the centromere does not split and the sister chromatids remain associated at their centromeres.



11. List the main differences between mitosis and meiosis.

Ans. Differences between mitosis and meiosis

Mitosis	Meiosis
i.Takes place in somatic cells.	i.Takes place in gametic cells.
ii.Two daughter cells are formed in the end.	ii.Four daughter cells are formed in the end.
iii.The number of chromosomes remains the same in daughter cells as compared to those in	iii.The number of chromosomes is halved in daughter cells as compared to those in

parent cells.	parent cells.
iv.Chromosomes replicate before each mitotic division.	iv.Chromosomes do not replicate before the second meiotic division.

12. What is the significance of meiosis?

Ans. Significance of meiosis

1. Meiosis maintains the chromosome number from generation to generation. It reduces the chromosome number to half so that the process of fertilisation restores the original number in the zygote.

2. Variations are caused by the cross-over and the random distribution of homologous chromosomes between daughter cells. Variations play an important role in evolution.

3. Chromosomal mutations are brought about by the introduction of certain abnormalities. These chromosomal mutations may be advantageous for an individual.

13. Discuss with your teacher about

(i) haploid insects and lower plants where cell-division occurs, and

(ii) some haploid cells in higher plants where cell-division does not occur.

Ans. (i) In some insects and lower plants, fertilization is immediately followed by zygotic meiosis, which leads to the production of haploid organisms. This type of life cycle is known as haplontic life cycle.

(ii) The phenomenon of polyploidy can be observed in some haploid cells in higher plants in which cell division does not occur. Polyploidy is a state in which cells contain multiple pairs of chromosomes than the basic set. Polyploidy can be artificially induced in plants by applying colichine to cell culture.

14. Can there be mitosis without DNA replication in S phase?

Ans. Mitotic cell division cannot take place without DNA replication in S phase. Two important events take place during S phase – one is the synthesis or duplication of DNA and the other is the duplication of the centriole. DNA duplication is important as it maintains the chromosome number in the daughter cells. Mitosis is an equational division. Therefore, the duplication of DNA is an important step.

15. Can there be DNA replication without cell division?

Ans. There can be DNA replication without cell division. During cell division, the parent cell gets divided into two daughter cells. However, if there is a repeated replication of DNA without any cell division, then this DNA will keep accumulating inside the cell. This would increase the volume of the cell nucleus, thereby causing cell expansion.

An example of DNA duplication without cell division is commonly observed in the salivary glands of Drosophila. The chromosome undergoing repeated DNA duplication is known as polytene chromosome.

16. Analyse the events during every stage of cell cycle and notice how the following two parameters change

(i) Number of chromosomes (N) per cell

(ii) Amount of DNA content (C) per cell

Ans. During meiosis, the number of chromosomes and the amount of DNA in a cell change.

(i) Number of chromosomes (N) per cell During anaphase I of the meiotic cycle, the homologous chromosomes separate and

start moving toward their respective poles. As a result, the bivalents get divided into two sister chromatids and receive half the chromosomes present in the parent cell. Therefore, the number of chromosomes reduces in anaphase I.

(ii) Amount of DNA content (C) per cell During anaphase II of the meiotic cycle, the chromatids separate as a result of the splitting of the centromere. It is the centromere that holds together the sister chromatids of each chromosome. As a result, the chromatids move toward their respective poles. Therefore, at each pole, a haploid number of chromosomes and a haploid amount of DNA are present.

During mitosis, the number of chromosomes remains the same. The DNA duplicated in the S phase gets separated in the two daughter cells during anaphase. As a result, the DNA content (C) of the two newly-formed daughter cells remains the same.