Biology

(Chapter – 10)(Cell Cycle and Cell Division)

(Class – XI)

Question 1:

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

Answer 1:

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

Question 2:

Distinguish cytokinesis from karyokinesis.

Answer 2:

Cytokinesis		Karyokinesis	
(i)	Cytokinesis is the biological process involving the division of a cell's cytoplasm during mitosis or meiosis.	**(i)**	Karyokinesis is the biological process involving the division of a cell's nucleus during mitosis or meiosis.
(ii)	It is divided into four stages – prophase, metaphase, anaphase, and telophase.	**(ii)**	Stages such as prophase, metaphase, anaphase, and telophase are not present in karyokinesis.

Question 3:

Describe the events taking place during interphase.

Answer 3:

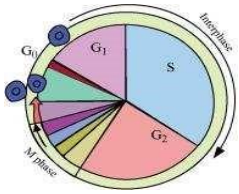
Interphase involves a series of changes that prepare a cell for division. It is the period during which the cell experiences growth and DNA replication in an orderly manner. Interphase is divided into three phases.

- G_1 phase
- S phase
- G_2 phase

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.



Question 4:

What is G_0 (quiescent phase) of cell cycle?

Answer 4:

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.

Question 5:

Why is mitosis called equational division?

Answer 5:

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.

Question 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

Answer 6:

(i) Metaphase

(ii) Anaphase

(iii) Zygotene of meiosis **I**

(iv) Pachytene of meiosis **I**

Question 7:

Describe the following:

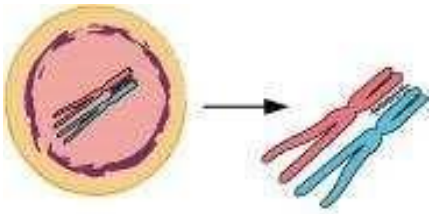
(a) synapsis **(b)** bivalent **(c)** chiasmata

Draw a diagram to illustrate your answer.

Answer 7:

(a) Synapsis

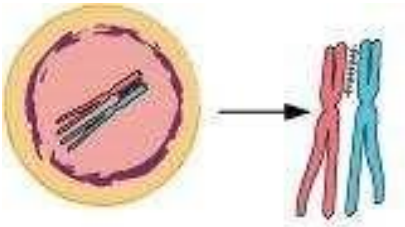
The pairing of homologous chromosomes is called synapsis. This occurs during the second stage of prophase **I** or zygotene.



Synapsis: pairing of homologous chromosomes

(b) Bivalent

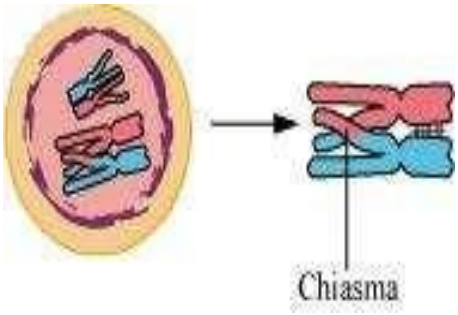
Bivalent or tetrad is a pair of synapsed homologous chromosomes. They are formed during the zygotene stage of prophase **I** of meiosis.



4 Homologous chromatids or 2 Homologous chromosomes

(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.



Question 8:

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

Answer 8:

Cytokinesis in plant cells		Cytokinesis is animal cells	
(i)	The division of the cytoplasm takes place by cell plate formation.	**(i)**	The division of the cytoplasm takes place by cleavage.
(ii)	Cell plate formation starts at the centre of the cell and grows outward, toward the lateral walls.	**(ii)**	Cleavage starts at the periphery and then moves inward, dividing the cell into two parts.

Question 9:

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

Answer 9:

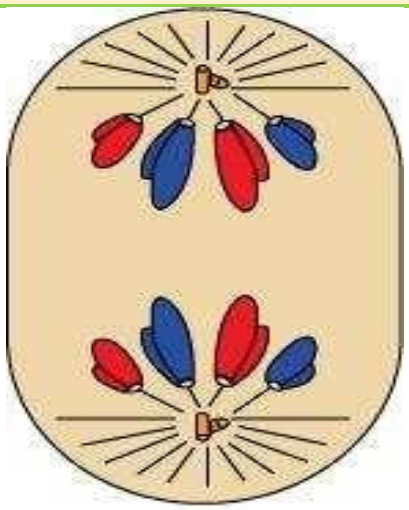
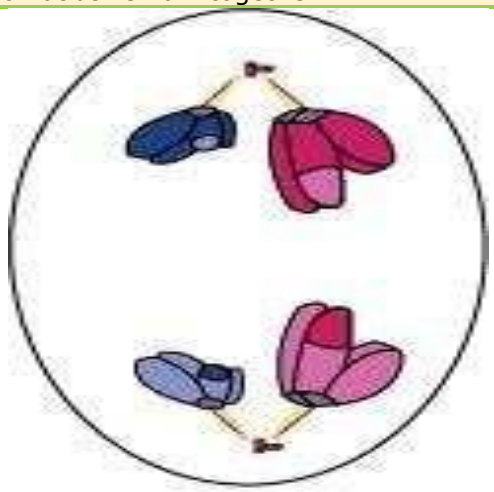
(a) Spermatogenesis or the formation of sperms in human beings occurs by the process of meiosis. It results in the formation of four equal-sized daughter cells.

(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.

Question 10:

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

Answer 10:

Anaphase of mitosis	**Anaphase I of meiosis**
Anaphase is the stage during which the centromere splits and the chromatids separate. The chromosomes move apart, toward the opposite poles. These chromosomes are genetically identical.	During anaphase **I**, the homologous chromosomes separate, while the chromatids remain attached at their centromeres. Hence, in anaphase **I**, the chromosomes of each bivalent pair separate, while the sister chromatids remain together.
 Anaphase	 Anaphase

Question 11:

List the main differences between mitosis and meiosis.

Answer 11:

	Mitosis		Meiosis
1.	In mitotic division, a single division results in two daughter cells.	**1.**	Meiotic division involves two successive divisions – meiosis **I** and meiosis **II**. These divisions result in four daughter cells.
2.	Mitosis is known as equational division. This is because the daughter cells have the same diploid number of chromosomes as the parent.	**2.**	Meiosis **I** is known as reductional division. This is because the chromosome number is reduced to half. Meiosis **II** is known as equational division. This is because the sister chromatids separate and the chromosome number remains the same.
3.	Prophase is short and does not comprise any phase.	**3.**	Prophase **I** is very long and comprises 5 phases –leptotene, zygotene, pachytene, diplotene, and diakinesis.
4.	There is no pairing of chromosomes, crossing-over, or chiasmata-formation during prophase.	**4.**	In the zygotene stage of prophase, the pairing of chromosomes occurs. During pachytene, the crossing-over occurs. The chiasmata are formed in the diplotene stage.
5.	Synaptonemal complex is not formed.	**5.**	Synaptonemal complex is formed during the zygotene stage of prophase **I**.
6.	Anaphase involves the separation of the chromatids of each chromosome.	**6.**	During anaphase **I**, the homologous chromosomes separate, while the chromatids remain attached at their centromeres. During anaphase **II**, the chromatids separate as a result of the splitting of the centromere.
7.	Mitosis plays a significant role in the healing, repair, and growth of a cell.	**7.**	Meiosis brings about variation and maintains the chromosome number from generation to generation.

Question 12:

What is the significance of meiosis?

Answer 12:

Meiosis is the process involving the reduction in the amount of genetic material. It comprises two successive nuclear and cell divisions, with a single cycle of DNA replication. As a result, at the end of meiosis II, four haploid cells are formed.

Significance of meiosis

- 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.
- Variations are caused by the cross-over and the random distribution of homologous chromosomes between daughter cells. Variations play an important role in evolution.
- Chromosomal mutations are brought about by the introduction of certain abnormalities. These chromosomal mutations may be advantageous for an individual.

Question 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.

Answer 13:

(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.

Question 14:

Can there be mitosis without DNA replication in S phase?

Answer 14:

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.

Question 15:

Can there be DNA replication without cell division?

Answer 15:

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.

Question 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

Answer 16:

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.