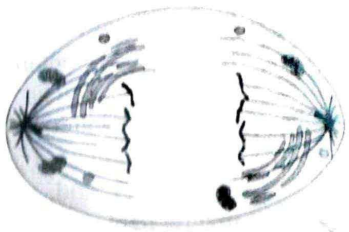
CHAPTER



10 Cell Cycle and Cell Division

10.1. Cell Cycle

1. Match List-I with List-II:

List-I	List-II
(a) Cells are metabolically active and proliferate	(i) G_2 phase
(b) DNA replication takes place	(ii) G_1 phase
(c) Proteins are synthesised	(iii) G_0 phase
(d) Quiescent stage with metabolically active cells	(iv) S phase

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iv)	(ii)	(iii)	(i)
(B)	(i)	(iii)	(iv)	(ii)
(C)	(ii)	(i)	(iii)	(iv)
(D)	(ii)	(iv)	(i)	(iii)

[Re-NEET 2024]

2. Among eukaryotes, replication of DNA takes place in:

(A) G_1 phase (B) G_2 phase

(C) M phase (D) S phase **[NEET 2023]**

3. Match List I with List II:

List I	List II
(a) M Phase	(i) Proteins are synthesized
(b) G_2 Phase	(ii) Inactive phase
(c) Quiescent stage	(iii) Interval between mitosis and initiation of DNA replication
(d) G_1 Phase	(iv) Equational division

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iv)	(i)	(ii)	(iii)
(B)	(ii)	(iv)	(i)	(iii)
(C)	(iii)	(ii)	(iv)	(i)
(D)	(iv)	(ii)	(i)	(iii)

[NEET 2023, 21]

4. Given below are two statements:

Statement I: During G_0 phase of cell cycle, the cell is metabolically inactive.

Statement II: The centrosome undergoes duplication during S phase of interphase.

In the light of the above statements, choose the most appropriate answer from the options given below:

(A) Statement I is correct but Statement II is incorrect.

(B) Statement I is incorrect but Statement II is correct.

(C) Both Statement I and Statement II are correct

(D) Both Statement I and Statement II are incorrect.

[NEET 2023]

5. The fruit fly has 8 chromosomes (2n) in each cell. During interphase of Mitosis if the number of chromosomes at G_1 phase is 8, what would be the number of chromosomes after S phase?

(A) 8 (B) 16

(C) 4 (D) 32 **[NEET 2021]**

6. The centriole undergoes duplication during:

(A) S phase (B) Prophase

(C) Metaphase (D) G_2 phase **[NEET 2021]**

7. Match the following (Columns) events that occur in their respective phases of cell cycle and select the correct option from the codes given below.

Column I	Column II
(a) G_1 phase	(i) Cell grows and organelle duplication
(b) S phase	(ii) DNA replication and chromosome duplication
(c) G_2 phase	(iii) Cytoplasmic growth
(d) Metaphase in M phase	(iv) Alignment of chromosomes

Select the correct option.

	(a)	(b)	(c)	(d)
(A)	(ii)	(iii)	(iv)	(i)
(B)	(iii)	(iv)	(i)	(ii)
(C)	(iv)	(i)	(ii)	(iii)
(D)	(i)	(ii)	(iii)	(iv)

[NEET Oct. 2020]

8. Some dividing cells exit the cell cycle and enter vegetative inactive stage. This is called quiescent stage (G_0). This process occurs at the end of:
(A) G_1-phase (B) S-phase
(C) G_2-phase (D) M-phase.
[NEET Sept. 2020]

9. Cells in G_0 phase:
(A) enter the cell cycle
(B) suspend the cell cycle
(C) terminate the cell cycle
(D) exit the cell cycle. **[NEET National 2019]**

10. DNA replication in bacteria occurs:
(A) during S-phase (B) within nucleolus
(C) prior to fission (D) just before transcription.
[NEET 2017]

11. During cell growth, DNA synthesis takes place in:
(A) S-phase (B) G_1-phase
(C) G_2-phase (D) M-phase.
[NEET Phase-II 2016, AIPMT 2000]

12. A somatic cell that has just completed the S phase of its cell cycle, as compared to gamete of the same species has:
(A) twice the number of chromosomes and twice the amount of DNA.
(B) same number of chromosomes but twice the amount of DNA.
(C) twice the number of chromosomes and four times the amount of DNA.
(D) four times the number of chromosomes and twice the amount of DNA. **[AIPMT Cancelled 2015]**

13. During which phase(s) of cell cycle, amount of DNA in a cell remains at 4C level if the inital amount is denoted as 2C?
(A) G_0 and G_1 (B) G_1 and S
(C) Only G_2 (D) G_2 and M **[AIPMT 2014]**

14. In S phase of the cell cycle:
(A) amount of DNA doubles in each cell.
(B) amount of DNA remains same in each cell.
(C) chromosome number is increased.
(D) amount of DNA is reduced to half in each cell.
[AIPMT 2014]

15. At what stage of the cell cycle, histone proteins are synthesised in a eukaryotic cell?
(A) During G_2 stage of prophase
(B) During S phase
(C) During entire prophase
(D) During telophase. **[AIPMT 2005]**

16. In the somatic cell cycle:
(A) in G_1 phase DNA content is double the amount of DNA present in the original cell.
(B) DNA replication takes place in S phase.
(C) a short inter phase is followed by a long mitotic phase.
(D) G_2 phase follows mitotic phase. **[AIPMT 2004]**

17. Which one of the following precedes reformation of the nuclear envelope during M phase of the cell cycle?
(A) Decondensation from chromosomes, and reassembly of the nuclear lamina.
(B) Transcription from chromosomes, and reassembly of the nuclear lamina.
(C) Formation of the contractile ring, and formation of the phragmoplast.
(D) Formation of the contractile ring, and transcription from chromosomes. **[AIPMT 2004]**

18. A bacterium divides every 35 minutes. If a culture containing 10^5 cells per ml is grown for 175 minutes, what will be the cell concentration per ml after 175 minutes?
(A) 5×10^5 cells (B) 35×10^5 cells
(C) 32×10^5 cells (D) 175×10^5 cells
[AIPMT 1998]

19. Which one of the following structures will not be common to mitotic cells of higher plants?
(A) Cell plate (B) Centriole
(C) Centromere (D) Spindle fibres
[AIPMT 1997]

10.2. M Phase

20. Spindle fibers attach to kinetochores of chromosomes during:
(A) Metaphase (B) Anaphase
(C) Telophase (D) Prophase **[NEET 2024]**

21. Following are the stages of cell division:
(I) Gap 2 phase (II) Cytokinesis
(III) Synthesis phase (IV) Karyokinesis
(V) Gap 1 phase
Choose the correct sequence of stages from the options given below:
(A) (V)-(II)-(IV)-(I)-(III) (B) (II)-(IV)-(V)-(I)-(III)
(C) (V)-(III)-(I)-(IV)-(II) (D) (III)-(V)-(IV)-(I)-(II)
[NEET 2024]

22. Which one of the following never occurs during mitotic cell division?
(A) Movement of centrioles towards opposite poles
(B) Pairing of homologous chromosomes

(C) Coiling and condensation of the chromatids
(D) Spindle fibres attach to kinetochores of chromosomes

[NEET 2022]

23. Select the incorrect statement with reference to mitosis:
(A) spindle fibres attach to centromere of chromosomes.
(B) chromosomes decondense at telophase.
(C) splitting of centromere occurs at anaphase.
(D) all the chromosomes lie at the equator at metaphase.

[NEET 2022]

24. Attachment of spindle fibres to kinetochores of chromosomes becomes evident in:
(A) anaphase (B) telophase
(C) prophase (D) metaphase.

[NEET Oct. 2020]

25. Which of the following options gives the correct sequences of events during mitosis?
(A) Condensation → nuclear membrane disassembly → crossing over → segregation → telophase
(B) Condensation → nuclear membrane disassembly → arrangement at equator → centromere division → segregation → telophase
(C) Condensation → crossing over → nuclear membrane disassembly → segregation → telophase
(D) Condensation → arrangement at equator → centromere division → segregation → telophase

[NEET 2017]

26. Which of the following is not a characteristic feature of mitosis in somatic cells?
(A) Disappearance of nucleolus
(B) Chromosome movement
(C) Synapsis
(D) Spindle fibres **[NEET Phase-I 2016]**

27. A cell at telophase stage is observed by a student in a plant brought from the field. He tells his teacher that this cell is not like other cells at telophase stage. There is no formation of cell plate and thus the cell is containing more number of chromosomes as compared to other dividing cells. This would result in:
(A) polyploidy (B) somaclonal variation
(C) polyteny (D) aneuploidy.

[NEET Phase-I 2016]

28. During the metaphase stage of mitosis, spindle fibres attach to chromosomes at:
(A) kinetochore
(B) both centromere and kinetochore
(C) centromere, kinetochore and are as adjoining centromere
(D) centromere.

[NEET Karnataka 2013, AIPMT Mains 2011]

29. A stage of mitosis is shown in the diagram. Which stage is it and what are its characteristics?

(A) Metaphase – Spindle fibers attached to kinetochores, centromeres split and chromatids separate.
(B) Metaphase – Chromosomes moved to spindle equator, chromosomes made up of two sister chromatids.
(C) Anaphase – Centromeres split and chromatids separate and start moving away.
(D) Late prophase – Chromosomes move to spindle equator. **[NEET Karnataka 2013]**

30. Select the correct option with respect to mitosis.
(A) Chromatids start moving towards opposite poles in telophase.
(B) Golgi complex and endoplasmic reticulum are still visible at the end of prophase.
(C) Chromosomes move to the spindle equator and get aligned along equatorial plate in metaphase.
(D) Chromatids separate but remains in the centre of the cell in anaphase. **[AIPMT Screening 2011]**

31. What would be the number of chromosomes of the aleurone cells of a plant with 42 chromosomes in its root tip cells?
(A) 63 (B) 84
(C) 21 (D) 42

[AIPMT Screening 2011]

32. Which stages of cell division do the following figures (a) and (b) represent respectively?

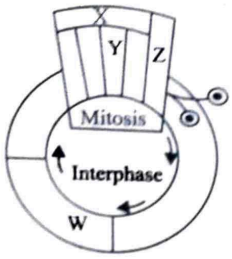
(a)

(b)

(a)	(b)
(A) Metaphase	Telophase
(B) Telophase	Metaphase
(C) Late anaphase	Prophase
(D) Prophase	Anaphase

[AIPMT Screening 2010]

33. Given below is a schematic break-up of the phases/stages of cell cycle.



Which one of the following is the correct indication of the stage/phase in the cell cycle?

(A) Y-Metaphase (B) Z-Karyokinesis
(C) W-Synthesis phase (D) X-Cytokinesis

[AIPMT Screening 2009]

34. If you are provided with root-tips of onion in your class and are asked to count the chromosomes. Which of the following stages can you most conveniently look into?

(A) Metaphase (B) Telophase
(C) Anaphase (D) Prophase **[AIPMT 2004]**

35. How many mitotic divisions are needed for a single cell to make 128 cells?

(A) 7 (B) 14
(C) 28 (D) 84 **[AIPMT 1997]**

36. Best stage to observe shape, size and number of chromosomes is:

(A) interphase (B) metaphase
(C) prophase (D) telophase. **[AIPMT 1994]**

10.3. Significance of Mitosis

37. Best material for the study of mitosis in laboratory is:

(A) anther (B) root tip
(C) leaf tip (D) ovary. **[AIPMT 2002]**

38. If a diploid cell is treated with colchicine then it becomes:

(A) triploid (B) tetraploid
(C) diploid (D) monoploid.

[AIPMT 2002]

39. Colchicine is an inhibitory chemical, which:

(A) stops the functioning of centriole
(B) prevents attaching of centromeres with rays
(C) prevents the spindle formation in mitosis
(D) prevents the formation of equatorial plane.

[AIPMT 1996]

10.4. Meiosis

40. Recombination between homologous chromosomes is completed by the end of:

(A) Diakinesis (B) Zygotene
(C) Diplotene (D) Pachytene.

[Re-NEET 2024]

41. Match List-I with List-II:

List-I Event	List-II Stage of Prophase-I (Meiosis-I)
(a) Chiasmata formation	(i) Pachytene
(b) Crossing over	(ii) Diakinesis
(c) Synaptonemal complex formation	(iii) Diplotene
(d) Terminalisation of chiasmata	(iv) Zygotene

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iii)	(i)	(iv)	(ii)
(B)	(ii)	(i)	(iii)	(iv)
(C)	(iii)	(i)	(ii)	(iv)
(D)	(ii)	(iii)	(iv)	(i)

[Re-NEET 2024]

42. Given below are two statements:

Statement I: Chromosomes become gradually visible under light microscope during leptotene stage.

Statement II: The begining of diplotene stage is recognized by dissolution of synaptonemal complex.

In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are false.
(B) Statement I is true but Statement II is false.
(C) Statement I is false but Statement II is true.
(D) Both Statement I and Statement II are true.

[NEET 2024]

43. Match List I with List II:

List I (Sub Phases of Prophase I)	List II (Specific characters)
(a) Diakinesis	(i) Synaptonemal complex formation
(b) Pachytene	(ii) Completion of terminalisation of chiasmata
(c) Zygotene	(iii) Chromosomes look like thin threads
(d) Leptotene	(iv) Appearance of recombination nodules

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(i)	(ii)	(iv)	(iii)
(B)	(ii)	(iv)	(i)	(iii)
(C)	(iv)	(iii)	(ii)	(i)
(D)	(iv)	(ii)	(iii)	(i)

[NEET 2024]

44. Select the correct statements.

(I) Tetrad formation is seen during Leptotene.
(II) During Anaphase, the centromeres split and chromatids separate.
(III) Terminalization takes place during Pachytene.

(IV) Nucleolus, Golgi complex and ER are reformed during Telophase.

(V) Crossing over takes place between sister chromatids of homologous chromosome.

Choose the correct answer from the options given below:

(A) (I), (III) and (V) only

(B) (II) and (V) only

(C) (I) and (III) only

(D) (II) and (IV) only **[NEET 2023]**

45. The process of appearance of recombination nodules occurs at which sub-stage of prophase I in meiosis?

(A) Diplotene (B) Diakinesis

(C) Zygotene (D) Pachytene **[NEET 2023]**

46. Which of the following stages of meiosis involves division of centromere?

(A) Anaphase II (B) Telophase

(C) Metaphase I (D) Metaphase II

[NEET 2023, NEET 2021]

47. Regarding Meiosis, which of the statements is incorrect?

(A) DNA replication occurs in S phase of Meiosis-II.

(B) Pairing of homologous chromosomes and recombination occurs in Meiosis-I.

(C) Four haploid cells are formed at the end of Meiosis-II.

(D) There are two stages in Meiosis, Meiosis-I and II.

[NEET 2022]

48. Which stage of meiotic prophase shows terminalisation of chiasmata as its distinctive feature?

(A) Leptotene (B) Zygotene

(C) Diakinesis (D) Pachytene **[NEET 2021]**

49. Match the following columns with respect to meiosis.

Column I	Column II
(a) Zygotene	(i) Terminalisation
(b) Pachytene	(ii) Chiasmata
(c) Diplotene	(iii) Crossing over
(d) Diakinesis	(iv) Synapsis

Select the correct option.

	(a)	(b)	(c)	(d)
(A)	(iv)	(iii)	(ii)	(i)
(B)	(i)	(ii)	(iv)	(iii)
(C)	(ii)	(iv)	(iii)	(i)
(D)	(iii)	(iv)	(i)	(ii)

[NEET Sept. 2020]

50. During meiosis I in which stage synapsis takes place?

(A) Pachytene (B) Zygotene

(C) Diplotene (D) Leptotene

[NEET Oct. 2020]

51. Dissolution of the synaptonemal complex occurs during:

(A) zygotene (B) diplotene

(C) leptotene (D) pachytene.

[NEET Sept. 2020]

52. Meiotic division of the secondary oocyte is completed

(A) at the time of copulation

(B) after zygote formation

(C) at the time of fusion of a sperm with an ovum

(D) prior to ovulation. **[NEET 2020]**

53. After meiosis-I, the resultant daughter cells have:

(A) same amount of DNA as in the parent cell in S-phase

(B) twice the amount of DNA in comparison to haploid gamete.

(C) same amount of DNA in comparison to haploid gamete.

(D) four times the amount of DNA in comparison to haploid gamete. **[NEET Odisha 2019]**

54. Crossing over takes place between which chromatids and in which stage of the cell cycle?

(A) Non-sister chromatids of non-homologous chromosomes at zygotene stage of prophase I.

(B) Non-sister chromatids of homologous chromosomes at pachytene stage of prophase I.

(C) Non-sister chromatids of homologous chromosomes at zygotene stage of prophase I.

(D) Non-sister chromatids of non-homologous chromosomes at pachytene stage of prophase I.

[NEET Odisha 2019]

55. The stage during which separation of the paired homologous chromosomes begins is:

(A) diakinesis (B) diplotene

(C) pachytene (D) zygotene. **[NEET 2018]**

56. In meiosis crossing over is initiated at:

(A) leptotene (B) zygotene

(C) diplotene (D) pachytene.

[NEET Phase-I 2016]

57. Anaphase Promoting Complex (APC) is a protein degradation machinery necessary for proper mitosis of animals cells. If APC is defective in human cells, which of the following is expected to occur?

(A) Chromosomes will not condense.

(B) Chromosomes will be fragmented.

(C) Chromosomes will not segregate.

(D) Recombination of chromosome arms will occur.

[NEET 2017]

58. Match the stages of meiosis in column I to their characteristic features in column II and select the correct option using the codes given below:

Column I	Column II
(a) Pachytene	(i) Pairing of homologous chromosomes
(b) Metaphase-I	(ii) Terminalisation of chiasmata
(c) Diakinesis	(iii) Crossing-over takes place
(d) Zygotene	(iv) Chromosomes align at equatorial plate

Select the correct option.

	(a)	(b)	(c)	(d)
(A)	(iii)	(iv)	(ii)	(i)
(B)	(i)	(iv)	(ii)	(iii)
(C)	(ii)	(iv)	(iii)	(i)
(D)	(iv)	(iii)	(ii)	(i)

[NEET Phase-II 2016]

59. Match the following column I with column II.

Column I	Column II
(a) Synapsis aligns homologous chromosomes	(i) Anaphase-II
(b) Synthesis of RNA and protein	(ii) Zygotene
(c) Action of enzyme recombinase	(iii) G_2 -phase
(d) Centromeres do not separate but chromatids move towards opposite poles.	(iv) Anaphase-I
	(v) Pachytene

Select the correct option.

	(a)	(b)	(c)	(d)
(A)	(ii)	(i)	(iii)	(iv)
(B)	(ii)	(iii)	(v)	(iv)
(C)	(i)	(ii)	(v)	(iv)
(D)	(ii)	(iii)	(iv)	(v)

[AIPMT Cancelled 2015]

60. Arrange the following events of meiosis in correct sequences:

(I) Crossing over

(II) Synapsis

(III) Terminalisation of chiasmata

(IV) Disapperance of nucleolus

Options:

(A) (II), (I), (IV), (III)

(B) (II), (I), (III), (IV)

(C) (I), (II), (III), (IV)

(D) (II), (III), (IV), (I) **[AIPMT Latest July 2015]**

61. The enzyme recombinase is required at which stage of meiosis?

(A) Pachytene (B) Zygotene

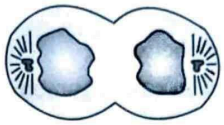
(C) Diplotene (D) Diakinesis **[AIPMT 2014]**

62. The complex formed by a pair of synapsed homologous chromosomes is called:

(A) equatorial plate (B) kinetochore

(C) bivalent (D) axoneme. **[NEET 2013]**

63. A stage in cell division is shown in the figure. Select the answer which gives correct identification of the stage with its characteristics.



(A) Telophase — Nuclear envelope reforms, Golgi complex reforms.

(B) Late anaphase — Chromosomes move away from equatorial plate, Golgi complex not present.

(C) Cytokinesis — Cell plate formed mitochondria distributed between two daughter cells.

(D) Telophase — Endoplasmic reticulum and nucleolus not reformed yet.

[NEET 2013]

64. During meiosis I, the chromosomes start pairing at:

(A) zygotene (B) pachytene

(C) diplotene (D) leptotene.

[NEET Karnataka 2013]

65. The appearance of recombination nodules on homologous chromosomes during meiosis characterises:

(A) bivalent

(B) sites at which crossing over occurs

(C) terminalisation

(D) synaptonemal complex. **[AIPMT 2012]**

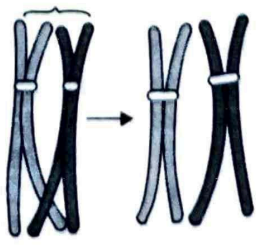
66. During gamete formation, the enzyme recombinase participates during:

(A) metaphase I (B) anaphase II

(C) prophase I (D) prophase II

[AIPMT Screening 2012]

67. Given is the representation of a certain event at a particular stage of a type of cell division. Which is this stage?



(A) Prophase I during meiosis
(B) Prophase II during meiosis
(C) Prophase of mitosis
(D) Both prophase and metaphase of mitosis

[AIPMT Screening 2012]

68. Identify the meiotic stage in which the homologous chromosomes separate while the sister chromatids remain associated at their centromeres:
(A) Metaphase I (B) Metaphase II
(C) Anaphase I (D) Anaphase II

[AIPMT Mains 2012]

69. Synapsis occurs between:
(A) a male and a female gamete
(B) *m*RNA and ribosomes
(C) spindle fibres and centromere
(D) two homologous chromosomes.

[AIPMT Screening 2009]

70. Crossing over that results in genetic recombination in higher organisms occurs between:
(A) sister chromatids of a bivalent
(B) non-sister chromatids of a bivalent
(C) two daughter nuclei
(D) two different bivalents. **[AIPMT 2004]**

71. Lampbrush chromosomes occur during:
(A) prophase of mitosis
(B) diplotene of meiosis
(C) metaphase of meiosis
(D) interphase. **[AIPMT 1996]**

72. The exchange of genetic material between chromatids of paired homologous chromsomes during first meiotic division is called:
(A) transformation (B) chiasmata
(C) crossing over (D) synapsis. **[AIPMT 1996]**

73. Meiosis II performs:
(A) separation of sex chromosomes.
(B) synthesis of DNA and centromere.
(C) separation of homologous chromosomes.
(D) separation of chromatids. **[AIPMT 1993]**

74. In meiosis, the daughter cells differ from parent cell as well as amongst themselves due to:
(A) segregation, independent assortment and crossing over.
(B) segregation and crossing over.
(C) independent assortment and crossing over.
(D) segregation and independent assortment.

[AIPMT 1991]

75. Segregation of mendelian factor (Aa) occurs during:
(A) diplotene (B) anaphase I
(C) zygotene/pachytene (D) anaphase II

[AIPMT 1990]

76. Meiosis I is reductional division. Meiosis II is equational division due to:
(A) pairing of homologous chromosomes
(B) crossing over
(C) separation of chromatids
(D) disjunction of homologous chromosomes

[AIPMT 1988]

10.5. Significance of Meiosis

77. Genetic map is one that:
(A) shows the distribution of various species in a region.
(B) establishes sites of the genes on a chromosome.
(C) establishes the various stages in evolution.
(D) establishes the various stages in evolution.

[AIPMT 2003]

78. Meiosis is evolutionary significant because it results in:
(A) genetically similar daughters
(B) four daughter cells
(C) eggs and sperms
(D) recombinations. **[AIPMT 1994]**

SOLUTIONS

1. (D) Cells are metabolically active and proliferate during G_1 phase, where cells grow and prepare for DNA replication. DNA replication takes place during S phase. During G_2 phase, cells prepare for mitosis by synthesising proteins. During G_0 phase (Quiescent stage), cells are in a resting state but remain metabolically active.

2. (D) Among eukaryotes, replication of DNA takes place in the S phase of the cell cycle.

The cell cycle consists of different phases, including G_1, S, G_2, and M. During the G_1 phase, the cell grows and prepares for DNA replication. The S phase is where DNA replication takes place. The cell synthesises a complete copy of its DNA, so each daughter cell will have a complete set of genetic information. During the G_2 phase, the cell prepares for cell division, and during the M phase, the cell divides into two daughter cells.

3. (A) M phase is the phase of the cell cycle in which mitosis occurs, leading to the division of the nucleus into two identical daughter nuclei. This phase is also known as the mitotic phase or cell division phase and results in equational division of the chromosomes.

G_2 phase is the second gap phase of the cell cycle that follows DNA synthesis (S phase) and precedes M phase. During G_2 phase, the cell prepares for mitosis by synthesising proteins that are necessary for cell division.

Quiescent stage, also known as G_0 phase, is a stage of the cell cycle in which the cell is neither dividing nor preparing to divide. The cell may remain in this stage for an extended period of time, and may or may not re-enter the cell cycle at a later time.

G_1 phase is the first gap phase of the cell cycle, following mitosis and preceding DNA synthesis (S phase). During G_1 phase, the cell grows and carries out normal metabolic activities. This phase also marks the interval between mitosis and the initiation of DNA replication.

4. (B) During G_0 phase or the quiescent stage of the cell cycle, the cell remain metabolically active but it no longer proliferates unless being called upon to do so depending upon the need of the organism.

5. (A) In S phase, amount of DNA doubles but number of chromosomes remains the same.

6. (A) Centrioles undergo duplication during S phase of interphase and begin to move toward opposite poles of the cell during prophase stage of mitosis.

Related Theory

- *Centrioles help in distributing the duplicated genetic material equally. Also, during S phase, DNA replication occurs inside the nucleus. During the G_2 phase, there is overall cell growth and proteins needed for cell division like tubulin are synthesised.*

7. (D) In G_1 phase, cell grows and duplication of organelles occur. In S phase, DNA replication and chromosome duplication occurs. In G_2 phase, cytoplasmic growth occurs, i.e., proteins are synthesised for mitosis. In M phase, chromosomes get aligned on equatorial plate during metaphase stage.

Related Theory

- *Cell cycle is the ordered sequence of events that occur in a cell in preparation for cell division. The cell cycle is a four-stage process in which the cell increases in size (gap 1, or G_1 stage), copies its DNA (synthesis, or S stage), prepares to divide (gap 2, or G_2 stage), and divides (mitosis, or M stage). The stages G_1, S, and G_2 make up interphase, which accounts for the span between cell divisions.*

8. (D) Not all cells adhere to the classic cell cycle pattern in which a newly formed daughter cell immediately enters the preparatory phases of interphase, closely followed by the mitotic phase. Cells in G_0 phase are not actively preparing to divide. This occurs at the end of M phase and beginning of G_2 phase, before entering a new cell cycle. The cell is in a quiescent (inactive) stage that occurs when cells exit the cell cycle. Some cells enter G_0 temporarily until an external signal triggers the onset of G_1. Other cells that never or rarely divide, such as mature cardiac muscle and nerve cells, remain in G_0 permanently.

9. (D) The quiescent (inactive) stage or G_0 stage that occurs when cells exit the cell cycle. Some cells enter G_0 temporarily until an external signal triggers the onset of G_1. Other cells that never or rarely divide, such as mature cardiac muscle and nerve cells, remain in G_0 permanently. Cells in G_1 phase enter the cell cycle. Cells in G_2 phase enter M phase.

Related Theory

- *During G_1 phase of interphase, cell is metabolically active and continuously grows. DNA synthesis/replication occurs in S phase or synthesis phase. In the G_2 stage, cell prepares itself to divide and involve protein synthesis required for M phase. Nuclear division occurs in M phase.*

10. (C) Bacteria being a prokaryotic organisms, lacks nucleus. The cell cycle in bacteria lacks S-phase. Thus, DNA replication occurs just prior to fission.

11. (A) G_1 is the stage where the cell is preparing to divide. It then moves into the S phase where the cell copies all the DNA. S stands for synthesis phase (of DNA). In G_2 stage, organisation and condensation of the genetic material take place and cell prepares to divide. M stands for mitosis. This is the stage where the cell actually divides the two copies of the genetic material into the two daughter cells.

12. (C) Gamete contains 'n' chromosomes and 'x' amount of DNA and the somatic cell contains '$2n$' chromosomes and '$2x$' amount of DNA. In S phase DNA content becomes double, but the chromosome number remains same. Thus, after S phase, the cell contains '$4x$' amount of DNA and '$2n$' chromosome number.

	Chromosome no.	DNA content
Gamete	n	x
Somatic cell (diploid)	$2n$	$2x$
Somatic cell (after S-phase)	$2n$	$4x$

Caution

- *Students should always remember that in S phase only the amount of DNA doubles but the chromosome number remains the same.*

13. (D) During G_1 phase of interphase, cell is metabolically active and continuously grows. DNA synthesis/ replication occurs in S phase or synthesis phase. In the G_2 stage, cell prepare itself to divide and involve protein synthesis required for M phase. Nuclear division occurs in M phase. Initially, if the DNA amount was '2C', after S phase the DNA amount

becomes doubled, *i.e.*, '4C'. Thus, after S phase, cell contains 4C amount of DNA, till the anaphase of the mitosis (M phase), where segregation of chromosome (ultimately DNA) occurs.

14. (A) During S phase of the cell cycle, amount of DNA doubles, but the chromosome number remains the same.

15. (B) Cell cycle is the series of events in which cells replicate and make two new cells. Cell cycle consists of stages- G_1, S, G_2, and M (karyokinesis and cytokinesis). G_1 is the stage where the cell is preparing to divide. It then moves into the S phase where the cell copies all the DNA. S stands for synthesis phase of DNA. Histone proteins are also synthesised during this phase. After the DNA is copied and there's a complete extra set of all the genetic material, the cell moves into the G_2 stage, where it organises and condenses the genetic material, or starts to condense the genetic material, and prepares to divide.

16. (B) During the S phase, DNA replication occurs and cells get prepared for division. Interphase takes around 18-20 hours, whereas mitosis takes about 2 hours. G_2 phase precedes mitosis. It follows the sucessful completion of S phase. Cell growth and all the other required preparations, such as protein synthesis, occurs during the G_1 phase.

17. (A) The reformation of the nuclear envelope during M phase of the cell cycle takes place during telophase.

The nuclear membrane which disappears during prophase reappears in the telophase. But before it is reformed the nucleus gets reorganised by decondensation from chromosome and reassembly of the nuclear lamina.

18. (C) Given, the starting cell concentration = 10^5 cell/ml.

So, for calculating the cell concentration per ml after 175 minutes,

$$N = N_0 2^{(t/d)}$$

Where, N = The final cell concentration

N_0 = The initial cell concentration

t = time (in minutes)

d = time taken for doubling

On putting the values,

$$N = 10^5 \times 2^{(175/35)}$$

$$N = 10^5 \times 2^5$$

$$N = 32 \times 10^5 \text{ cells/ml.}$$

19. (B) Centriole is not common to mitotic cell of higher plants. In animal cells during cell division centrosomes produce spindle fibres, which attach to the kinetochore of chromosomes during the metaphase stage. The centrioles duplicate during interphase stage before cell division starts.

20. (A) Spindle fibres attach to kinetochores of chromosomes during the metaphase stage of mitosis. Chromosomes are moved to the spindle equator and get aligned along the metaphase plate through spindle fibres to both poles.

21. (C) The cell cycle is divided into two basic phases: Interphase and M Phase (Mitosis phase).

The interphase is the time during which the cell is preparing for division by undergoing both cell growth and DNA replication in an orderly manner. It is divided into three further phases:

(I) G_1 phase (Gap 1); (II) S phase (Synthesis); (III) G_2 phase (Gap 2)

S-phase or synthesis phase occurs just after the G_1 phase and is characterised as the period during which DNA synthesis takes place. The M phase starts with the nuclear division, corresponding to the separation of daughter chromosomes (karyokinesis) and usually ends with the division of cytoplasm (cytokinesis).

Thus, the correct sequence of stages of cell cycle is:

G_1 phase (Gap 1) → S phase (Synthesis) → G_2 phase (Gap 2) → Karyokinesis → Cytokinesis.

22. (B) The movement of centrioles towards opposite poles can be observed in the early prophase stage of mitosis.

Coiling and condensation of the chromatids occur in the prophase stage of mitosis.

Spindle fibers attach to the kinetochores of chromosomes. This can be seen in the metaphase of mitosis.

Pairing of homologous chromosomes is seen in meiosis.

23. (A) Spindle fibres attach to the kinetochores of chromosomes. Long protein fibers called microtubules extend from the centrioles in all possible directions, forming what is called a spindle. Some of the microtubules attach the poles to the chromosomes by connecting to protein complexes called kinetochores.

24. (D) In cell cycle, during metaphase stage, spindle fibres originating from the centrosome attaches to the kinetochore of the chromosomes. Kinetochore is a disc-shaped structure at the surface of centromere through which the sister chromatids are held together. During metaphase, the chromosome arrange themselves at equator on metaphasic plate. Due to this arrangement, the attachment of spindle fibres to kinetochore is clearly visible.

25. (B) In mitosis, there are four phases: Prophase, metaphase, anaphase and telophase. In prophase, condensation of chromosomes occurs, which is followed by nuclear membrane disintegration. Metaphase is characterised by arrangement of

chromosomes on nuclear plate. In anaphase, centromere division occurs, which align on opposite poles of the cell. The aligned chromosome are segregated. In telophase, chromosome moves to opposite poles and nuclear membrane reappear.

Related Theory

➥ *Anaphase separates the duplicated genetic material in the nucleus of a parent cell into two identical daughter cells. Before anaphase begins, sister chromatids are aligned along the equatorial plane. The sister chromatids are joined at a point called the centromere.*

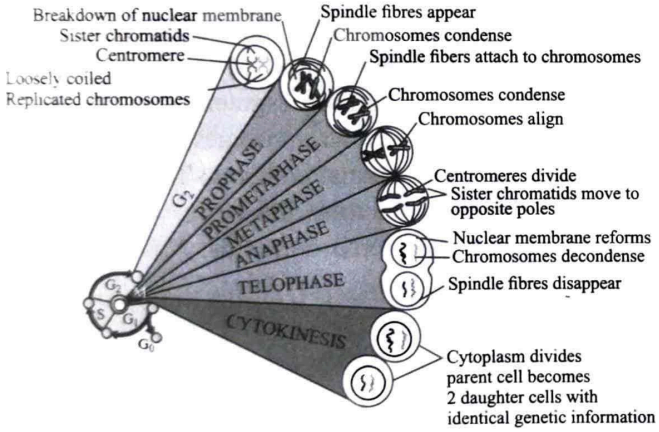
Caution

➥ *Students need to know that in mitosis, crossing over does not occur, as it is a characteristic of meiosis.*

26. (C) Synapsis occurs during zygotene phase of meiotic cycle. It is the pairing of homologous chromosomes, which leads to crossing over in the next stage. During early prophase, nucleolus and nuclear membrane disappears. During metaphase, the chromosome lies at the equatorial plane, attached to spindle fibres.The chromosome moves towards the opposite poles during anaphase.

Related Theory

➥ *Stages of mitosis:*



Mnemonics

➥ *Stages of Mitosis can be learned as:*
***PMAT** – **P**rophase, **M**etaphase, **A**naphase and **T**elophase.*

27. (A) Polyploidy cells have more number of chromosomes than a normal cell. Somaclonal variation is the genetic variation in cultured somatic cells. Polyteny is a condition of a chromosome, nucleus, or cell in which the DNA has repeatedly replicated, without subsequently separating and is found in dipterans. Aneuploidy is the presence of an abnormal number of chromosomes in a cell.

Caution

➥ *In a case study type question, one should read the passage/ situation/case carefully. Most of the time, the hint to the answer lies within the passage only. More practice and clear concepts helps in solving such questions more easily and accurately.*

➥ *Students often get confused in the term aneuploidy and polyploidy. Aneuploidy refers to abnormal number of chromosomes in a cell. In this, there is an extra chromosome present in the cell. Polyploidy is the presence of the extra set of the chromosome in the cells. There is a complete new set of the chromosome present.*

28. (A) Spindle fibres attach to chromosomes at the kineto chores, which are small disc-shaped structures present at the surface of centromeres.

Caution

➥ *Students must remember that the main difference between centromere and kinetochore is that the centromere is a DNA region, whereas kinetochore is an assembling protein complex in the centromere.*

29. (B) Metaphase is characterised by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its kinetochore to spindle fibres from one pole and its sister chromatid connected by its kinetochore to spindle fibres from the opposite pole.

30. (C) During metaphase, the sister chromatids line up along a linear plane in the middle of the cell, a metaphase plate forms between the centrosomes that are now located at either end of the cell. Chromatids start moving towards opposite poles in anaphase. Nuclear envelope and organelles disappear by the end of prophase. Chromatids separate and moves to opposite poles in anaphase.

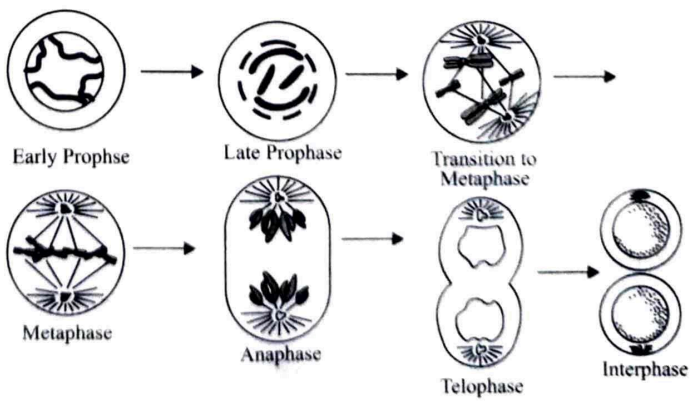
31. (A) The outermost layer of endosperm is called as aleurone and is triploid ($3n$) in nature, while root tip is diploid ($2n$).

Thus, $2n = 42$

$n = 21$

$3n = 63$

32. (C) Prophase is characterised by condensed chromosome, while metaphase represents the arrangement of chromatids on a equatorial plate, attached by spindle fibres. Anaphase shows separation of chromatid pairs, moving towards the opposite pole. Telophase is characterised by the decondensation of chromatids, and appearance of nuclear envelope.



Stages of Mitosis

33. (C) A normal cell cycle comprises of interphase and mitosis. The interphase normally comprises of first growth phase (G_1 phase), which starts immediately after the cytokinesis, synthesis phase (S phase), which is marked here as W and second growth phase (G_2 phase). The DNA synthesis or DNA replication occurs during S phase.

34. (A) Chromosomal morphology is best observed at metaphase. Metaphase is a stage of mitosis in the cell cycle in which chromosomes are at their most condensed and coiled stage.

Related Theory

- *In metaphase chromosomes line up at the metaphase plate, under tension from the mitotic spindle. The two sister chromatids of each chromosome are captured by microtubules from opposite spindle poles. In metaphase, the spindle has captured all the chromosomes and lined them up at the middle of the cell, ready to divide.*

35. (A) Mitosis is a process of equational division, where after division each cell produces two daughter cells. So starting from a single cell, the increase in a number of cells will occur as per the following progression- $1 \rightarrow 2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32 \rightarrow 64 \rightarrow 128$. Therefore, a total of 7 divisions is required to produce 128 cells.

36. (B) The best stage to observe shape, size and number of chromosomes is metaphase as at this stage, condensation of chromosomes is completed and they can be observed clearly under the microscope.

Related Theory

- *Mitosis is part of somatic cell division, which includes nuclear division (karyokinesis) and cytoplasmic division (cytokinesis).*

37. (B) Root tips are the best material to study mitosis. It is characteristic of meristematic cells present at the tip of the roots that provide the most suitable and sufficient raw material to study the different mitosis stages. Anther shows meiotic divisions mostly.

Related Theory

- *Onion is a monocot plant and is the most commonly used root tip to study mitosis.*

38. (B) Colchicine has the property of arresting and breaking the spindle so that a cell division without cell wall formation may be affected, leading to doubling of chromosome number. So, a diploid cell will become tetraploid by chromosome doubling.

Related Theory

- *Colchicine is an alkaloid extracted from seed and corm of Colchicum autumnale.*

39. (C) Colchicine is an alkaloid obtained from plant *Colchicum autumnale*. It inhibits spindle formation in cells during mitosis so that chromosome cannot separate during anaphase and it leads to introduction of multiple sets of chromosome. Colchicine is commonly used in genetics, cytology, and plant breeding research and also in cancer therapy to inhibit cell division.

40. (D) Pachytene stage marked by appearance of bivalent chromosomes clearly as tetrads, This stage is make distinct by the emergence of recombination nodules. It is the site where crossing over occurs between non-sister chromatids of the homologous chromosomes. Crossing over results to the recombination of genetic material on the two chromosomes. Recombination between homologous chromosomes is completed by the end of pachytene.

Terminalization of chiasmata is characteristic feature of the diakinesis stage.

Pairing of homologous chromosomes is seen in zygotene stage.

Events like desynapsis and chiasmata formation can be found in diplotene stage.

41. (A) Chiasmata formation occurs during diplotene stage of meiosis, where homologous chromosomes start to separate but remain attached at chiasmata. Crossing over occurs during pachytene stage of meiosis, where genetic material is exchanged between homologous chromosomes. Synaptonemal complex formation occurs during zygotene stage of meiosis, where homologous chromosomes begin to pair and form the synaptonemal complex. Terminalisation of chiasmata occurs during diakinesis, where chiasmata move towards chromosome ends.

42. (D) In prophase I of meiosis I, during the leptotene stage, the chromosomes become gradually visible under the light microscope. The compaction of chromosomes continues throughout leptotene. The beginning of diplotene is recognised by the dissolution of the synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped structures are called chiasmata.

43. (B) Diakinesis is the final stage of meiotic prophase I, which is marked by the terminalisation of chiasmata. Pachytene is characterised by the appearance of recombination nodules, the sites at which crossing over occurs between non-sister chromatids of the homologous chromosomes. During zygotene stage, chromosomes start pairing together and this process of association is called synapsis. This results in the formation of synaptonemal complex. During leptotene stage, the chromosomes become gradually visible as thin threads.

44. (D) Tetrad formation occurs during the zygotene stage of prophase I of meiosis, not during leptotene.

Terminalisation occurs during diplotene, not during pachytene.

Crossing over takes place between non-sister chromatids of homologous chromosomes, not between sister chromatids.

45. (D) The process of appearance of recombination nodules occurs during the pachytene sub-stage of prophase I in meiosis. Pachytene is the stage where homologous chromosomes are synapsed together to form bivalents. It is during this stage that the synaptonemal complex, a protein structure that holds the homologous chromosomes together, forms and the process of crossing over occurs. Recombination nodules are protein complexes that are involved in the exchange of genetic material between homologous chromosomes during crossing over.

46. (A) The division of the centromere occurs during anaphase I and anaphase II of meiosis.

During anaphase I, homologous chromosomes separate and move towards opposite poles of the cell. The centromeres, which hold the two sister chromatids of each homologous chromosome together, do not divide, leading to the separation of the homologous chromosomes.

During anaphase II, the centromeres divide, allowing the sister chromatids to separate and move towards opposite poles of the cell.

47. (A) Interphase is divided into three phases: G_1 phase, S phase, and G_2 phase. DNA replication occurs in S-Phase. There is no replication of DNA during interkinesis. Interkinesis is followed by prophase II, a much simpler prophase than prophase I.

48. (C) The final stage of meiotic prophase I is diakinesis. This is marked by terminalisation of chiasmata.

Related Theory

➥ *The chiasmata become visible during the diplotene stage of prophase I of meiosis, but the actual crossing-overs of genetic material are thought to occur during the previous pachytene stage.*

49. (A) During zygotene phase, the homologous chromosomes pair or come together to form synapsis. Crossing over takes place during pachytene stage and at each point of crossing over a chiasmata is formed between non-sister chromatids of homologous chromosomes. Chiasmata is the point of contact between the two non-sister chromatids of homologous chromosomes. Chiasmata becomes visible during diplotene stage. Terminalisation of chiasmata gets completed during diakinesis, where chromosomes gets freely distributed in the cytoplasm.

50. (B) In zygotene, the pairing of homologous chromosomes starts a process known as chromosomal synapsis, accompanied by the formation of a complex structure called synaptonemal complex. A pair of synapsed homologous chromosome forms a complex known as bivalent or tetrad.

51. (B) Dissolution of the synaptonemal complex occurs during diplotene stage of prophase I of meiosis I.

52. (C) The meiotic division of the secondary oocyte is completed after the entry of sperm in secondary oocyte, which forms the large ovum and a tiny second polar body.

53. (B) During meiosis I, the homologous chromosomal pairs of parental cell are segregated into two daughter cells (say DNA = 48). After the completion of the process, the amount of DNA is halved (DNA = 24 each between two haploid daughter cells. However, when these two daughter cells are subjected to meiosis II, the amount of DNA is further divided between the resulting four haploid daughter cells (DNA= 24 each).

Related Theory

➥ *Meiosis I begins with one diploid parent cell and ends with two haploid daughter cells, halving the number of chromosomes in each cell. Meiosis II starts with two haploid parent cells and ends with four haploid daughter cells, maintaining the number of chromosomes in each cell. Homologous pairs of cells are present in meiosis I and separate into chromosomes before meiosis II.*

54. (B) At pachytene stage of prophase I, crossing over of non-sister chromatids of homologous chromosomes occurs at the recombination nodules. The chromosomes remain linked at the sites of crossing over.

Caution

➥ *Students must remember that crossing over always occurs in between non-sister chromatids of homologous chromosome. It never occurs between sister chromatids or non-homologous chromosomes.*

55. (B) The separation of homologous chromosomes and dissolution of synaptonemal complex occurs at diplotene stage. In zygotene stage, formation of synapsis occurs. During pachytene, crossing over between non-sister chromatids of homologous chromosomes occurs. Diakinesis is marked by the terminalisation of chiasmata.

Related Theory

➥ *During diplotene the homologous chromosomes develops a repulsive force and begins to separate from each other. This cytogenetic activity results in the crossing over of genetic traits and the recombination of genetic material. Nucleolus though diminished, still persists. No nuclear membrane can be seen at this stage.*

56. (D) During leptotene, condensation of chromosome occurs. During zygotene, synapsis of homologous chromosome occurs. Pachytene involves crossing over of sister chromatids of non-homologous chromosomes. Diplotene involves the dissolution of synaptonemal complex and appearance of chiasmata. Diakinesis includes terminalisation of chiasmata.

57. (C) During anaphase, the pair of chromosomes segregate or split into two identical, independent chromosomes. Anaphase promoting Complex triggers the transition from metaphase to anaphase by tagging specific proteins by degradation. Thus, if APC is non-functional, the chromosomes will not segregate. Condensation of chromosomes is completed in interphase and recombination of chromosome occurs in pachytene stage of prophase I in meiosis.

Related Theory

During mitosis, anaphase stage is characterized by splitting of the centromere. At anaphase stage, each chromosome splits at the centromere and start moving towards the two opposite poles.

Caution

Students need to know that crossovers results in recombination and the exchange of genetic material between the maternal and paternal chromosomes. Recombination of chromosomes do not occur during mitosis, but only meiosis.

58. (A) Meiotic cell division is a reduction division.

Meiosis I separates the pair of homologous chromosomes and reduces the diploid cell to haploid. It is divided into several stages that include, prophase, metaphase, anaphase and telophase.

(1) **Leptotene:** The chromosomes begin to condense and are attached to the nuclear membrane via their telomeres.

(2) **Zygotene:** Synapsis begins with a synaptonemal complex forming between homologous chromosomes.

(3) **Pachytene:** Crossing over of genetic material occurs between non-sister chromatids.

(4) **Diplotene:** Synapsis ends with disappearance of synaptonemal complex; homologous pairs remain attached at chiasmata.

(5) **Diakinesis:** Chromosomes become fully condensed and nuclear membrane disintegrates prior to metaphase I. This stage is also characterised by the terminalisation of chiasmata.

During metaphare-I, the chromosomes align at equatorial plate.

Mnemonics

Phases of meiosis can be learned as:
***L**ittle **Z**afar **P**ractice **D**ance **D**aily*

Little – Leptotene
Zafar – Zygtene
Practice – Pachytene
Dance – Diplotene
Daily – Diakinesis

59. (B) In zygotene, the pairing of homologous chromosomes starts a process known as chromosomal synapsis, accompanied by the formation of a complex structure called synaptonemal complex. A pair of synapsed homologous chromosome forms a complex known as bivalent or tetrad.

During G_2, the cell has to grow some more and synthesise RNA and proteins required for mitosis stage.

At pachytene stage, crossing over of non-sister chromatids of homologous chromosomes occurs at the recombination nodules. The chromosomes remain linked at the sites of crossing over.

In anaphase I, the two chromosomes of each bivalent separate and move to the opposite ends of the cells. The sister chromatids are attached to each other.

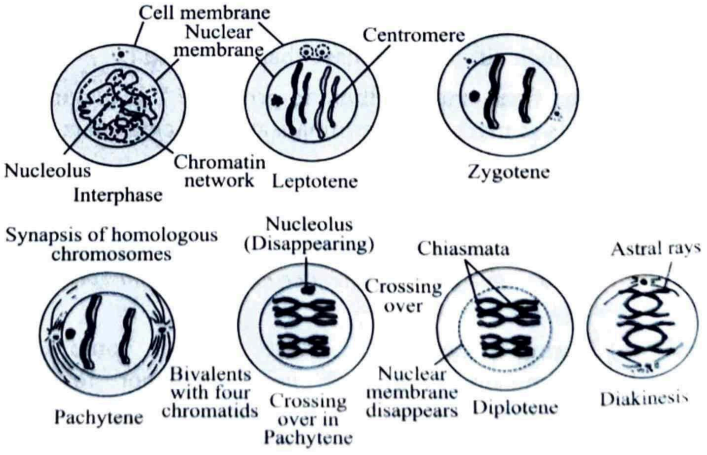
During anaphase II, the sister chromatids are then pulled to opposite poles due to the action of the meiotic spindle.

60. (B) The correct sequence of events in prophase-I of meiosis-I are:

Synapsis in zygotene → Crossing over in pachytene → Terminalisation of chaismata in diplotene → Disapperance of nucleolus in diakinesis.

Related Theory

Stages in prophase-I of meiosis-I:



Caution

Students usually mix up the stages of meiosis of prophase I. They should memorise the events key occurring in each stage with the help of diagrams for longer retaining of the memory.

61. (A) The enzyme recombinase helps in recombination of genes between homologous chromosomes. This process is called crossing over. It takes place in

the pachytene stage in prophase I of meiosis. In zygotene, pairing of homologous chromosome takes place. Diplotene is marked by the completion of crossing over. Diakinesis is marked by condensation of chromosomes.

Mnemonics

➥ ***Phases of Prophase I in Meiosis can be memorised as:***

Lazy Zebras Pander Dire Disasters

Lazy	–	*Leptotene*
Zebras	–	*Zygotene*
Ponder	–	*Pachytene*
Dire	–	*Diplotene*
Disasters	–	*Diakinesis*

62. (C) During synapsis in pachytene stage, homologous chromosomes gets paired to form bivalents. During metaphase, chromosomes line up at the equator, attached to the spindle fibres. Kinetochore is the site of attachment of spindle fibres. Axoneme is the central core of cilia or flagella consisting of microtubules.

Related Theory

➥ *A tetrad, or two homologous chromosomes consisting of four chromatids, is connected to produce a chromosome pair during meiosis. In order to attach as a pair, a synapsis is formed. Ladder-like filaments bring together and attach the chromosome pair at a central point. These filaments make up the synaptonemal complex. Only once the pair has been connected can it be called a tetrad or bivalent.*

63. (A) Telophase marks the end of mitosis. The process that separates the replicated genetic material carried in the nucleus of a parent cell into two identical daughter cells.

Telophase begins once the replicated, paired chromosomes have been separated and pulled to opposite sides, or poles, of the cell. By the end of telophase the nuclear envelope and golgi complex is reformed.

Caution

➥ *Students need to know that telophase is the reverse of prophase. Students confuse with the organelle reformed during substages. Remember, in cell cycle, the cell organelles except centrioles are dissolved and disappear during prophase only.*

64. (A) During zygotene phase of meiosis I, the chromosomes becomes shorter and thicker. The homologous chromosomes come to lie side-by-side in pairs, called synapsis and form bivalent. During pachytene, crossing over occurs. During diplotene, the paired chromosomes begin to separate into two pairs of chromatids. During leptotene, each chromosome becomes visible as two fine threads (chromatids).

Related Theory

➥ *Zygotene is that phase wherein the homologous chromosomes pair or come together in synapse. The pairing or coming together of homologous chromosomes is called synapsis. It may be facilitated by the synaptonemal complex. The zygotene stage is also described as bouquet stage since the telomeres cluster at one end of the nucleus.*

65. (B) (1) The pachytene stage of meiosis is characterised by the appearance of recombination nodules.

(2) It is the site at which crossing over occurs between non-sister chromatids of homologous chromosomes.

66. (C) The enzyme recombinase helps in recombination of genes between homologous chromosomes (crossing over). It takes place in the pachytene stage in prophase I of meiosis.

67. (A) The figure represents the crossing over between the bivalent of non-sister chromatids of homologous chromosomes, occurred during pachytene stage of prophase I of meiotic cycle.

68. (C) In anaphase I of meiosis, homologous chromosomes separate and pass towards different poles of the spindle creating two haploid sets of chromosomes. During anaphase II of meiosis, centromere of two chromatids of a chromosome separate. The separated chromatids become independent daughter chromatids.

Related Theory

➥ ***Significance of crossing over:*** *Crossing over creates new combinations of genes in the gametes that are not found in either parent, contributing to genetic diversity or variations. Thus, recombination or crossing over is defined as a process by which the two chromosomes of a homologous pair exchange chromosome segments between non-sister chromatids.*

69. (D) The synapsis is the process by which pairing of homologous chromosomes occurs by crossing over. It helps in the pairing of chromosomes before the segregation process. Fertilisation occurs between male and female gamete.

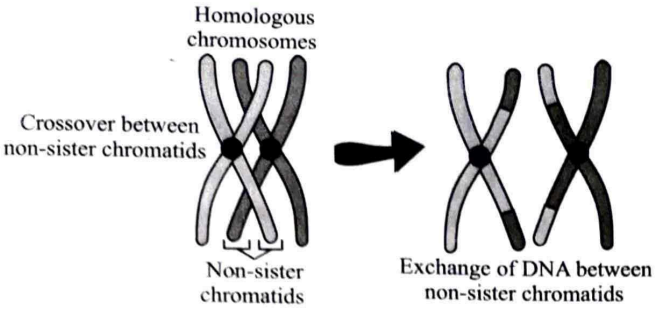
Related Theory

➥ *During the zygotene stage of prophase I (meiosis I) chromosomes start pairing together, this process is known as synapsis. Synapsis is accompanied by the development of the synaptonemal complex. The synapsed pair of homologous chromosomes are called bivalent. It enables the matching of homologous pairs before they segregate and a probable chromosomal crossover occurring between them.*

Caution

➥ *Students must remember that the main difference between synapsis and crossing over is that synapsis is the pairing of homologous chromosomes during the prophase I of the meiosis I, whereas crossing over is the exchange of the genetic material during synapsis.*

70. (B) Crossing over is the exchange of chromosomal segments between non-sister chromatids of homologous chromosomes during the production of gametes. It occurs during pachytene stage.



Crossing Over

71. (B) Lampbrush chromosomes are special type of chromosomes found in the developing oocytes of most animals (except mammals). They are also called diplotene chromosomes because they are formed during the diplotene stage of prophase I of meiosis cell division due to the active transcription of many genes.

72. (C) Crossing over, as related to genetics and genomics, refers to the exchange of DNA between paired homologous chromosomes (one from each parent) that occurs during the development of egg and sperm cells (meiosis). This process results in new combinations of alleles in the gametes (egg or sperm) formed, which ensures genomic variation in any offspring produced.

73. (D) Meiosis II performs separation of chromatids, which are the separation of one of the two similar halves of a replicated chromosome.

74. (A) As a result of segregation, independent assortment, and crossing over during meiosis, the daughter cells differ from the parent cell as well as from one another. Meiosis causes gene or character recombinations or novel combinations as a result of crossing over. These recombinations produce variations that play a part in the evolutionary process.

75. (B) During the production of gametes or spores, meiosis causes the two alleles controlling each character to shift apart because of the separation of the homologous chromosomes present on them. As a result, each gamete or spore only obtains one allele of each character at random. It is called the Law of segregation. It happens during the anaphase I of meiosis.

76. (C) Meiosis is a reductional division because the end result of this special type of cell division is four haploid cells. The first meiotic division occurs, which results in two daughter cells, each with 46 chromosomes. Then, the second round of meiotic division occurs and each of these two cells divides resulting in four haploid cells.

In meiosis II, the two chromatids of each chromosome separate from each other and go to separate daughter cells. As a result, the number of chromosomes remains the same as produced by meiosis I. Therefore, meiosis II is also called as homotypic or equational division.

77. (B) A genetic map is based on the concept of genetic linkage, *i.e.*, the closer two markers are to each other on a chromosome, the greater the probability that they will be inherited together. By studying inheritance patterns, the relative order and location of genetic markers along a chromosome can be established.

78. (D) Meiosis plays a crucial role in ensuring that all creatures created through sexual reproduction have the appropriate amount of chromosomes. Through the mechanism of recombination, meiosis also results in genetic variety.