

Chapter 10: Cell Cycle and Cell Division

NCERT Exemplar · Class 11 · Biology

Multiple Choice Questions

Question 1

Meiosis in diploid organisms results in

A.

Production of gametes

B.

Reduction in the number of chromosomes

C.

Introduction of variation

D.

All of the above

Answer

Correct option: D

Solution

Ans: (d) All of the above

Explanation: Meiosis results in reduction of the number of chromosomes and gametes are formed only after meiosis. Crossing over during meiosis leads to variations. Hence, all the options are correct.

Question 2

At which stage of meiosis does the genetic constitution of gametes is finally decided

A.

Metaphase I

B.

Anaphase II

C.

Metaphase II

D.

Anaphase I

Answer

Correct option: D

Solution

Ans: (d) Anaphase I

Explanation: In anaphase I of meiosis, each homologous chromosome with its two chromatids and undivided centromere; moves towards the opposite poles of the cell. Hence , the actual reduction occurs in this stage which decides the genetic constitution of gamete.

Question 3

Meiosis occurs in organisms during

A.

Sexual reproduction

B.

Vegetative reproduction

C.

Both sexual and vegetative reproduction

D.

None of the above

Answer

Correct option: A

Solution

Ans: (a) Sexual reproduction

Explanation: Meiosis is the reductional division that leads to production of gametes. It is not required during vegetative reproduction. Hence, option 'a' is the correct answer.

Question 4

During anaphase-I of meiosis

A.

Homologous chromosomes separate

B.

Non-homologous autosomes separate

C.

Sister chromatids separate

D.

Non-sister chromatids separate

Answer

Correct option: A

Solution

Ans: (a) Homologous chromosomes separate

Explanation: Homologous chromosomes separate during Anaphase I.

Question 5

Mitosis is characterised by

A.

Reduction division

B.

Equal division

C.

Both reduction and equal division

D.

Pairing of homologous chromosomes

Answer

Correct option: B

Solution

Ans: (b) Equal division

Explanation: There is no reduction in chromosome number during the mitosis hence it is also called an equational division that is required for growth & repairment of cells.

Question 6

A bivalent of meiosis-I consists of

A.

Two chromatids and one centromere

B.

Two chromatids and two centromere

C.

Four chromatids and two centromere

D.

Four chromatids and four centromere

Answer

Correct option: C

Solution

Ans: (c) Four chromatids and two centromere

Explanation: Bivalent is formed by pairing of two chromosomes. Thus, bivalent contains four chromatids and two centromeres.

Question 7

Cells which are not dividing are likely to be at

A.

G_1

B.

G_2

C.

G_0

D.

S phase

Answer

Correct option: C

Solution

Ans: (c)

$$G_0$$

Explanation: Phase

$$G_0$$

is also called quiescent phase and no cell division takes place during this phase.

Question 8

Which of the events listed below is not observed during mitosis?

A.

Chromatin condensation

B.

Movement of centrioles to opposite poles

C.

Appearance of chromosomes with two chromatids joined together at the centromere.

D.

Crossing over

Answer

Correct option: D

Solution

Ans: (d) Crossing over

Explanation: Crossing over takes place only during prophase I of meiosis. It is the exchange of genetic material between homologous chromosomes that results in mixing of parental characteristics. It occurs during meiosis.

Question 9

Identify the wrong statement about meiosis

A.

Pairing of homologous chromosomes

B.

Four haploid cells are formed

C.

At the end of meiosis the number of chromosomes are reduced to half

D.

Two cycles of DNA replication occur

Answer

Correct option: D

Solution

Ans: (d) Two cycles of DNA replication occur

Explanation: Since the number of chromosomes in daughter cells is going to become half, there is no need for an additional cycle of DNA replication.

Question 10

Select the correct statement about

G_1

phase

A.

Cell is metabolically inactive

B.

DNA in the cell does not replicate

C.

It is not a phase of synthesis of macromolecules

D.

Cell stops growing

Answer

Correct option: B

Solution

Ans: (b) DNA in the cell does not replicate

Explanation: During

G_1

phase, the cell is metabolically active, continuously grows and carries out synthesis of macromolecules, but DNA synthesis does not take place during this phase.

Very Short Answer Questions**Question 1**

Between a prokaryote and a eukaryote, which cell has a shorter cell division time?

Solution

Ans: Prokaryotic cells have a shorter cell division time. Bacteria takes 30-60 mins to divide.

Question 2

Which of the phases of the cell cycle is of longest duration?

Solution

Ans: Interphase of the cell cycle is of longest duration. Its time period is generally 18-20 hours.

Question 3

Name a stain commonly used to colour chromosomes.

Solution

Ans: Acetocarmine and Giemsa stain.

Question 4

Which tissue of animals and plants exhibits meiosis?

Solution

Ans: Germ cells of male and female reproductive organs in animals and plants exhibit meiosis.

Question 5

Given that the average duplication time of E. coli is 20 minutes, how much time will two E. coli cells take to become 32 cells?

Solution

Ans: 1 hour 20 minutes required by the two E. coli cells to become 32 cells.

Number of cells after 20 minutes = 4 cells

Number of cells after 40 minutes = 8 cells

Number of cells after 60 minutes = 16 cells

Number of cells after 80 minutes = 32 cells

Question 6

Which part of the human body should one use to demonstrate stages in mitosis?

Solution

Ans: Any part containing somatic cells can be used to demonstrate stages in mitosis in human beings. Germinal cells of human body divide by the meiosis.

Question 7

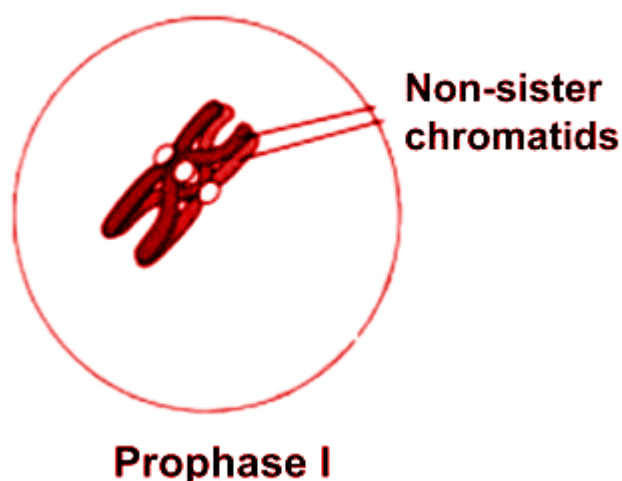
What attributes does a chromatid require to be classified as a chromosome?

Solution

Ans: There should be two identical sister chromatids attached at centre by centromere; to be classified as a chromosome.

Question 8

The diagram shows a bivalent at prophase-I of meiosis. Which of the four chromatids can cross over?



Solution

Ans: In this case, non-sister chromatids can cross over. It is important to remember that crossing over always takes place between two non-sister chromatids and never between two sister chromatids.

Question 9

If a tissue has at a given time 1024 cells, how many cycles of mitosis had the original parental single cell undergone?

Solution

Ans: The product of each cycle of mitosis is 2 daughter cells. One can solve the above problem via the formula-: No. of daughter cells = $2^{\text{no. of cycles}}$. Hence, the cell must undergo 10 rounds of mitosis to produce 1024 cells.

Question 10

An anther has 1200 pollen grains. How many pollen mother cells must have been there to produce them?

Solution

Ans:

$$\frac{1200}{4} = 300$$

This is because one mother cell produces four daughter cells after meiosis. Hence, 300 pollen mother cells are required to produce 1200 pollen grains.

Question 11

At what stage of cell cycle does DNA synthesis take place?

Solution

Ans: DNA synthesis takes place during the S phase of the cell cycle.

Question 12

It is said that the one cycle of cell division in human cells (eukaryotic cells) takes 24 hours. Which phase of the cycle do you think occupies the maximum part of the cell cycle?

Solution

Ans: Interphase occupies the maximum part of the cell cycle. Its time period is generally 18-20 hours.

Question 13

It is observed that heart cells do not exhibit cell division. Such cells do not divide further and exit _____ phase to enter an inactive stage called _____ of cell cycle. Fill in the blanks.

Solution

Ans:

G_1

phase, quiescent phase

G_0

.

Question 14

In which phase of meiosis are the following formed? Choose the answers from hint points given below.

- (a) Synaptonemal complex _____
- (b) Recombination nodules _____
- (c) Appearance/activation of _____ enzyme recombinase
- (d) Termination of chiasmata _____
- (e) Interkinesis _____
- (f) Formation of dyad of cells _____

Hint-:

1) Zygotene

2) Pachytene

3) Pachytene

4) Diakinesis

5) After Telophase-I /before Meiosis-II

6. Telophase-I /After Meiosis-I

Solution

Ans:

- a. Zygotene
 - b. Pachytene
 - c. Telophase - I/After Meiosis – I
 - d. Diakinesis
 - e. After Telophase - I/before Meiosis – II
 - f. Pachytene
-

Short Answer Questions

Question 1

State the role of centrioles other than spindle formation.

Solution

Ans: The role of centrioles other than spindle formation are-:

1. Formation of basal body of cilia and flagella.
 2. Formation of microtubules.
 3. Formation of sperm tail.
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Question 2

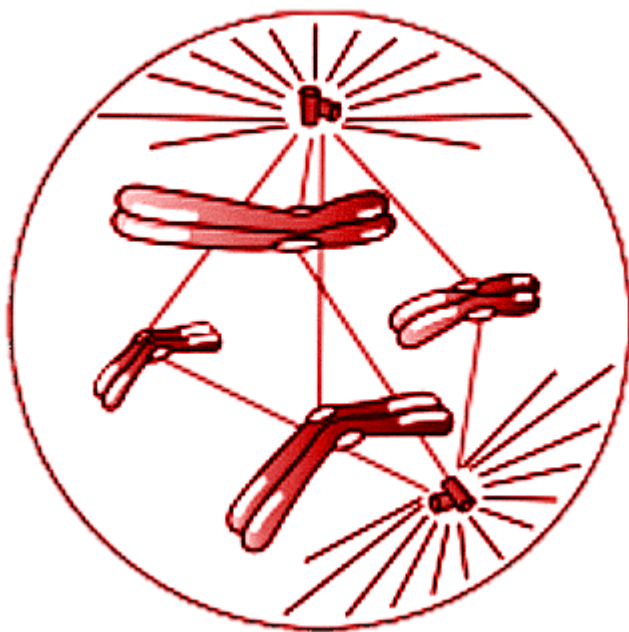
Mitochondria and plastids have their own DNA (genetic material). What is known about their fate during nuclear division like mitosis?

Solution

Ans: Extra-genomic DNA is found in mitochondria and plastids. It has nothing to do with the division of the nucleus during mitosis. As a result, extra-genomic DNAs are unaffected by karyokinesis during cell division.

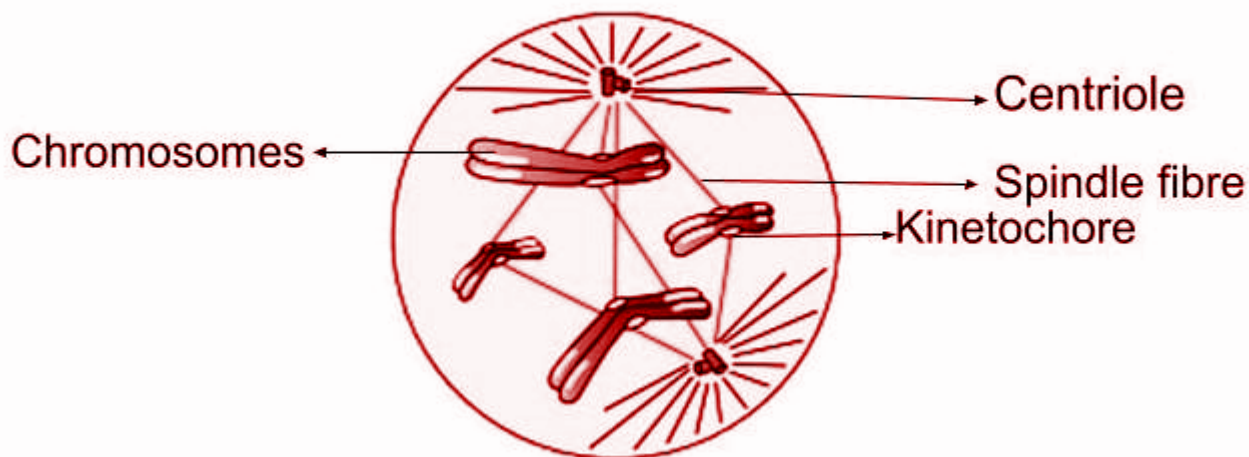
Question 3

Label the diagram and also determine the stage at which this structure is visible.



Solution

Ans: This figure shows the transition from prophase to metaphase during mitosis.



Question 4

A cell has 32 chromosomes. It undergoes mitotic division. What will be the chromosome number (N) during metaphase? What would be the DNA content (C) during anaphase?

Solution

Ans: We know that DNA replication takes place during S phase and hence, the DNA content becomes double just after the S phase; and will remain so during the whole event of mitosis.

Question 5

While examining the mitotic stage in a tissue, one finds some cells with 16 chromosomes and some with 32 chromosomes. What possible reasons could you assign to this difference in chromosome number? Do you think cells with 16 chromosomes could have arisen from cells with 32 chromosomes or vice versa?

Solution

Ans: Because of mosaicism, this can happen. Mosaicism refers to the coexistence of two populations of cells with different genotypes in a single person. Mosaicism can occur due to a variety of factors, including nondisjunction, anaphase lag, and endoreplication.

Mosaicism appears to be caused primarily by anaphase lag. The cells with 16 chromosomes must have developed from those with 32 chromosomes in this case.

Question 6

The following events occur during the various phases of the cell cycle, Name the phase against each of the events.

- a. Disintegration of nuclear membrane
- b. Appearance of nucleolus
- c. Division of centromere
- d. Replication of DNA

Solution

Ans:

- a. Disintegration of nuclear membrane occurs in prophase.
- b. Appearance of nucleolus occurs in telophase.
- c. Division of centromere occurs in anaphase.
- d. Replication of DNA occurs in S-phase.

Question 7

Mitosis results in producing two cells which are similar to each other. What would be the consequence if each of the following irregularities occur during mitosis?

- a. Nuclear membrane fails to disintegrate
- b. Duplication of DNA does not occur
- c. Centromeres do not divide
- d. Cytokinesis does not occur.

Solution

Ans: If the nuclear membrane fails to disintegrate, then the spindle fibres would not be able to reach chromosomes. Due to that, the chromosomes would not be able to reach the opposite poles of the cell.

Ans: If DNA duplication does not take place, then the cell may not be able to reach the M phase. This will result in cessation of the cell cycle.

Ans: If division of centromeres does not take place, then one of the daughter cells will get a complete pair of chromosomes and another daughter cell will get none. This may result in trisomy. Trisomy is a type of abnormal number of chromosomes, i.e. aneuploidy.

Ans: If cytokinesis does not occur, then a cell with a multinucleate condition would be formed.

Question 8

Both unicellular and multicellular organisms undergo mitosis. What are the differences, if any, observed in the process between the two?

Solution

Ans: The differences are:

Mitosis in unicellular organisms	Mitosis in multicellular organisms
1. The cell is directly divided into two parts. This type of cell division is known as amitosis	1. Karyokinesis (division of nucleus) takes place before the division of cytoplasm (cytokinesis)
2. Duplication of DNA content takes place simultaneously with the division of nucleus	2. Duplication of DNA occurs in separate phase i.e. S phase.

Question 9

Name the pathological condition when uncontrolled cell division occurs.

Solution

Ans: The pathological condition that occurs due to uncontrolled cell division is called malignancy. The disease which happens because of malignancy is called cancer.

Question 10

Two key events take place, during S phase in animal cells, DNA replication and duplication of centriole. In which parts of the cell do events occur?

Solution

Ans: DNA replication takes place in the nucleus. Duplication of centriole takes place in the cytoplasm.

Question 11

Comment on the statement – Meiosis enables the conservation of specific chromosome number of each species even though the process per se, results in reduction of chromosome number.

Solution

Ans: Meiosis is called reduction division because the number of chromosomes in daughter cells becomes half of the number of chromosomes in mother cells. In spite of this, meiosis enables the conservation of specific chromosome numbers of each species. In fact, if there has been no meiosis, organisms would not have been able to evolve to sexual mode of reproduction. We know that fertilization involves fusion of male and female gametes. Hence, the zygote gets the chromosome pool from two cells and the number of chromosomes in a zygote becomes double that of the gametes. To maintain the specific no. of chromosomes after fertilization, it is necessary that the gametes should have half the number of chromosomes compared to what it is in somatic cells.

Question 12

Name a cell that is found arrested in the diplotene stage for months and 1 years. Comment in 2-3 lines how it completes cell cycle?

Solution

Ans: This happens in mammalian oocytes. In female mammals, the egg formation begins while the female is still inside the womb. But meiosis gets arrested in the diplotene stage itself. This pause remains till the female attains sexual maturity. Once she enters the adolescence phase, meiosis gets resumed but this does not happen to all the oocytes. This happens in the phased manner because in each ovulation cycle; only a certain number of eggs are released by the ovary. For example; in human beings, only one egg is released roughly once in a month. The whole process continues till the cessation of reproductive capability in the female.

Question 13

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

Solution

Ans: The difference between cytokinesis in plant cells and in animal cells are as follows:-

Cytokinesis in Plant Cell	Cytokinesis in Animal Cell
i. Division of cytoplasm takes place by cell plate formation.	i. Division of cytoplasm takes place by formation of a cleavage furrow.
ii. Cell plate formation begins at the centre and moves towards the periphery.	ii. Cleavage begins at the periphery and moves towards the centre.

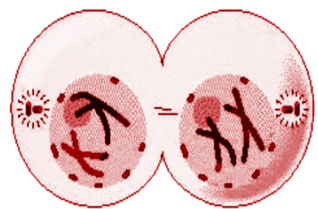
Long Answer Questions

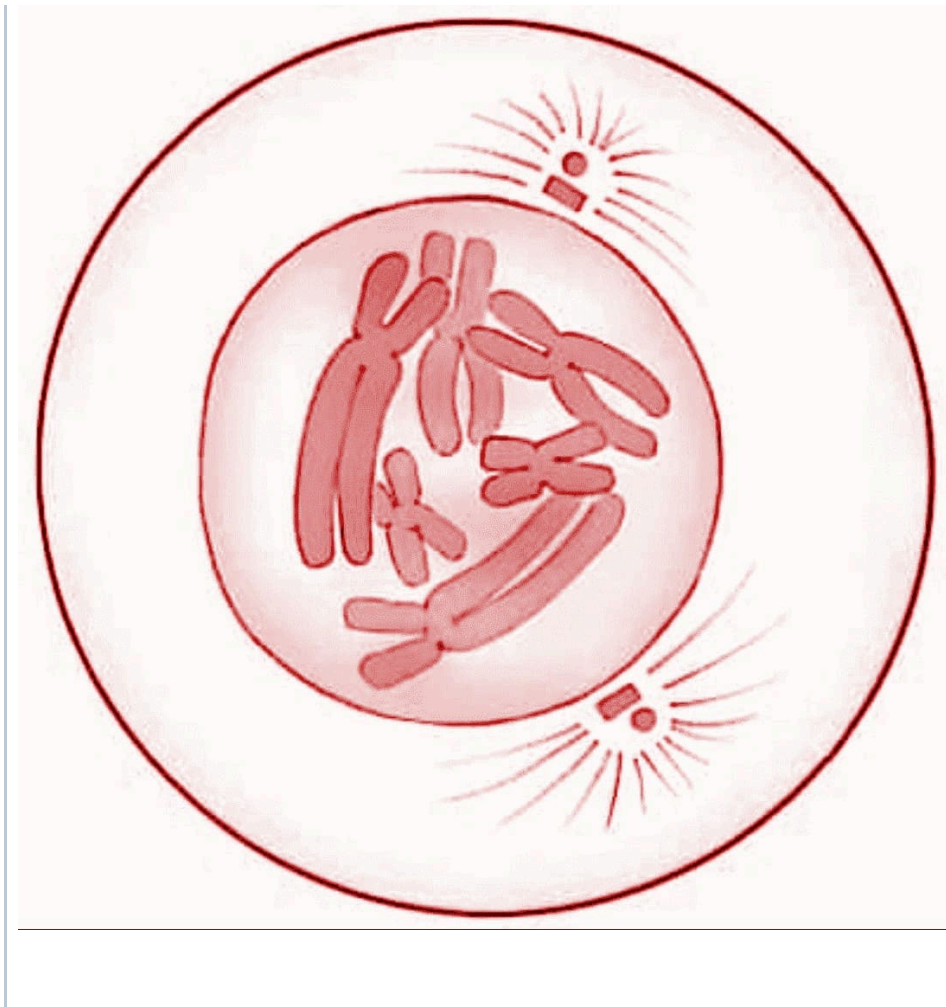
Question 1

Comment on the statement — Telophase is the reverse of prophase.

Solution

Ans: Following contrasting features of prophase and telophase show that telophase is the reverse of prophase.

Prophase	Telophase
i. Mitochondria, ER, Golgi Complex, etc. disappear.	i. Mitochondria, ER, Golgi Complex, etc. reappear.
ii. Nuclear membrane disintegrates.	ii. Nuclear membrane gets reformed.
iii. Chromosomes become clearly visible.	iii. Chromosomes lose their visible identity.
	

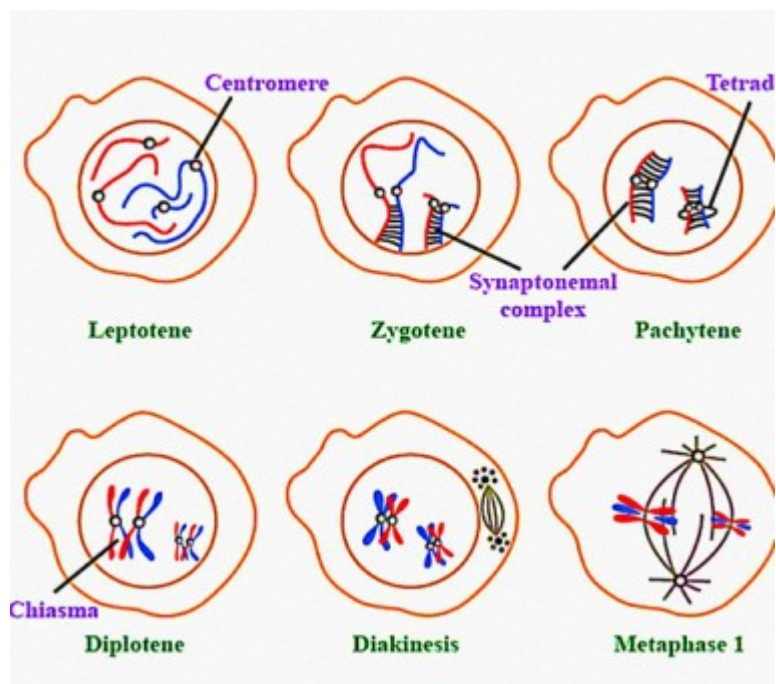


Question 2

What are the various stages of meiotic prophase-I? Enumerate the chromosomal events during each stage?

Solution

Ans: Following are the various stages of meiotic prophase – I:



a. **Leptotene**: In this stage, chromosomes are visible clearly under the light microscope. The chromosomal compaction continues through this stage. The bond between the sister chromatids is so much that one cannot be differentiated from another.

b. **Zygotene**: During this stage, chromosomes start forming the pairs. This process is called synapsis. Formation of synapsis is accompanied by formation of synaptonemal complexes. Each & every pair is called a bivalent or the tetrad.

c. **Pachytene**: The bivalent chromosomes are distinct & the recombination nodules (site at which crossing over takes place) appear on the tetrads. The process of crossing over takes place between non-sister chromatids of homologous chromosomes & it facilitates exchange of genes between them.

d. **Diplotene**: During this stage, the synaptonemal complex gets dissolved & the recombined chromosomes begin to separate from each other. But they remain attached at the site of crossing over. This makes an X-shaped structure that is termed as chiasmata.

e. **Diakinesis**: Chiasmata is terminated at this stage. Nucleolus as well as the nuclear membrane disappears.

Question 3

Differentiate between the events of mitosis and meiosis.

Solution

Ans: The following are the differences between mitosis and meiosis:-

Event	Mitosis	Meiosis
Prophase	The prophase lasts for a shorter period of time. At this point, the chromosomes are not distinguishable. Two distinct chromatids can be seen on chromosomes. During this stage, there is no crossing over. The prophase is straightforward and devoid of sub-stages.	Prophase–I is the longer of the two phases, while prophase–II is the shorter of the two. Chromosomes are distinct from one another. Prophase–I chromosomes do not have distinct chromatids. The chiasmata is formed, and the crossing over occurs.
Metaphase	There is only one metaphasic plate. Chromosomes are self-contained and do not have any connections. The chromosomes' limbs are pointing in different directions. A chromosome's two chromatids are genetically identical.	During metaphase–I, two metaphasic plates form, but during metaphase–II, only one metaphasic plate forms. The chromosomes that are homologous are linked together. The chromosomes' limbs point to the centre. A chromosome's two chromatids are usually genetically distinct.

Anaphase	Two centromeres are formed when a centromere splits along its length. Single-stranded chromosomes are found in all living organisms. Chromosomes that are similar move to opposite poles.	Centromeres do not divide during anaphase–I; however, centromere division occurs during anaphase–II. In anaphase–I, double-stranded chromosomes are present, but single-stranded chromosomes are present in anaphase–II. Dissimilar chromosomes move in opposite directions.
Telophase	Telophase lasts a little longer. It causes interphase nuclei to form.	Telophase–I is the shortest phase.
Cytokinesis	Every mitosis is followed by cytokinesis. At the end, two daughter cells are formed.	After meiosis–I, cytokinesis takes place, but not before meiosis–II. At the end of meiosis–II, there are four daughter cells.

Question 4

Write brief note on the following

a. Synaptonemal complex:

b. Metaphase plate:

Solution

Ans: Protein makes up the synaptonemal complex. During meiosis, it is formed between two homologous chromosomes. Pairing, synapsis, and recombination all take place here. The homologous chromosomes are paired through the synaptonemal complex during prophase–I of meiosis. This complex facilitates the exchange of genes. Synaptonemal complexes play a role in the recombination of genetic characters.

Ans: Metaphase plate is an imaginary line which is equidistant from the two centrosome poles. During metaphase, the chromosomes assemble at the metaphase plate. The even alignment of chromosomes is due to the opposing kinetochore microtubules.

Question 5

Write briefly the significance of mitosis and meiosis in multicellular organisms.

Solution

Ans:

Significance of Mitosis:

1. Mitosis facilitates development of single-cell zygote into a full-grown organism
2. It facilitates the repair of worn out or damaged tissues.
3. It facilitates the vegetative propagation in flowering plants.
4. It facilitates regeneration in some animals; like Planaria.

Significance of Meiosis:

1. Meiosis ensures that the number of chromosomes becomes diploid in gametes. This helps in ensuring conservation of specific chromosomal numbers in each species.
2. Meiosis facilitates genetic variability in populations & This is because of crossing over events that occur during prophase-I.

Question 6

An organism has two pairs of chromosomes (i.e., chromosome number = 4). Diagrammatically represent the chromosomal arrangement during different phases of meiosis-II.

Solution

Ans: The following diagram shows different phases of meiosis—II of an organism which has two pairs of chromosomes.

