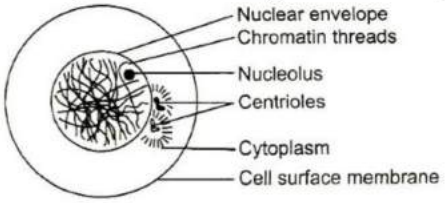
CELL CYCLE AND CELL DIVISION

1. The second meiotic division leads to
   a) Separation of sex chromosomes
   b) Fresh DNA synthesis
   c) Separation of chromatids and centromere
   d) Separation of homologous chromosomes
2. In meiosis, chromosome number becomes
   a) Half of its parent chromosome
   b) Same as that of parent chromosome
   c) One fourth of its parent chromosome
   d) None of the above
3. Consider the following statements about plant cytokinesis
   I. It usually occurs by cell plate method
   II. The spindle usually persists during cytokinesis
   III. Cell plate grows centrifugally
   Which of the statements given above are correct?
   a) I and II b) I and III c) II and III d) I, II and III
4. I. ...A... phase corresponds to the interval between mitosis and initiation of DNA replication
   II. In animal cells, during the ...B... phase, DNA replication begins in the nucleus and the centriole duplicates in the cytoplasm
   III. During the ...C... phase, proteins are synthesized for the preparation of mitosis, while cell growth continues
   Identify the blanks (A-C) to complete the given statements (I-III) with reference to NCERT textbook
   a) A-G_2, B-S, C-G_1 b) A-S, B-G_2, C-G_1 c) A-S, B-G_1, C-G_2 d) A-G_1, B-S, C-G_2
5. Select the matched ones.
   I. S-phase - DNA replication
   II. Zygotene - Synapsis
   III. Diplotene - Crossing over
   IV. Meiosis - Both haploid and diploid cells
   V G_2-phase - Quiescent stage
   a) I and II only b) III and IV only c) III and V only d) I,III and V only
6. Which type of cell division helps in regeneration of cells?
   a) Mitosis b) Amitosis c) Meiosis d) Karyokinesis
7. Which of the following statement(s) is/are not correct about meiosis?
   I. Meiosis involves pairing of homologous chromosomes and recombination between them
   II. Two diploid cells are formed at the end of meiosis-II
   III. Meiosis involves two sequential cycles of nuclear and cell division called meiosis-I and meiosis-II, but only a single cycle of DNA replication
   IV. Meiosis-I is initiated after the parental chromosome replication which produce identical sister chromatids at the S-phase
   The correct option is

a) I and III b) II only c) II and III d) I, II, III and IV

8. Choose the correct statements regarding cell cycle
   I. Interphase is called the resting phase
   II. Interphase is the time during which the cell is preparing for division
   III. The interphase is divided into phases, *i. e.*, G_1, S and G_2-phase
   IV. Interphase represents the phase between the two successive M-phases
   The option with correct statements is
   a) I and IV b) II and III c) I and III d) I, II, III and IV
9. Crossing over occurs during
   a) Leptotene b) Diplotene c) Pachytene d) Zygotene
10. During meiosis, the alleles of the parental pair separate or segregated from each other. How many allele(s) is/are then transmitted to a gamete?
    a) Four b) Two c) Six d) One
11. The phragmoplast is organized at the
    a) Beginning of anaphase
    b) End of anaphase
    c) Beginning of telophase
    d) End of telophase
12. The morphology of chromosomes can be studied most easily in
    a) Prophase b) Metaphase c) Anaphase d) Telophase
13. Identify the correct stage of mitosis by viewing the diagram carefully?



    a) Interphase b) Prophase c) Metaphase d) Anaphase
14. The number of chromosomes becomes half in
    a) Anaphase-I b) Anaphase-II c) Telpohase-I d) Telophase-II
15. In which of the following phase of cell cycle, mitotic division got arrested?
    a) G_2-phase b) G_0-phase c) S-phase d) M-phase
16. Which of the following phase of cell cycle is also known as the resting phase?
    a) G_1-phase b) M-phase c) S-phase d) Interphase
17. Differentiated cell remains at which stage?
    a) G_1 b) G_2 c) G_0 d) M
18. The process of cytokinesis refers to the division of
    a) Nucleus b) Chromosomes c) Cytoplasm d) None of these
19. Choose the correct combination of options to select the correct statement for prophase
    I. Chromosomal material condenses to form compact mitotic chromosomes
    II. The assembly of mitotic spindle is initiated by the microtubules
    III. Cells do not show organelles when viewed under the prophase
    IV. The nucleolus or nucleoli degenerate completely
    a) I only b) II and III c) I and II d) All of these
20. Which of the following event distinguishes prophase-I of meiosis from prophase of mitosis?
    a) Nuclear membrane breaks down b) Chromosomes become visible
    c) Homologous chromosomes pair up d) Spindle forms
21. During mitosis, number of chromosomes gets
    a) Change
    b) No change

c) May be change if cell is mature
d) May be change if cell is immature

22. I. Chromosomes cluster at opposite spindle poles their identity is lost as discrete elements
II. Nuclear envelope assembles around the chromosome clusters
III. Nucleolus, Golgi complex and ER reform
Above features indicates which phase of mitosis
a) Anaphase b) Telophase c) Cytokinesis d) S-phase

23. What would be the change in the chromosome number, during S-phase?
a) No change
b) The number of chromosome doubles
c) The number of chromosome doubles only in case of diploid cell
d) The number of chromosome doubles only in case of haploid cell

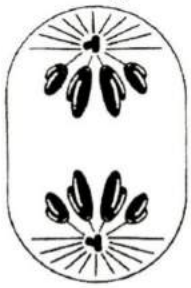
24. Arrange the following events of meiosis in a correct sequence and choose the correct option
I. Terminalisation
II. Crossing over
III. Synapsis
IV. Disjunction of genomes
a) IV, III, II and I b) III, II, I and IV c) II, I, IV and III d) I, IV, III and II

25. What is the approximate percentage duration of cell cycle that comes under interphase in humans?
a) 99% b) 95% c) 25% d) 5%

26. Which of the following stage of meiosis is responsible for deciding genetic constitution of gametes?
a) Metaphase-II b) Anaphase-II c) Metaphase-I d) Anaphase-I

27. ...A.... mitotic cell division is only seen in the diploid somatic cells, while the ...B... can show mitotic divisions in both haploid and diploid cells.
Identify A and B form the options given below
a) A-Animals; B-plants b) A-Plants; B-animals c) A-Bacterial; B-viruses d) None of these

28. Given diagram indicates which of the following phase of mitosis? Choose the correct option



a) Interphase b) Prophase c) Metaphase d) Anaphase

29. In meiosis, the chromosome number
a) Reduces by half
b) Increase by twice
c) Increase by four times
d) Reduces by one-fourth

30. The phase between two successive M-phase is called
a) S-phase b) G_1-phase c) G_2-phase d) Interphase

31. At the end of meiosis-II, number of haploid cells formed are
a) Two b) Four c) Eight d) None of these

32. The transition between meiosis-I and meiosis-II is
a) Interkinesis b) Cytokinesis c) Diakinesis d) Karyokinesis

33. Synapsis occurs between
a) A male and a female gamete
b) *m*RNA and ribosomes
c) Spindle fibres and centromere
d) Two homologous chromosomes

34. In which stage of cell division, chromosomes are most condensed?
a) Prophase b) Metaphase c) Anaphase d) Telophase

35. Which of the protein is found in spindle fibre?
a) Tubulin b) Albumin c) Mucin d) Haemoglobin

36. Which of the following events occurs during G_1-phase?
a) DNA replication
b) Growth and normal function of cell
c) Mutation
d) Fertilization

37. Select the correct statements regarding S-phase of interphase
I. Occurs between G_1 and G_2
II. DNA replication begins in the nucleus
III. Centrioles duplicate in the cytoplasm
IV. As DNA is doubled, number of chromosomes also doubles
The option with correct statements is
a) IV and III b) I, II, III and IV c) II, III and IV d) I, II and III

38. A material, which arrests cell division, is obtained from
a) *Crocus* b) *Colchicum* c) *Dalbergia* d) *Chrysanthemum*

39. During cell division, sometimes there will be failure of separation of sister chromatids. This event is called
a) Interference b) Complementation c) Non-disjunction d) Coincidence

40. I. The cells that do not divide further, exit G_1-phase to enter an inactive stage called ...A... phase of the cell cycle
II. The cells that are in G_2-phase definitely continue with the ...B... phase.
Identify A and B to complete the given NCERT statements
a) A-G_0; B-S b) A-S; B-G_0 c) A-M; B-G_0 d) A-G_0; B-M

41. Which type of chromosomes segregate when a cell undergoes meiosis?
a) Homologous chromosomes
b) Non- homologous chromosomes
c) Both (a) and (b)
d) Centric and acentric chromosomes

42. Term 'meiosis' was proposed by
a) Farmer and Moore b) Flemming c) Strasburger d) Darlington

43. Meiosis can be observed in
a) tapetal cells
b) Megaspores
c) Micropores
d) Spore mother cells

44. Crossing over that results in genetic recombination in higher organisms occurs between
a) Sister chromatids of bivalent
b) Non-Sister chromatids of a bivalent
c) Two daughter nuclei
d) Two different bivalents

45. In which of the following stage of the cell cycle, the attachment of spindle fibres to kinetochores of chromosomes occurs?
a) Prophase b) Metaphase c) Anaphase d) Telophase

46. The sequence of events by which a cell duplicates its genome, synthesizes the other constituents of the cell and eventually divides into two daughter cells is termed as
a) Cell division b) Cell cycle c) Cell growth d) Cell duplication

47. In animal cell has, cytokinesis involves
a) The separation of sister chromatids

b) The contraction of the contractile ring of micro filament
c) Depolymerization of kinetochore microtubules
d) A protein kinase that phosphorylaes other enzymes

48. Which is correct for meiotic metaphase-I?
a) Bivalents are arranged at equator
b) Univalents are arranged at equator
c) Non-homologous chromosomes forms pair
d) Spindle fibres are attached at chromomere

49. Crossing over is the exchange of genetic material between
a) Non-sister chromatids of the homologous chromosomes
b) Sister chromatids of the homologous chromosome
c) Chromatids of non-homologous chromosomes
d) The genes those are completely linked

50. Which of the following phase of the cell cycle is not a part of interphase?
a) S b) M c) G_0 d) G_1

51. Colchicine arrests which of the following stage of cell division?
a) Prophase b) Anaphase c) Telophase d) Metaphase

52. 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

53. Small disc-shaped structures at the surface of the centromeres that appear during metaphase are
a) Kinetochores b) Metaphase plate c) Spindle fibres d) Chromatid

54. Cell division can not be stopped in which phase of the cell cycle?
a) G_1-phase b) G_2-phase c) S-phase d) Prophase

55. Meiosis in AaBb will produce gametes
a) AB, aB, Ab, ab b) AB, ab c) Aa, bb d) Aa, Bb

56. The stage between two meiotic division is called
a) Interphase b) Cytokinesis c) Interkinesis d) Karyokinesis

57. If we ignore the effect of crossing over, how many different haploid cells arise by meiosis in a diploid cell having $2n = 12$?
a) 8 b) 16 c) 32 d) 64

58. Which of the following CdKs and cyclins comes under G_1 check point?
a) CdK_4/ Cyclin D b) CdK_6/ Cyclin D c) Both (a) and (b) d) CdK_2/ Cyclin B

59. Crossing over occurs at
a) Single strand stage
b) Two strand stage
c) Four strand stage
d) Eight strand stage

60. Chromosome number can be doubled by using which of the following?
a) Indole acetic acid
b) GA
c) Zeatin
d) Colchicines

61. Dictyotene a is prolonged
a) Leptotene b) Pachytene c) Diplotene d) Zygotene

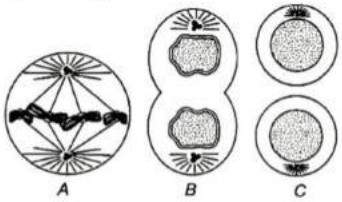
62. Which of the following is unique to mitosis and not a part of meiosis?
a) Homologous chromosomes behave independently
b) Chromatids are separated during anaphase

c) Homologous chromosomes pair and form bivalents
d) Homologous chromosomes crossover

63. Spindle fibre is made up of
a) Humulin
b) Intermediate filament
c) Flagellin
d) Tubulin

64. There are three genes a, b, c with percentage of crossing over between a and b is 20%, b and c is 28% and a and c is 8%. What is the sequence of genes on chromosome?
a) b, a, c b) a, b, c c) a, c, b d) None of these

65. See the diagrams carefully and identify the different stages of mitosis $(A - C)$ by choosing appropriate options given below



a) A-Metaphase; B-Telophase; C-Interphase
b) A-Telophase; B-Metaphase; C-Prophase
c) A-Anaphase; B-Telophase; C-Interphase
d) A-Telophase; B-Anaphase; C-Prophase

66. During which stage of meiosis, do tetrads line up at the equator?
a) Prophase-I b) Telophase-I c) Metaphase-I d) Anaphase-I

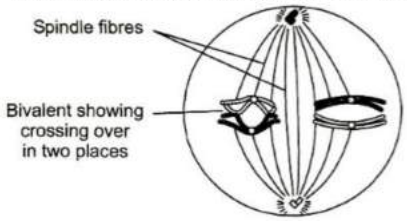
67. The anaphase promoting complex is activated by
a) M cdk cyclin b) G_1 cdk cyclin c) S cdk cyclin d) Transaction factor

68. A cell plate is laid down during
a) Cytokinesis
b) Karyokinesis
c) Interphase
d) None of these

69. During which stage of meiosis, do the sister chromatids begin to move towards the poles?
a) Prophase-I b) Telophase-I c) Anaphase-II d) Anaphase-I

70. In a cell cycle, which structures serves as the site of attachment of spindle fibres?
a) Chromosomes b) Histone c) Chromonemeta d) Kinetochore

71. Identify the diagram and name the phase of meiosis carefully



a) Telophase-I b) Anaphase-I c) Metaphase-I d) Prophase-I

72. Which of the following serves as mitotic spindle poison?
a) Ca^{2+} b) Mg^{2+} c) Tubulin d) Colchicine

73. Chromosomes are visible with chromatids at which phase of mitosis?
a) Interphase b) Prophase c) Metaphase d) Anaphase

74. RNA and proteins are formed in
a) G_1-phase b) G_2-phase c) S-phase d) G_0-phase

75. Give the name of the phases of meiosis, in which

I. the chromosome number is reduced to haploid state
II. the amount of DNA is reduced to haploid state
The correct option is
a) Anaphase-II; anaphase-I
b) Anaphase-I, metaphase-II
c) Anaphase-I, anaphase-II
d) Anaphase-II, metaphase-I

76. What type of cell division takes place in the functional megaspore initially in angiosperms?
a) Homeotypic without cytokinesis
b) Reductional without cytokinesis
c) Somatic followed by cytokinesis
d) Meiotic followed by cytokinesis

77. Which of the following statements are correct for multicellular cell division?
I. Cell division brings about embryonic development and growth
II. It plays a role in repair and maintenance of the body
III. It is important for reproduction
The correct option is
a) Only I b) I and III c) Only II d) I, II and III

78. Meiosis involves two sequential cycles of ...A... called meiosis-I and meiosis-II but only a single cycle of ...B...
Identify A and B to complete the given statement
a) A-nuclear and cell division, B-DNA replication b) A-cell division, B-DNA replication
c) A-DNA replication, B-cell division d) A-nuclear division, B-DNA replication

79. During, meiosis-I, the bivalent chromosomes clearly appear as tetrads during
a) Diakinesis b) Diplotene c) Leptotene d) Pachytene

80. DNA replicates
a) Twice in each cell cycle
b) Only once in each cell cycle
c) Once in mitotic cell cycle, once in meiotic-I (reductional division) and once in meiotic-II (equational division)
d) None of the above

81. Select the correct sequence of a cell cycle
a) $G_2 \rightarrow M \rightarrow G_1 \rightarrow S$ b) $S \rightarrow G_2 \rightarrow M \rightarrow G_1$
c) $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$ d) $M \rightarrow G_1 \rightarrow G_2 \rightarrow M$

82. Which of the following statements are correct for meiosis?
I. Meiosis is a double division. It gives rise to four cells
II. The cells undergoing meiosis may be haploid or diploid
III. No bouquet stage is recorded
IV. Pairing or synapsis of homologous chromosomes takes place during zygotene of prophase-I and continues upto metaphase-I
Option containing correct statement is
a) I only b) I and IV c) II and III d) All of these

83. Mature nerve cells are incapable of cell division. These cell are probably considered in
a) G_2-phase b) S-phase c) Mitosis d) G_0-phase

84. Mitosis or the equational division is usually restricted to ...A... cells. However, in some lower plants and in some social insects ...B... cells also divide by mitosis.
Choose the correct option for A and B from the given options
A B
a) Haploid; diploid b) Haploid; haploid c) Diploid; diploid d) Diploid; haploid

85. The spindles are formed of

a) Chromosome b) Actin c) Microtubules d) Myosin

86. During mitosis, ER and nucleolus begin to disappear at
a) Late prophase b) Early metaphase c) Late metaphase d) Early prophase

87. The plane of alignment of chromosome at the metaphase stage of cell cycle is referred to as the
a) Prophase plate b) Metaphase plate c) Anaphase plate d) Telophase plate

88. From the following, identify the two correct statements with reference to meiosis
I. Bead-like structures are absent on chromosomes
II. Displacement of chiasmata occurs in diakinesis
III. Separation of two basic sets of chromosomes
IV. No division of centromere
The correct option is
a) II and III b) II and IV c) III and IV d) I and III

89. Consider the following statements about colchicine
I. It is an alkaloid widely used in plant breeding for doubling the chromosome number
II. Colchicine induced polyploidy has been used in raising several varieties of horticulture and agricultural plants
Which of the statements given above is/are correct?
a) Only I b) Only II c) Both I and II d) None of these

90. Separation of linked genes is called
a) Linkage b) Segregation c) Crossing over d) Genetic mutation

91. Sequence of four phases of cell cycle is
a) $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$
b) $G_1 \rightarrow G_2 \rightarrow S \rightarrow M$
c) $S \rightarrow G_1 \rightarrow G_2 \rightarrow M$
d) $M \rightarrow G_1 \rightarrow G_2 \rightarrow S$

92. The division of the cytoplasm is termed as
a) Karyokinesis b) Mitosis c) Cytokinesis d) Meiosis

93. Cell would normally proceed to mitosis without interruption
a) Once it had started the S-period
b) Once it had entered the G_2-phase
c) At anytime during cell division
d) None of the above

94. The two chromatids of a metaphase chromosome represent
a) Replicated chromosomes to be separated at anaphase
b) Homologous chromosomes of a diploid set
c) Non-homologous chromosomes joined at the centromere
d) Maternal and paternal chromosomes joined at the centromere

95. In the process of mitotic division during interphase, chromosome material remains in the form of very loosely coiled threads called
a) Chromosome b) Chromatin c) Chromatid d) Microtubules

96. Which is synthesized in G_1-phase?
a) DNA polymerase b) Histones c) Nucleolar DNA d) Tubulin protein

97. Which of the following occurs more than one and less than five in a chromosome?
a) Chromatid b) Chromomere c) Centromere d) Telomere

98. Longest phase of meiosis, is
a) Prophase-I b) Prophase-II c) Anaphase-I d) Metaphase-II

99. Mitotic stages are not observed in
a) *Cosmarium* b) *E. coli* c) *Saccharomyces* d) *Chlorella*

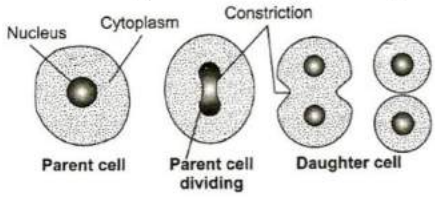
100. Crossing over is also an enzyme mediated process and the enzyme involved is called
a) Ligase b) Polymerase c) Recombinase d) Endonuclease

101. Which one of the following stages corresponds to Mendel's law of independent assortment?
a) Anaphase-II b) Anaphase-I c) Metaphase-I d) Telophase-I

102. Which stages of mitosis is known for occurrence of cytokinesis?
a) Metaphase b) Telophase c) Anaphase d) None of these

103. Characteristic of meiosis is
a) Two nuclear and two chromosome divisions
b) Two nuclear and one chromosome division
c) One nuclear and two chromosome divisions
d) One nuclear and one chromosome division

104. See the diagram carefully and sequentially arrange the steps of amitosis given below?



I. The constriction appears in the cytoplasm
II. The nucleus of cell elongates and develops a constriction round its middle
III. The constriction in nucleus gradually deepens and finally cuts the nucleus into two daughter nuclei
IV. The cytoplasmic constriction divides the parent cell into two daughter cells, each with a nucleus
Option containing correct sequence of events is
a) I → III → II → IV b) I → II → III → IV c) II → I → III → IV d) II → III → I → IV

105. The number of mitotic cell divisions required to produce 256 cells from single cell would be
a) 10 b) 12 c) 6 d) 8

106. The second check point in cell cycle occurs at
a) $G_0 - G_1$ b) $G_1 - G_2$ c) G_1 –S d) G_2 –M

107. The M-phase starts with the ...A..., corresponding to the separation of daughter chromosomes, known as ...B... and usually ends with division of cytoplasm which is known as ...C...
Identify A-C to complete the given NCERT statement
a) A-cell division; B-cytokinesis; C-karyokinesis
b) A-nuclear division; B-karyokinesis; C-cytokinesis
c) A-cell division; B-karyokinesis; C-cytokinesis
d) A-nuclear division; B-cytokinesis; C-karyokinesis

108. DNA replication in a cell cycle occurs during
a) G_1-phase b) S-phase c) G_2-phase d) M-phase

109. If the cell has 14 chromosomes at interphase. Than how many chromosomes will the cell have at G_1-phase of cell cycle?
a) 28 b) 14 c) 7 d) 21

110. When parental and maternal chromosomes change their material with each other in cell division, this event is called
a) Bivalent forming b) Crossing over c) Synapsis d) Dyad forming

111. Which of the following stage is responsible for the appearance of Lampbrush chromosomes?
a) Meiotic prophase b) Mitotic prophase c) Mitotic anaphase d) Mitotic metaphase

112. The given figure is the representation of a certain event at a particular stage of a type of cell division. Identify the stage and choose the correct option?

a) Prophase-I during meiosis
b) Prophase-II during meiosis
c) Prophase during meiosis
d) Both prophase and metaphase of mitosis

113. Chiasmata are most appropriately observed in meiosis during
a) Diakinesis
b) Diplotene
c) Metaphase-II
d) Pachytene

114. In which of the following stages, the chromosome is single thin and like long thread?
a) Leptotene
b) Zygotene
c) Pachytene
d) Diakinesis

115. From the following, identify the two correct statements with reference to meiosis
I. Bead like reference to meiosis
II. Displacement of chaismata occurs in diakinesic
III. Separation of two basic sets of chromosomes
IV. No division of centromere
The correct option is
a) II, III
b) II, IV
c) III, IV
d) I, III

116. Which of the following stage of cell cycle is known as quiescent stage?
a) G_1-phase
b) S-phase
c) G_0-phase
d) G_2-phase

117. At which stage of mitosis, chromatids separated and passes to different poles?
a) Prophase
b) Metaphase
c) Anaphase
d) Telophase

118. When dividing cells are examined under a light microscope, chromosomes become visible in
a) Interphase
b) S-phase
c) Prophase
d) G_1-phase

119. Phenomenon of crossing over in diploid organisms is responsible for
a) Linkages between genes
b) Recombination between linked genes
c) Segregation between genes
d) Dominance of gene

120. In G_1-phase of cell cycle, what would be the change in DNA content of the cell?
a) DNA content increases to double
b) DNA content gets reduced
c) Four fold increase of DNA content
d) No change in DNA content

121. What is the approximate duration of cell cycle for a mammalian cell?
a) 90 min
b) 24 hrs
c) 24 days
d) 12 hrs

122. Karyokinesis refers to the division of
a) The cytoplasm
b) The nucleus
c) Cytoplasm and nucleus
d) all constituents of the cell

123. Which of the following statements are correct for cell cycle?
I. Cell cycle is the sequence of events involving growth and division of a cell from the time of its formation to its own division into daughter cells
II. Cell growth (in terms of cytoplasmic increase) is a continuous process
III. DNA synthesis occurs only during one specific stage in the cell cycle
IV. The replicated chromosomes (DNA) are distributed to daughter nuclei during cell division
a) I and III
b) I and II
c) III and IV
d) I, II, III and IV

124. Which of the following statement is true for cells in G_0 stage of cell cycle?
a) Cells in G_0 stage are metabolically more active
b) Cells are metabolically inactive
c) Cells are metabolically active but no longer proliferate in normal condition
d) None of the above

125. In which stage of the first meiotic division, two sister chromatids are formed?
a) Leptotene
b) Zygotene
c) Pachytene
d) Diplotene

126. Synapsis occurs in ..... phase of meiosis.

a) Zygotene
b) Diplotene
c) Pachytene
d) Leptotene

127. Mitosis usually results in the
a) Production of diploid daughter cells
b) Growth of multicellular organisms
c) Cell repair
d) All of the above

128. Which of the following type of cell cycle is known as equational division?
a) Amitosis
b) Mitosis
c) Meiosis
d) None of the above

129. The complete disintegration of nuclear envelope in a cell cycle marks the
a) Start of prophase of mitosis
b) Start of metaphase of mitosis
c) End of anaphase of mitosis
d) Start of telophase of mitosis

130. Chromosomes are arranged along the equator during
a) Prophase
b) Metaphase
c) Anaphase
d) Telophase

131. What is the average duration for mitosis?
a) 3 min 30 min
b) 3 hr to 5 hr
c) 30 min to 3 hr
d) 2 hr to 3 hr

132. Which of the following stage of mitosis follows the S and G_2-phases of interphases?
a) Prophase
b) Metaphase
c) Anaphase
d) Telophase

133. I. Phases of cell cycle are controlled by proteins, ...A... and ...B...
II. There are two regulatory mechanisms, called ...C... which take decision about cell division.
III. The second check point, called ...D... is responsible for transition from G_2 to M-phase.
Identify A-D to complete the given statements (I-III)
a) A-cyclins; B-CdKs; C-check points; D-mitotic cyclin (Cm)
b) A-cyclins; B-check points; C-mitotic cyclin, D-CdKs
c) A-mitotic cyclin (Cm), B-CdKs; C-check points, D-Cyclin
d) A-mitotic cyclin (Cm), B-cyclins; C-check points, D-CdKs

134. When synapsis is complete all along the chromosome, the cell is said to have entered a stage called
a) Zygotene
b) Pachytene
c) Diplotene
d) Diakinesis

135. 'XX' is a phase of mitosis, in which the chromatin condenses into discrete chromosomes. During 'XX' phase, nuclear envelope breaks down and spindles forms at opposite ends of the cell
Identify 'XX'
a) Interphase
b) Anaphase
c) Telophase
d) Prophase

136. Which of the following CdKs and cyclins comes under G_2 check point?
a) CdK_4/ Cyclin B
b) CdK_2/ Cyclin B
c) CdK_6/ Cyclin B
d) CdK_2/ Cyclin D

137. Mitosis is divided into
a) Five stages
b) Three stages
c) Four stages
d) Six stages

138. Which of the following statements (events) is/are true for mitotic telophase?
a) Nucleolus, GB and ER form
b) NM assembles around each chromosomes clusters
c) Arrival of chromosomes cluster at opposite poles and loss of their identity as discrete elements
d) All of the above

139. Identify A-C in the given statements, and choose the correct option
I. Spindle microtubules that extend from the two poles of a dividing cell are called ...A...
II. A centromere connects two identical copies of a single chromosomes. These two copies are called ...B...
III. In 'X' phase, the paired chromosomes separate and begin moving to opposite ends of the cell. This 'X' is called ...C...
a) A-kinetochore fibres; B-chromatids; C-metaphase
b) A-polar fibres; B-homologous chromosomes; C-Prophase
c) A-polar fibres; B-sister chromatids; C-anaphase
d) A-kinetochore fibres; B-asters; C-anaphase

140. Among the following, which one is longest phase in prophase of meiosis?
a) Leptotene b) Zygotene c) Pachytene d) Diplotene

141. The interphase is divided into three main phases. There phases are
a) G_1-phase, M-phase and G_2-phase
b) M-phase, S-phase and divisional phase
c) Gap 1 phase, synthesis phase and gap 2 phase
d) M-phase G_2-phase and divisional phase

142. In which of the following stages of the cell cycle chromosome number becomes half?
a) Metaphase-I b) Anaphase-I c) Prophase-I d) Metaphase-II

143. What type of plant is formed when colchicines is used in the process of development of *Raphanobrassica*?
a) Triploid b) Haploid c) Autotetraploid d) Allotetraploid

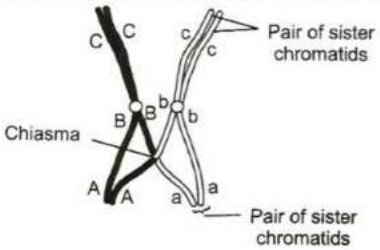
144. The proteins involved in the movement of chromosomes towards the poles during cell division are
a) Actin b) Myosin c) Tubulin d) Elastin

145. Which of the following specie's haploid cell has maximum chromosome counts?
a) *Ophioglossum* b) Cat c) *Allium* d) Dog

146. Which one of the following precedes re-formation of the nuclear envelope during M-phase of the cell cycle?
a) Decondensation from chromosome 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

147. Synaptonemal complex is formed during
a) Pachytene b) Zygotene c) Leptotene d) Diplotene

148. Identify the diagram and name the stage of meiosis correctly



a) Pachytene (crossing over) b) Zygotene
c) Leptotene d) Diplotene

149. G_0-phase is
a) Phase after G_2-phase
b) Phase after M-phase, in which daughter cell enters new cell cycle
c) Arrest of cell cycle on the onset of differentiation
d) All of the above

150. During cell division, chromosome attaches with spindles
a) Kinetochore
b) Centrosome
c) Centriole
d) Secondary constriction

151. The spindle microtubules are polar, their orientation is
a) Positive (+) and negative (-) both ends towards the equator
b) Positive (+) ends towards the poles
c) negative (-) ends towards the poles
d) Positive (+) and negative (-) both ends towards the poles

152. The non-sister chromatids twist around and exchange segments with each other during
a) Diplotene b) Diakinesis c) Leptotene d) Pachytene

153. Two basic stages of cell cycle are
a) Interphase and M-phase/divisional phase
b) Karyokinesis and cytokinesis
c) Prophase, metaphase, anaphase and telophase
d) G_1, S and G_2 phases

154. Which of the following statements are correct for G_1-phase?
I. It is the last substage of interphase
II. Cell organelles do not increase in number
III. Both cell and nucleus grow in size
IV. It synthesizes RNAs, proteins and other biochemical for cell growth and subsequent replication of DNA
Choose the correct option
a) I and II b) II and IV c) I and III d) II and III

155. From the following identify the two correct statements with reference to meiosis
I. Bead-like structures are absent on chromosomes.
II. Displacement of chiasmata occurs in diakinesis.
III. Separation of two basic sets of chromosomes.
IV. No division of centromere.
a) II,III b) II,IV c) III,IV d) I,III

156. The S-phase of cell cycle is characterized by
a) Duplication of chromosome
b) Shortening of chromosome
c) Duplication of DNA
d) Duplication of centriole

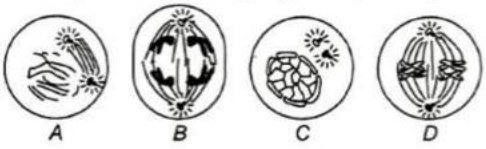
157. Congression is a phenomenon of
a) Movement of sister chromatids towards the poles
b) Pairing of homologous chromosomes
c) Separation of paired chromosomes
d) Bringing the chromosomes on equator of spindle apparatus

158. Find the correctly matched pairs and choose the correct option
I. Leptotene – The chromosomes become invisible
II. Zygotene – Pairing of homologous chromosomes
III. Pachytene – Dissolution of the synaptonemal complex takes place
IV. Diplotene – Bivalent chromosomes appear as tetrads
V. Diakinesis – Terminalisation of chiasmata takes place
a) I and II b) II and IV c) II and V d) II and III

159. The number of DNA strands in chromosome at G_2-stage is
a) One b) Two c) Four d) Eight

160. Meiosis occurs in which of the following cells?
a) Sperm cells b) Unicellular organisms c) Liver cells d) All of these

161. Identify the following figures $(A - D)$ and choose the correct option

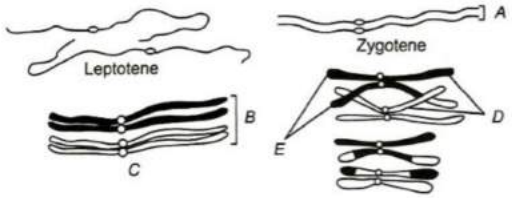


a) A-Metaphase-II, B-Anaphase-I, C-Prophase-I, D-Anaphase-II
b) A-Prophase-I, B-Anaphase-I, C-Interphase, D-Metaphase-I
c) A-Metaphase-I, B-Anaphase-I, C-Prophase-I, D-Anaphase-II
d) A-Prophase-II, B-Anaphase-I, C-Interphase, D-Metaphase-II

162. During the G_1-phase of cell division
a) RNA and proteins are synthesized

b) DNA and proteins are synthesized
c) Cell prepares for M-phase
d) Cell undergoes duplication

163. Study the diagram showing meiosis carefully and choose the correct options for $A - E$



a) A –Tetrad, B –Bivalent, C –Zygotene stage, D –Sister chromatids, E –Non-sister chromatids
b) A –Bivalent, B –Tetrad, C –Pachytene stage, D –Crossing over, E –Non-sister chromatids
c) A –Bivalent, B –Tetrad, C –Pachytene stage, D-Non-Sister chromatids, E-Sister chromatids
d) A –Bivalent, B –Tetrad, C –Pachytene stage, D –Sister chromatids, E –Non-Sister chromatids

164. In ...A.... phase, there is synthesis of RNAs and proteins that are needed for cell growth and replication of DNA. While it is ...B... phase, where synthesis of protein occur that is needed for spindle formation and mitosis to continue.
Identify A and B to complete the given statement
a) A-G; B-S b) A-G_2; B-S c) A-G; B-G_2 d) None of these

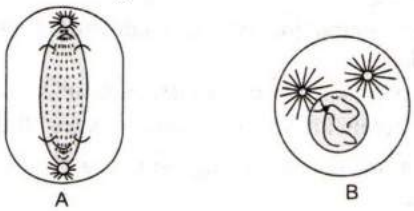
165. Interphase nucleus is enclosed by
a) Non-porous nuclear membrane
b) Porous double nuclear membrane
c) Non-porous double discontinuous nuclear membrane
d) A single porous unit membrane

166. Read the following statements and select the correct option
I. M-phase represents the phase when the actual cell division or mitosis occurs
II. Interphase represents the phase between two successive M-phases
III. In the 24 hrs average duration of cell cycle of a human cell, cell division proper lasts for only about an hour
IV. The M-phase lasts more than 95% of the duration of cell cycle
a) I, II and III b) II and IV c) II, III and IV d) I and IV

167. What change would occur in DNA content, during S-phase?
a) No change
b) The amount of DNA per cell doubles
c) The amount of DNA per cell increase four folds
d) The amount of DNA per cell decreases

168. In meiosis, the daughter cells are not similar to that of parent because of
a) Crossing over b) Synapsis c) Both (a) and (b) d) None of these

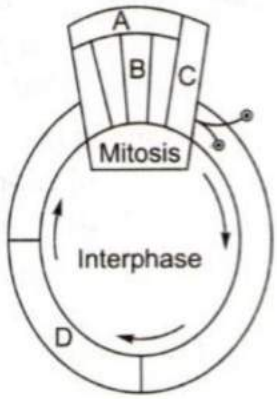
169. Which stages of cell division do the following figures 'A' and 'B' represent respectively?



a) Metaphase - Telophase
b) Telophase - Metaphase
c) Late anaphase - Prophase
d) Prophase - Anaphase

170. During cell cycle, RNA and non-histone proteins are synthesized in
a) S-phase b) G -phase c) G -phase d) M-phase

171. Alleles of different genes that are on the same chromosome may occasionally separated by a phenomenon known as
   a) Pleiotropy
   b) Epistasis
   c) Continuous variation
   d) Crossing over
172. In meiosis, division is
   a) I reductional and II equational
   b) I equational and II reductional
   c) Both reductional
   d) Both equational
173. Cells in G_0-phase of cell cycle
   a) Exit cell cycle
   b) Enter cell cycle
   c) Suspend cell cycle
   d) Terminate cell cycle
174. 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) B-Metaphase b) C-Karyokinesis c) D-Synthetic phase d) A-Cytokinesis
175. Choose the correct answer for the statements given below
   I. Protein involved in the shortening and thickening of chromosome fibres
   II. The name of early prophase when elongated chromosomes occur in overlapped condition like a ball of wool without their ends being visible
   III. Each group of astral rays along with its centriole pair
   IV. Name the narrow point which is responsible for attaching two sister chromatids to each other
   a) I-Codensins, II-Aster, III-Spirme stage, IV-Kinetochore
   b) I-Codensins, II-Aster, III-Spirme stage, IV-Centromere
   c) I-Codensins, II-Spirme stage, III-Aster, IV-Centromere
   d) I-Tubulins, II-Spirme stage, III-Amphiaster, IV-Kinetochore
176. 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
177. In cell cycle, during which phase chromosomes are arranged at equatorial plate?
   a) Metaphase b) Anaphase c) Telophase d) Prophase
178. Meiosis in a plant occurs when there is a change
   a) From gametophyte to sporophyte
   b) From sporophyte to gametophyte
   c) From gametophyte to gametophyte

d) From sporophyte to sporophyte

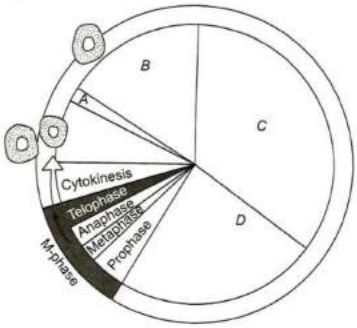
179. When number of chromosomes is already reduced to half in the first reductional division of meiosis, what is the necessity of second meiotic division?
    a) The division is required for the formation of four gametes
    b) Divisions ensures equal distribution of haploid chromosomes
    c) Division ensures equal distribution of genes on chromosomes
    d) Division is required for segregation of replicated chromosomes
180. Select the correct option
    a) Division of the cytoplasm occurs before the division of the nucleus
    b) Division of the nucleus occurs before the division of the cytoplasm
    c) Both the division of the nucleus and cytoplasm occurs at the same time
    d) None of the above
181. During meiotic division, the
    a) Homologous chromosomes are separated
    b) The linkage is disturbed
    c) The homologous chromosomes do not segregate
    d) All of the above
182. Recombination is involved in the process of
    a) Cytokinesis
    b) Spindle formation
    c) Crossing over
    d) Chromosome duplication
183. A diploid living organism develops from zygote by which type of the following repeated cell divisions?
    a) Meiosis b) Amitosis c) Mitosis d) Segmentation
184. Pick out the correct statements.
    I.Synapsis of homologous chromosomes takes place during prophase-I of meiosis.
    II.Division of centromeres takes place during anaphase-I of meiosis.
    III.Spindle fibres disappear completely in telophase of mitosis.
    IV.Nucleoli reappear at telophase-I of meiosis.
    a) I only b) III only c) I and II only d) I, III and IV only
185. An egg cell has 5pico gram of DNA in its nucleus. How much amount of DNA will be, in this animal, at the end of G_2-phase of mitosis?
    a) 2.5pico gram b) 5pico gram c) 5 g d) 20pico gram
186. The term 'meiosis' was given by
    a) Rusk b) Flemming c) Johannsen d) Former and Moore
187. After the separation of centromeres during mitosis, the chromatids move towards opposite poles of the spindle. Name the term used for these chromatids
    a) Daughter chromosomes b) Kinetochores
    c) Half spindles d) Centrosomes
188. In which phase, proteins for spindle fibre are synthesized?
    a) G_1-phase b) G_2-phase c) S-phase d) Anaphase
189. In meiosis-I, a bivalent is an association of
    a) Four chromatids and four centromeres
    b) Two chromatids and two centromeres
    c) Two chromatids and one centromeres
    d) Four chromatids and two centromeres
190. Colchicine arrests spindle at
    a) Anaphase b) Prophase c) Telophase d) Metaphase
191. How many chromosomes will the cell the cell have at G_1, after S and after M-phase respectively, if it has 14 chromosomes at interphase?

a) 14,14,7 b) 14,14,14 c) 7,7,7 d) 7,14,14

192. Chiasmata are formed due to
a) Crossing over of same part between homologous chromosomes
b) Crossing over of same part between non-homologous chromosomes
c) Duplication of homologous and non-homologous chromosomes
d) Loss of some part of chromosomes

193. Which of the following shows diplotene stage of cell cycle?
a) Separation of synapsed homologous chromosomes except at the site of cross overs
b) Degenecation of nucleolus
c) Chiasmata shift towards cheromosome ends
d) All of the above

194. Given diagram represents the events occurring in cell cycle. Identify A, B, C and D and select the correct option



A B C D
a) G_0 G_1 S G_2 b) G_1 G_0 S G_2 c) S G_0 G_1 G_2 d) G_1 S G_2 G_0

195. 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 interphase is followed by a long mitotic phase
d) G_2-phase follows mitotic phase

196. Which phase comes in between the G_1 and G_2 phases of cell cycle?
a) M-phase b) G_0-phase c) S-phase d) Interphase

197. Select the event of cell cycle which shows the importance of synapsis and the formation of chiasmata
a) An increase in the variation of progeny occurs b) The DNA on homologous chromosomes mix
c) Reciprocal exchange of chromosomal sections occurs d) All of the above

198. Mitosis is a process by which eukaryotic cells
a) Grow
b) Get specialized in structure
c) Multiply
d) Expose the genes

199. Phragmoplast is
a) Proplasted in cytoplasm of dividing cells
b) Cell plate formed by vesicles ER and dictyosomes during cytokinesis
c) Cell plate formed by ER, dictyosomes, secretory vesicles and spindle fibre
d) None of the above

200. Mitosis is characterized by
a) Reduction division b) Equal division
c) Both (a) and (b) d) Absence of spindle formation

201. Choose the correct sequence of two main events in mitosis
a) Karyokinesis followed by cytokinesis

b) Cytokinesis followed by karyokinesis
c) Karyokinesis followed by separation of the daughter cells
d) Cytokinesis followed by separation of the daughter cells

202. What is the correct sequence of the steps given here?
Also work out the process depicted in the steps?
V. Homologous chromosomes move toward opposite poles of the cell; chromatids do not separate.
VI. Chromosomes gather together at the two poles of the cell and the nuclear membrances reform.
VII. Homologous chromosomes pair and exchanges segments.
VIII. Homologous chromosomes align on a central plate.
IX. The haploid cells separate completely.
a) The correct sequence is III → IV → I → II → V and the process is meiosis-I
b) The correct sequence is II → I → V → IV → III and the process is mitosis
c) The correct sequence is IV → I → III → II → V and the process is meiosis-I
d) The correct sequence is II → V → IV → I → III and the process is mitosis

203. What is the nature of cells formed at the end of meiosis-II?
a) Haploid b) Diploid c) Tetrad d) None of these

204. Significance of meiosis lies in
a) Reduction of chromosome number to one half
b) Maintaining consistency of chromosome number during sexual reproduction
c) Production of genetic variability
d) All of the above

205. The major event that occurs during the anaphase of mitosis, which brings about the equal distribution of chromosomes is
a) Replication of the genetic material
b) Splitting of the chromatids
c) Splitting of the centromeres
d) Condensation of the chromatin

206. Chiasma shows the sites of
a) Spindle formation b) Synapsis c) Crossing over d) None of these

207. What is the function of centromere?
a) Cell division
b) Cell plate formation
c) Cell differentiation
d) Cell wall formation

208. The cell cycle of yeast takes about
a) 24 hrs b) 60 min c) 30 min d) 90 min

209. What is not seen during mitosis in somatic cells?
a) Spindle fibre
b) Chromosomes movement
c) Disappearance of nucleolus
d) Synapsis

210. In which phase, DNA content will be doubled?
a) Interphase b) Anaphase c) Prophase d) Telophase

211. At which stage of cell cycle colchicine arrests the spindle?
a) Anaphase b) Prophase c) Telophase d) Interphase

212. Arrange the following events of meiosis in the correct sequence.
X. Terminalization
XI. Crossing over
XII. Synapsis
XIII. Disjunction of genomes

The correct sequence is

a) 4, 3, 2, 1 b) 3, 2, 1, 4 c) 2, 1, 4, 3 d) 1, 4, 3, 2

213. Spindle fibre is made up of
   a) Tubulin
   b) Humulin
   c) Intermediate filament
   d) Flagellin
214. Diakinesis is marked by
   a) Terminalisation of chiasmata b) Degeneration of nucleolus
   c) Chiasmata shift towards chromosome ends d) All of the above
215. Cleavage is a unique form of mitotic cell division in which
   a) There is no growth of cells
   b) The nucleus does not participate
   c) No spindle developers to guide the cells
   d) The plasma membranes of daughter cells do not separate
216. In plant cell has 12 chromosomes at the end of mitosis. How many chromosomes would it have in the G_2-phase of its next cell cycle?

   a) 6 b) 8 c) 12 d) 24
217. Meiosis occurs in organism during
   a) Vegetative reproduction b) Sexual reproduction
   c) Both (a) and (b) d) None of these
218. Chromosome reaches their respective poles in which of the following stages of mitosis?

   a) Cytokinesis b) Interphase c) S-phase d) Telophase
219. Replication of centriole occurs during

   a) Interphase b) Prophase c) Late prophase d) Late telophase
220. Genetic recombination is due to
   a) Fertilization and meiosis
   b) Mitosis and meiosis
   c) Fertilization and mitosis
   d) None of these
221. Pick out the correct statements.

   I.Mitosis takes place in the somatic cells and meiosis takes place in the germ cells

   II.During mitosis, the DNA replicates once for one cell division and in meiosis the DNA replicates twice for two cell divisions.

   III.Mitosis and meiosis occur both in sexually and asexually reproducing organisms.

   a) I only b) II only c) III only d) I and II only
222. Chromatid formation takes place in

   a) S-phase b) Metaphase c) G_1-phase d) G_2-phase
223. 56 cells are produced in meiosis where first division is
   a) Equal
   b) Reduction
   c) Mitosis
   d) None of these
224. A cell in post reproductive stage remains in

   a) G_2-phase b) S-phase c) G_1-phase d) M-phase
225. Most cytogenic activities occur during

   a) Interphase b) Telophase c) Prophase d) Anaphase
226. The term, mitosis was coined by

   a) Flemming b) Strasburger c) Remak d) Moore
227. Which of the following character is related with telophase?

a) Formation of nuclear membrane
b) Formation of nucleolus
c) Elongation of chromosome
d) Formation of two daughter nuclei

CELL CYCLE AND CELL DIVISION

: ANSWER KEY :

1)	c	2)	a	3)	d	4)	d	117)	c	118)	c	119)	b	120)	d
5)	a	6)	a	7)	b	8)	d	121)	b	122)	b	123)	d	124)	c
9)	c	10)	d	11)	b	12)	b	125)	c	126)	a	127)	a	128)	b
13)	a	14)	a	15)	b	16)	d	129)	b	130)	b	131)	c	132)	a
17)	c	18)	c	19)	d	20)	c	133)	a	134)	b	135)	d	136)	b
21)	b	22)	b	23)	a	24)	b	137)	c	138)	d	139)	c	140)	c
25)	b	26)	d	27)	a	28)	a	141)	c	142)	b	143)	d	144)	c
29)	a	30)	d	31)	b	32)	a	145)	a	146)	a	147)	b	148)	a
33)	d	34)	b	35)	a	36)	b	149)	c	150)	a	151)	c	152)	d
37)	d	38)	b	39)	c	40)	d	153)	a	154)	b	155)	a	156)	c
41)	a	42)	a	43)	d	44)	b	157)	d	158)	c	159)	c	160)	a
45)	b	46)	b	47)	b	48)	a	161)	b	162)	a	163)	a	164)	c
49)	a	50)	b	51)	d	52)	c	165)	b	166)	a	167)	b	168)	a
53)	a	54)	c	55)	a	56)	c	169)	c	170)	c	171)	d	172)	b
57)	d	58)	c	59)	c	60)	d	173)	c	174)	c	175)	c	176)	a
61)	c	62)	a	63)	d	64)	a	177)	a	178)	b	179)	d	180)	b
65)	a	66)	c	67)	a	68)	a	181)	a	182)	c	183)	c	184)	d
69)	d	70)	d	71)	c	72)	d	185)	d	186)	d	187)	a	188)	b
73)	c	74)	b	75)	c	76)	a	189)	d	190)	d	191)	b	192)	a
77)	d	78)	a	79)	d	80)	b	193)	d	194)	a	195)	b	196)	c
81)	c	82)	b	83)	d	84)	d	197)	a	198)	c	199)	b	200)	b
85)	c	86)	d	87)	b	88)	a	201)	a	202)	a	203)	a	204)	d
89)	c	90)	c	91)	a	92)	c	205)	c	206)	c	207)	b	208)	d
93)	a	94)	a	95)	b	96)	a	209)	d	210)	a	211)	a	212)	b
97)	d	98)	a	99)	b	100)	c	213)	a	214)	d	215)	c	216)	c
101)	b	102)	b	103)	b	104)	d	217)	b	218)	d	219)	a	220)	a
105)	d	106)	d	107)	b	108)	b	221)	a	222)	a	223)	b	224)	c
109)	b	110)	a	111)	a	112)	a	225)	a	226)	a	227)	d		
113)	b	114)	a	115)	d	116)	c								

CELL CYCLE AND CELL DIVISION

: HINTS AND SOLUTIONS :

1 **(c)**
Meiosis first is allowed by second meiotic division, which is essentially a mitotic division and is referred as mitotic. In anaphase-II of meiosis-II, the chromosome and centromere divide. The sister chromatids separate and move towards opposite pole.

2 **(a)**
In meiosis (meiotic-I), chromosome number becomes half to that of parent chromosome.

3 **(d)**
Plant cytokinesis usually occurs by cell plate method. The spindle usually pesists during cytokinesis. Central part of spindle grows in size and forms an interdigited complex called phragmoplast. Cell plate grows centrifugally

4 **(d)**
A-G_1, B-S, C-G_2.
Post reproductive stage of a cell includes cell growth. The term cell growth is used in the contexts of cell development and cell division. As we are concerned about growth (development) only, it refers to the growth of cell that is to increase in cytoplasmic and organelle volume that is in G_1-phase
S-phase is the sub-phase between G_1-phase and G_2-phase, during which DNA synthesis or replication takes place.
In animal cells, during the S-phase, DNA replication begins in the nucleus and the centriole duplication in the cytoplasm. The amount of DNA per cell doubles in the nucleus. If the initial amount of DNA is denoted as 2C, then it increases to 4C. However, there is no increase in the chromosome number

5 **(a)**
S or **synthetic** phase marks the period during which DNA synthesis or replication takes place. During this phase, the amount of DNA per cell doubles.

The second stage of prophase-I is called zygotene. During this stage, chromosomes start pairing together and this process of association is called **synapsis**. Such paired chromosomes are called **homologous chromosomes**. Synapsis is accompanied by the formation of a complex structure called **synaptonemal complex**.

6 **(a)**
Mitosis is one of the types of cell division, which helps in regeneration. Because it keeps all the somatic cells of an organism genetically similar, so that they are able to regenerate a part or whole of the organism

7 **(b)**
During meiosis, four haploid cells are produced by reductional division from a single diploid cell. Parent cell contains replicated chromosomes, but the daughter cells contains unreplicated chromosomes

8 **(d)**
The interphase, as called the resting phase, is the time during which the cell is preparing for division by undergoing both cell growth and DNA replication.
It is the phase between two successive M-phases
The interphase is divided into three further classes
G_1-phase (Gap 1), S-phase (synthesis) and G_2-phase (Gap 2)

9 **(c)**
Crossing over occurs during **pachytene** or **thick thread** or **pachynema** substage of prophase-I of meiosis. During this stage, an exchange of portions of chromatids between homologous chromosomes occur. At chiasma, the chromatids break rejoin in such a way that sections are exchanged.

10 **(d)**
Out of two alleles present at the same locus of two chromosomes of a homologous pair, one is

transmitted to a gamete as the later receive one chromosome of a homologous pair.

11 **(b)**
In plant cells, cytokinesis occurs by cell plate formation. A number of elements called phragmoplasts are derived from ER and Golgi body. These elements line up at equator during anaphase and later fuse to form cell plate.

12 **(b)**
During metaphase, the nuclear envelope disintegrates and the chromosomes are spread through the cytoplasm of the cell. Condensation of chromosomes is completed and it can be observed under the microscope. At this stage, the morphology as well as the number of chromosomes can be easily studied

13 **(a)**
Interphase has variable duration. During this period, the DNA of chromosomes replicates. Chromosome material is in the form of very loosely coiled threads called chromatin. Centrioles already have replicated

14 **(a)**
During **anaphase-I**, the number of chromosomes become half.

15 **(b)**
G_0-phase.
Some cells that do not divide further, exit G_1-phase and enter an inactive stage called quiescent stage (G_0) of the cell cycle. Cells in this stage remains metabolically active but no longer proliferate unless called on to do so depending on the requirement of the organism

16 **(d)**
The interphase is also called the resting phase. It is the time during which the cell gets prepared for division by undergoing both cell and DNA replication in an orderly manner

17 **(c)**
The cells, which do not divide further, do not proceed beyond the G_1-phase and start undergoing differentiation into specific type are said to be in G_0-phase.

18 **(c)**
Division of **cyptoplasm** is called cytokinesis (Gr. *kitos*=cell; **kinesis**=movement).

19 **(d)**
At the end of prophase, several characteristic events can be observed. Chromosomal material condenses to form compact mitotic chromosomes. Two chromatids attach together to form chromosomes
Assembly of mitotic spindle is initiated by, microtubules (proteinaceous components) of the cell cytoplasm. When observed under the microscope cells at the last stage of prophase, do not shows cell organelles like, Golgi complexes, endoplasmic reticulum, nucleolus and the nuclear envelope

20 **(c)**

Prophase-I of Meiosis	**Prophase of Mitosis**
Prophase-I is very long and elaborate, comprising 5 sub-phases	Prophase is relatively very short and simple
Prophase chromosomes appear double from the very start	Prophase-I chromosome do not look double in the beginning
There is no pairing of homologous Chromosomes, hence no chance of crossing over	Homologous chromosomes pair and often undergo crossing over in prophase-I

21 **(b)**
Mitosis was first observed by **Strasburger** and termed by **W Flemming**. During mitosis, chromosome number remain same in the daughter cells. During meiosis (reduction division), the chromosome number reduced to half in the daughter cells.

22 **(b)**
Telophase is the reverse stage of prophase. During this phase, the cytoplasmic viscosity decreases and the two chromosome groups reorganize themselves into nuclei. A nucleae envelope appears outside the nucleoplasm collected in the area of chromatin. Spindle fibres disappear around the poles and Golgi complex and endoplasmic reticulum are reformed

23 **(a)**
During S-phase, there is no increase in the chromosomes number. If the cell has diploid or $2n$ number of chromosomes at G_1, even after S-phase the number of chromosomes remains the same, *i.e., 2n*

24 **(b)**
The correct sequence is
Synapsis → crossing over → terminalisation → disjunction of genomes

25 **(b)**

The interphase takes approximate 75-95% of the entire generation time

26 **(d)**
The paternal and maternal chromosomes of each homologous pair segregates during anaphase-I. Although, both (maternal and paternal) chromosomes of a homologous pair have the genes for the same traits, either chromosome of a pair may carry different alleles of the same genes. Therefore, in anaphase-I, homologous chromosomes introduces genetic variability

27 **(a)**
A-Animals; B-Plants

28 **(a)**
At the onset of anaphase, each chromosome arranged at the metaphase plate is split simultaneously and the two daughter chromatids, now referred to as chromosomes of the future daughter nuclei, begin their migration towards the two opposite poles. As each chromosome moves away from the equatorial plate, the centromere of each chromosome is towards the pole and hence at the leading edge, with the arms of the chromosome trailing behind. *Thus, anaphase stage is chracterised by the following key events*

1. Centromeres split and chromatids separate
2. Chromatids move to opposite poles

29 **(a)**
After meiosis, the chromosomes get reduce by half, producing haploid cells. The sperm and the egg are haploid cells and when they fuse during fertilization, they produce diploid original

30 **(d)**
The phase between two successive M-phases is called interphase.
The M-phase represents the phase when the actual cell division or mitosis occurs and the interphase represents the phase between two successive M-phases. It is significant to note that in the 24 hour average duration of cell cycle of a human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle

31 **(b)**
Meiosis start with one diploid containing copies of chromosome, one from mother and one from father. The cell divides twice, producing up to four haploid cells containing one copy of each chromosome

32 **(a)**
Interkinesis is the transition stage between meiosis-I and meiosis-II.

33 **(d)**
In zygotene of prophase-I, homologous chromosomes pair up. This process is called **synapsis**. One chromosome of the pair is from the male parent and other from the female parent.

34 **(b)**
In metaphase, chromosomes are shortest and show maximum condensation. Chromosomes are arranged at equatorial metaphasic plate. Structure, size and number of chromosomes are best studied at metaphase.

35 **(a)**
Microtubules are mainly composed of tubulin protein. These are found only in eukaryotic cellular structures like cilia, flagella, centriole, basal body, spindle fibre, etc.

36 **(b)**
G_1-phase is called as pre-synthetic phase or post-mitotic phase. It is the longest phase of cell cycle. In G_1-phase, a cell has two options:

3. Continues cycle and enters S-phase
4. Stops cell cycle and enters G_0-phase for undergoing differentiation.

37 **(d)**
S-phase is the sub-phase between G_1-phase and G_2-phase, during which DNA synthesis or replication takes place.
In animal cells, during the S-phase, DNA replication begins in the nucleus and the centriole duplication in the cytoplasm. The amount of DNA per cell doubles in the nucleus. If the initial amount of DNA is denoted as 2C, then it increases to 4C. However, there is no increase in the chromosome number

38 **(b)**
Colchicine is an antimitotic drug (alkaloid) which is obtained from *Colchicum* (family-Liliaceae). It binds to one tubulin molecule and prevents its polymerization. The depolymerisation of tubulin result in disappearance of mitotic spindle blocking the cell's mitotic chromosomal division at metaphase and anaphase.

39 **(c)**

Non-disjunction occurs when a pair of homologous chromosomes do not separate in meiosis but migrate to the same pole of the cell, resulting in an even number of chromosomes being present in the daughter cells.

40 **(d)**
A-G_0; B-M

41 **(a)**
Homologous chromosomes segregate when a cell undergoes meiosis.

42 **(a)**
Meiosis is a reductional division, in which the chromosome number is reduced to half. It was proposed by **Farmer** and **Moore**. It is found only in diploid germ cells and is main cause of variations. During meiosis, four daughter cells are formed from one cell.

43 **(d)**
Meiosis is a reductional division, in which chromosome number is reduced to half, *i. e*, haploid. It is generally observed in sex cells, *i. e*., male and female gametes. In bryophyte or pteridophyte, meiosis occurs in generative cells like **spore mother cells**.

44 **(b)**
The process of crossing over takes place in pachytene stage of prophase-I of meiosis-I. In this process, some genes of two non-sister chromatids of a bivalent are exchanged.

45 **(b)**
Metaphase plate is the plane of alignment of the chromosomes at metaphase.
During metaphase, spindle fibres attach to kinetochores of chromosomes.
Chromosome are moved to spindle equator and get aligned along metaphase plate through spindle fibres to both poles

46 **(b)**
Cell cycle was described by **Howard** and **Pelc** in 1953. The sequence of events by which a cell duplicates its genome, synthesizes the other constituents of the cell and eventually divides into two daughter cells is termed as **cell cycle**

47 **(b)**
In animal cells, cytokinesis involves the contraction of the contractile ring of microfilaments.

48 **(a)**
In meiotic division metaphase-I spindle apparatus starts appearing and bivalents become attached to spindle through centromeres. Bivalents then appear in the form of an equatorial plate due to the movement known as 'congression'.

49 **(a)**
Crossing over is a process that produces new combination of genes by interchanging of segments between nonl-sister chromatids of homologous chromosomes. It occur between homologous chromosomes at four stranded stage during pachytene of prophase-I of meiosis-I.

50 **(b)**
The cell cycle is divided into two basic phases
Interphase and M-phase (mitotic phase).
Interphase further divides into three phases:
G_1-phase, S-phase and G_2-phase

51 **(d)**
Colchicine prevents spindle formation, which occurs during **metaphase** stage of cell division.

53 **(a)**
Kinetochores serve as the sites of attachment of spindle fibres to the chromosomes that are moved into position at the centre of the cell.

54 **(c)**
Cell division cannot be stopped in S-phase. The S-phase is the synthesis phase, in which the cell synthesises a replica of its genome, *i. e*., DNA replication occurs which ultimately result in the duplication of chromosomal material.

55 **(a)**
As a result of meiosis, the gamete of AaBb will be AB, aB, Ab, ab.

56 **(c)**
The stage between two meiotic divisions is called **interkinesis**. It is generally short lived and is followed by prophase-II, a much simpler prophase than prophase-I of meiosis-I.

57 **(d)**
The number of different haploid cells arise by meiosis can be calculated by 2^n where, n=number of haploid chromosomes.

58 **(c)**
The cell cycle is controlled by enzymes like cyclin dependent kinases (CdKs). CdKs phosphorylate amino acids like serine and threonine which initiates or blocks the activities related to cell cycle. *The other check points involved in cell cycle are*

5. G_1 check point (Enter S or synthesis) is controlled by CdK_4/Cyclin D, CdK_6/Cyclin D

6. G_2 check point (Enter M or maturation promoting factor) by is controlled CdK_2/cyclin B
7. Metaphase check point is controlled by cyclin B degradation

59 **(c)**
During pachytene substage of prophase-I of meiosis, the chromosomes are tetravalent *i. e.*, contain two chromatids with each chromosome arms. Crossing over during this substage, which involves the exchange of segments between the non-sister chromatid of homologues.

60 **(d)**
Colchicine treatment doubles the chromosome number.

61 **(c)**
In oocytes, a special, extremely prolonged form of diplotene occurs, called dictyotene. The primary oocyte undergoes the first three substages of prophase-I (laptotene, zygotene and pachytene) during late foetal life.
The process is then, suspended during diplotene until puberty or thereafter. Therefore, dictyotene, lasts for months or even years. Diplotene is also known as diplonema

62 **(a)**
During mitosis, all the chromosomes behave independently while during meiosis, homologous chromosomes pair up through synapsis and form bivalents in zygotene substage of prophase-I, then in pachytene substage, crossing over occurs between homologous chromosomes and during diplotene substage of prophase-I of meiosis chiasma formation takes place.
During anaphase of both mitosis and meiosis, chromatids are separated and pulled towards opposite poles.

63 **(d)**
Microtubules are hollow, cylindrical structure built from tubulin protein. The mitotic spindle involved in separation of replicated chromosomes during mitosis is assembly of microtubules.

65 **(a)**
A. **Metaphase** Spindle fibres attaches to kinetochores of chromosomes
Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres of both poles
B. **Telophase** Chromosomes cluster at opposite spindle poles and their identify is lost as discrete elements
Nuclear envelope assembles around the chromosome clusters
Nucleolus, Golgi complex and ER reform
C. **Interphase** It is the duration which is a variable depending on the function of cell.
Just before nuclear division, the DNA of chromosome replicates thus, it becomes doubled.
During this phase, chromosome material is in the form of very loosely coiled threads called chromatin

66 **(c)**
During **metaphase-I** of meiosis, tetrads line up at the equator.

67 **(a)**
M cdk cyclin activates anaphase promoting complex.

68 **(a)**
During **cytokinesis** in plant cells spindle fibres do not degenerate and forms phragmoplast and cell plate.

69 **(d)**
During **anaphase-I** of meiosis, the sister chromatids begin to move towards the poles.

70 **(d)**
Small disc-shaped structure at the surface of the centromeres are called kinetochores. These structures serve as the sites of attachment of spindle fibres (formed by the spindle fibres) to the chromosomes that are moved into position at the centre of the cell
Hence, the metaphase is characterized by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its 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

71 **(c)**
Meiosis-I
(i) The bivalents become arranged around the equator of the spindle, attached by their centromeres
(ii) Each pair of the homologous chromosomes is called bivalent which pair up in the process of synapsis

72 **(d)**
Colchicine serves as mitotic spindle poison.

73 **(c)**
Chromosomes are visible with chromatids at **metaphase** stage of mitosis. It is the best stage to observe the shape, size and number of chromosomes.

74 **(b)**
The main events which take place in **G_1-phase** are:
8. Intensive cellular synthesis,
9. Pooling of nucleotides for synthesis of rRNA.
10. Synthesis of enzymes and ATP storage,
11. Synthesis of NHC protein, carbohydrates, liquids, etc.

75 **(c)**
Anaphase-I, anaphase-II.
In anaphase-I chromosome become half in number. Chromosomes split and move to opposite ends of the cell, both in anaphase-I and anaphase-II. The difference is that in anaphase-I, homologous pairs of chromosomes are split and in anaphase-II, sister chromatids are split

76 **(a)**
Initially, homeotypic cell division takes place in the functional megaspore without cytokinesis.

77 **(d)**
In multicellular organisms, cell division brings about embryonic development and growth and also plays an important role in repair and maintenance of the body and also in reproduction, both asexual and sexual

78 **(a)**
Meiosis involves two sequential cycles of nuclear and cell division called meiosis-I and meiosis-II but only a single cycle of DNA replication

79 **(d)**
During **pachytene** of meiosis-I, the chromosomes become bivalent (tetrad) in the beginning, *i.e*, each chromosome with two chromatids.

80 **(b)**
DNA replicates only once in each cell cycle (S-phase)

81 **(c)**
The cell cycle is divided into two basic phases
(i) Interphase
(ii) M-phase (mitosis phase)
The interphase is further divided into three phases
(i) G_1-phase (gap 1)
(ii) S-phase (synthesis)
(iii) G_2-phase (gap 2)
The correct sequence of a cell cycle is
$G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

82 **(b)**
It is mitosis, in which both diploid and haploid cells undergoes this process.
If a diploid cell undergoes mitosis, it results in two identical diploid cells. $2n \rightarrow n$
If a haploid cell undergoes mitosis, the result is two identical haploid cells ($n \rightarrow n$).
In meiosis however, a diploid cell participates that divides twice to produce four haploid cells

83 **(d)**
Some cells in the adult animals do not appear to exhibit division (*e. g*., heart cells, and many other cells divide only occasionally *e. g*., when there is need to replace cells that have been lost due to injury or cell death. These cells that do not divide further and exit G_1-phase to enter an inactive stage called quiescent stage (G_0) of the cell cycle. Cells in this stage remains metabolically active but no longer proliferate

84 **(d)**
A-diploid; B-haploid

85 **(c)**
The spindle are formed of microtubules

86 **(d)**
In mitosis, prophase is the longest phase of karyokinesis. In early prophase, nuclear membrane and nucleolus start disintegrating. Cell cytoskeleton, Golgi complex, ER, etc, also disappear.

87 **(b)**
The plane of alignment of the chromosomes at metaphase is referred to as the **metaphase plat.**
They key features of metaphase are
(i) Spindle fibres attach to kinetochores of chromosomes
(ii) Chromosomes are moved to spindle equator and get aligned along metaphase plate through spindle fibres to both poles

88 **(a)**
In meiosis-I, displacement of chiasmata takes place in diakinesis and homologous chromosomes segregates during anaphase-I

89 **(c)**
Colchicine is an alkaloid widely used in plant breeding for doubling the chromosome number.

Colchicine is extracted from the corms of *Autumn crocus (Colchicum autumnale)*. The alkaloid does not allow the formation of spindle. Colchicine induced polyploidy has been used in raising several varieties of horticultural and agricultural plants, *e. g.*, potato

90 **(c)**
Crossing over leads to separation of linked genes and recombination with the genes present on homologous chromosome to form new combinations.

91 **(a)**
The correct sequence of cell cycle phases is $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$.

92 **(c)**
There are two main ways of cell division *i.e.,* mitosis and meiosis. In each case, division of the nucleus, called karyokinesis, occurs before the division of the cytoplasm, termed as cytokinesis

93 **(a)**
Cell would normally proceed to mitosis without interruption once it had started the S-period.

94 **(a)**
The two chromatids of a metaphase chromosome represent replicated chromosomes to be separated at anaphase.

95 **(b)**
During interphase, the chromosome material (DNA of chromosome) replicates and becomes doubled. Chromosome material in the form of very loosely coiled threads is called chromatin

96 **(a)**
G_1-phase is the longest phase of the cell cycle and is also called as presynthetic or post mitotic phase. During it, the synthesis of biochemicals like RNAs, proteins, enzymes (DNA polymerase) for DNA synthesis, amino acids for histone formation, nucleotides and ATP, takes place.

97 **(d)**
Telomeres are the ends of chromosomes. These are required for the individuality of chromosomes. Generally, these are present more than one and less than five in a chromosome.

98 **(a)**
Meiosis is division necessary for the formation of gamates in animals and spores in plants.
Prophase-I is longest phase of meiosis and composed of leptotene, zygotene, pachytene, diplotene and diakinesis.

100 **(c)**
Crossing over is also an enzyme mediated process and the enzyme involved is called recombinase

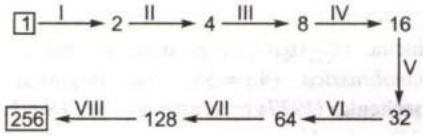
101 **(b)**
Independent Assortment of Chromosomes The paternal and maternal chromosomes of each homologous pairs segregates during anaphase-I independently of the other chromosomes. Anaphase-I is the cytological event that corresponds to Mendel's law of independent assortment.
Although the paternal and maternal chromosomes of a homologous pair have the genes for the same traits, either chromosome of a pair may carry different alleles of the same genes. Therefore, independent assortment of homologous chromosomes in anaphase-I introduces genetic variability

102 **(b)**
Cytokinesis is thought to be the final part of telophase, however, it is a separate process that begins at the same time as telophase.
In telophase, new membranes forms around the daughter nuclei, when chromatids arrive at opposite poles of cell.
The chromosomes disperse and are no longer visible under the light microscope. The spindle fibres disperse and cytokinesis or the partitioning of the cell also begin during their stage

103 **(b)**
In meiosis, nucleus undergoes two divisions (first is reductional and second is equational), while chromosomes divide only once (in anaphase-II).

104 **(d)**
Amitosis is known as direct division. In this method, nuclear envelope remains intact. *The steps involved in amitosis are as follows*
(i) The nucleus of the cell elongates and develops a constriction round its middle
(ii) The constriction in nucleus gradually deepens and finally cuts the nucleus into two daughter nuclei
(iii) The constriction appears in the cytoplasm
(iv) The cytoplasmic constriction divides the parent cell into two daughter cells, each with a nucleus

105 **(d)**
As a result of mitotic division, the number of daughter cells becomes double. Thus, 8 mitotic divisions are required to produce 256 daughter cells from a single cell.



106 **(d)**
The second check point called mitotic cyclin lies between G_2 and M-phase and causes transition from G_2 to M-phase

107 **(b)**
A-Nuclear division; B-Karyokinesis; C-Cytokinesis

108 **(b)**
In the G_1-phase of interphase, the cell is metabolically active and continuously grows but do not replicate its DNA S or synthesis phase marks the period during which DNA synthesis or replication takes place. During this time, the amount of DNA per cell gets double

109 **(b)**
Replication of DNA takes place during S-phase of cell cycle. The number of chromosomes reduced only in meiosis. So, the number remains 14 in G_1-phase

110 **(a)**
Chromosomal crossing over is the exchange of genetic material between homologous chromosomes that results in the recombinant chromosomes. It occurs during prophase-I of meiosis

111 **(a)**
Lampbrush chromosomes are present in growing oocytes, during the diplotene stage of meiotic prophase-I. Chromosomes transform into the Lampbrush form due to an active transcription of many genes

112 **(a)**
Prophase-I is the longest stage in the first division of meiosis and is divided into a number of substages. The chronological sequence is leptotene, zygotene, pachytene, diplotene and diakinesis.
The characteristic phenomenon during pachytene is the exchange of chromosomal segments, *i.e.,* the recombination of gene or crossing over

113 **(b)**
Chiasmata formation is the consequence of crossing over. Each chiasma possesses the site of exchange of material between non-sister chromatids. It is produced by breakage and reunion between any two of the four strands present at each site. Chiasmata are most appropriately observed during **diplotene sub-stage** of **meiosis-I**.

114 **(a)**
Long thin thread-like chromosome lie in unpaired condition in **leptotene** of prophase-I.

115 **(d)**
During meiosis, beads like structures are absent on chromosomes and separation of two basic sets of chromosome occurs

116 **(c)**
Some cells that do not divide further, exit G_1-phase and enter an inactive stage called quiescent stage (G_0) of the cell cycle. Cells in this stage remains metabolically active but no longer proliferate unless called on to do so depending on the requirement of the organism

117 **(c)**
During **anaphase** stage of mitosis, centromere of the chromosome divides and the two chromatids start repelling each other, separate completely to become daughter chromosome and move towards the opposite poles.

118 **(c)**
The S and G_2-phases of interphase are followed by prophase. Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material become untangled during the process of chromatin condensation. Centriole, now begins to move towards opposite poles of the cell.
Therefore, when dividing cells are examined under a light microscope, in prophase only the chromosomes become visible

119 **(b)**
Recombination of **genes on** the same chromosome is accomplished by crossing over, a process by which parts of homologous chromosomes are interchanged. Crossing over takes place between non-sister chromatids of homologous chromosomes in pachytene stage of meiosis-I.

120 **(d)**
G_1-phase corresponds to the interval between mitosis and initiation of DNA replication. During G_1-phase, the cell is metabolically active and continuously grows but do not replicate its DNA

121 **(b)**
Duration of the cell cycle, *i.e.,* period between two successive cell divisions is called generation time. It depends on the type of cell and external factors such as temperature food and oxygen supplies.

Mammalian (*e. g.*, human) cell divides once in approximate every 24 hrs

122 **(b)**
There are two main ways of cell division *i.e.,* mitosis and meiosis. In each case, division of the nucleus, called karyokinesis, occurs before the division of the cytoplasm, termed as cytokinesis

123 **(d)**
All the statements are correct

124 **(c)**
During the G_0-phase, cells are metabolically active but no longer proliferate in normal condition

125 **(c)**
In **pachytene** substage of meiosis-I, the paired homologous chromosomes divide into sister chromatids. Thus, each bivalent is composed of four chromatids and known as tetrad.

126 **(a)**
The pairing of homologous chromosomes during **zygotene** is called synapsis, *i. e.*, the homologous chromosomes, which come from mother and father paired in zygotene.

127 **(a)**
Mitosis usually results in the production of diploid daughter cells with identical genetic complement. The growth of multicellular organisms is due to mitosis. Cell growth results in disturbing the ratio between the nucleus and the cytoplasm. It therefore, becomes essential for the cell to divide to restore the nucleo-cytoplasmic ratio. A very significant contribution of mitosis is cell repair The cells of the upper layer of the epidermis, cells of the lining of the gut and blood cells are being constantly replaced. Mitotic divisions in the meristematic tissues – the apical and the lateral cambium, result in a continuous growth of plants throughout their life

128 **(b)**
Mitosis divides the parent cell into two identical daughter cells, each with a nucleus having the same amount of DNA, the same number and kind of chromosomes and the same heredity instructions as the parent cell, that's why it is called as the equational division

129 **(b)**
The complete disintegration of the nuclear envelope marks the start of the second phase of mitosis, *i.e.,* metaphase. Hence the chromosomes are spread through the cytoplasm of the cell. By this stage, condensation of chromosomes is completed and they can be observed clearly under the microscope. This then, is the stage of which morphology of chromosomes is most easily studied. At this stage, metaphase chromosomes are made up of two sister chromatids, which are held together by the centromere

130 **(b)**
In plant cells, during metaphase chromosomes line up around the equator of the spindle and attached by their centromere to the spindle fibres (microtubules). In animal cells, during metaphase, smaller chromosomes are usually central in position with larger ones peripheral in position.

131 **(c)**
Mitosis lasts on an average from 30 min to 3 hrs

132 **(a)**
In the S and G_2-phases of interphase, the new DNA molecules formed are not distinct but interwined. Prophase, which is the first stage of mitosis follows the S and G_2-phases of interphase

133 **(a)**
A-Cyclins; B-CdK; C-Check points; D-Mitotic cyclin

134 **(b)**
Synapsis is the pairing of homologous chromosomes during the zygotene stage of meiosis. Each pair is called bivalent. One chromosome of the pair comes from the male parent and other from the female parent. Each member of the pair is of the same length, their centromeres are in the same position and they usually have the same number of genes arranged in the same order. After zygotene stage, cell entered in **pachytene** stage in which the bivalents become spiralled, shortened and thickened.

135 **(d)**
Prophase is generally identified by the initiation of condensation of chromosomal material. The chromosomal material condenses to form chromosomes. The nuclear envelope breaks down and spindles start to assemble at opposite ends of the cell

136 **(b)**
CdK_2/cyclin B.
The cell cycle is controlled by enzymes like cyclin dependent kinases (CdKs). CdKs phosphorylate amino acids like serine and threonine which initiates or blocks the activities related to cell cycle. *The other check points involved in cell cycle are*

12. G_1 check point (Enter S or synthesis) is controlled by CdK_4/Cyclin D, CdK_6/Cyclin D
13. G_2 check point (Enter M or maturation promoting factor) by is controlled CdK_2/cyclin B

Metaphase check point is controlled by cyclin B degradation

137 **(c)**

Mitosis is divided into four stages

A-Prophase, B-Metaphase, C-Anaphase, D-Telophase

138 **(d)**

Telophase is the reverse stage of prophase. During this phase, the cytoplasmic viscosity decreases and the two chromosome groups reorganize themselves into nuclei. A nucleae envelope appears outside the nucleoplasm collected in the area of chromatin. Spindle fibres disappear around the poles and Golgi complex and endoplasmic reticulum are reformed

139 **(c)**

I. Spindle microtubules that extends from the two poles of a dividing cell are called polar fibres

II. A centromere that connects two identical copies of single chromosome. These two copies are called sister chromatids

III. In 'X' phase, the paired chromosomes separate and begin moving to opposite ends of the cell. This 'X' phase is called anaphase

141 **(c)**

Interphase (L. inter-between, Gk, *phasis* – aspects) is a series of changes that takes place in a newly formed cell and its nucleus before it becomes capable of dividing again. It is a period of intense synthesis and growth. The interphase takes approximately 75-95% of the entire generation time. It is further divided into three periods of phases first gap or G_1-phase, synthetic or S-phase and second gap or G_2-phase

Duration of these phases varies in different organisms

142 **(b)**

In anaphase-I chromosome become half in number. Chromosomes split and move to opposite ends of the cell, both in anaphase-I and anaphase-II. The difference is that in anaphase-I, homologous pairs of chromosomes are split and in anaphase-II, sister chromatids are split

143 **(d)**

Colchinine ($C_{22}H_{25}O_6N$) is used to induce polyploidy. *Raphanobrassica* ($4n = 36$) was produced by **G D Karpechenko** (1927) by crossing radish (*Raphanus sativus* $2n = 18$) and cabbage (*Brassica oleracea* $2n = 18$). It is the first **allotetraploid**.

144 **(c)**

The spindle apparatus formed during cell division is composed of microtubules radiating in all directions. The microtubules are chemically composed of **tubulin** protein (α-tubulin, β-tubulin).

145 **(a)**

Ophioglossum is a gene of about 25-30 species. It is a plant. It has the highest chromosome count of any known living organism, with 1260 chromosomes. In haploid stage, 631 chromosomes in number

146 **(a)**

At telophase stage, nuclear membrane vesicles associate with the surface of individual chromosome and fuse to reform the nuclear membranes, which partially enclose cluster of chromosomes before coalescing to reform the complete nuclear envelope. During this process, the nuclear pores reassemble and reassociate to form the nuclear lamina. One of the lamina proteins (lamina-B) remains with the nuclear membrane fragments throughout mitosis and may help nucleate reassembly. After the nucleus reforms, the pores pump in nuclear proteins, the chromosome decondense and RNA synthesis resumes, causing the nucleolus to reappear.

147 **(b)**

In zygotene, a filamentous ladder like nucleoprotein complex called syaptomemal complex is observed between the homologous chromosomes. It forms structural basis for pairing and synapsis of meiotic chromosomes.

148 **(a)**

After completion of synapsis, the cell enters the pachytene stage. Here cell remains for four days. Chromosomes are paired and occurs in synaptonemal complexes. The paired chromosomes or bivalent gets shorten and crossing over takes place

149 **(c)**

After M-phase, daughter cell may enter G_0-phase, which is a stage of arrest of cell cycle, stoppage of cell division and on set of differentiation.

150 **(a)**
During cell division, chromosomes attaches with spindle at **kinetochore**.

151 **(c)**
In a spindle, negative ends of microtubules are towards the poles.

152 **(d)**
Pachytene or **thick thread** or **pachynema** substage is the longest substage of prophase-I of meiosis. It is characterised by the process of crossing over during which the non-sister chromatids twist around and exchange segments with each other by proper breakage and then fusion of broken ends.

153 **(a)**
Cell cycle consists of two basic stages. There is a long undividing stage called I-phase (interphase) and a short-dividing M-phase

154 **(b)**
The last substage of interphase is G_2-phase in G_2-phase, cell organelles increases in number and both cell and nucleus grows in size
G_1-phase, is the first stage of interphase during which cell organelles do not increase in number. Cell grows in size but the growth of nucleus is little. It synthesizes RNAs, proteins and other biochemical for cell growth and subsequent replication of DNA

155 **(a)**
In meiosis-I displacement of chiasmata takes place in diakinesis and homologous chromosomes segregate at anaphase-I.

156 **(c)**
Synthesis phase or S-phase is the phase in cell cycle during which DNA is replicated. The synthesis of histone proteins and RNA also takes place in this phase in this phase and each chromosome has two chromatids.

157 **(d)**
The directed movement of the chromosomes into position at the metaphase plate is termed as **congression**.

158 **(c)**
Leptotene The chromosomes appear as thin long threads and have a beaded appearance due to the presence of chromomeres
Pachytene Dissolution of the synaptonemal complex takes place in zygotene. The characteristic phenomenon during pachytene is the exchange of chromosomal segments, *i.e.,* the recombination of genes or crossing over
Diplotenes Tetrads formation takes place in pachytene stage. In diplotene the paired chromosomes begin to separate but remains united at the points of interchange of chiasma

159 **(c)**
The number of DNA strands in chromosome at G_2-stage of cell cycle is **four** due to the replication of DNA during S-phase.

160 **(a)**
Meiosis reduces chromosome number from diploid ($2n$) to haploid (n). It occurs in germ cells (eggs or sperm)

161 **(b)**
Prophase-I It is more complicated and prolonged as compared to the similar stage of mitosis. In this phase, chromosomes are not distinguishable because they are often seen as heterochromatic (heteropycnotic) bodies
Anaphase-I The homologous chromosomes break their connections and separate out. It is called disjunction
Interphase It is the phase of cell cycle in which the cell spends the majority of its time in preparing itself for cell division. It is the time between two mitotic or meiotic cell cycles
Metaphase-I A chromatic fibrous bipolar spindles are formed in the areas of dividing nuclei. The spindles are arranged in isobilateral or tetrahedral fashion. The chromosomes arrange themselves at equator

162 **(a)**
G_1 is the longest period, which involves preparation for RNA and protein synthesis.

163 **(a)**
Bivalent A pair of homologous chromosomes lying together is called a bivalent.
(i) **Tetrad** In pachytene stage, the chromatids of each synapsed chromosome slightly separate and become visible. The two visible chromatids of a chromosome are referred to as dyad
(ii) A group of four homologous chromatids (two dyads) is called a tetrad
(iii) **Pachytene Stage** Crossing over occurs during pachytene stage
(iv) **Non-sister Chromatids** The two chromatids of two homologous chromosomes (bivalent) are termed non-sister chromatids

(v) **Sister Chromatids** The two chromatids of the same chromosome are called sister chromatids

164 **(c)**
$A - G_1; B - G_2$

166 **(a)**
The M-phase represents the phase when the actual cell division or mitosis occurs and the interphase represents the phase between two successive M-phases. It is significant to note that in the 24 hour average duration of cell cycle of a human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle

167 **(b)**
It the initial amount of DNA is denoted as 2C, then it increases to 4C.
In the G_1-phase of interphase, the cell is metabolically active and continuously grows but do not replicate its DNA S or synthesis phase marks the period during which DNA synthesis or replication takes place. During this time, the amount of DNA per cell gets double

168 **(a)**
In meiosis, the daughter cells are not similar to that of parent genetically because of **crossing over**. Crossing over is the mutual exchange of homologous chromosomal regions between non-sister chromatids during the first prophase of meiosis.

169 **(c)**
Late anaphase is characterised by
(i) Centromeres split and chromatids separate
(ii) Chromatids move to opposite poles.

Prophase is characterised by centriole separation.

170 **(c)**
G_2-phase or second gap phase is the gap between DNA synthesis and division. This particular phase is spent in synthesizing molecules other than DNA, which are required for cell division.

171 **(d)**
The reciprocal exchange of chromosomal material between homologous chromosome is termed as **crossing over**.

172 **(b)**
In meiosis-I, division is reductional while II equational.

173 **(c)**
G_0-phase is the arrest phase or suspended phase of the cycle. The cells remain inactive or in a non-dividing resting state during this phase and may remain such for days to years before resuming cell division, *e. g.*, nerve cells remain in G_0-phase.

174 **(c)**
Cell cycle completes in two steps- Interphase and M-phase. Interphase is completed in three successive phases G_1-phase (post-mitotic phase), S-phase (synthetic phase) and G_2-phase (pre-mitotic or post-synthetic phase). In the given figure, D is representing the S-phase (synthesis phase) of cell cycle.

175 **(c)**
I. The shortening and thickening of chromosome fibres occurs due to the two reason
Coming together of axial proteins and coiling or spiralisation of chromatin fibres. This is assisted by the proteins, called condensins
II. Sometimes, overlapping is shown by the elongated chromosome. Their ends are not visible. Therefore, the chromosomes appears like a ball of wool and this stage is called sprime stage
III. Animal cells generally have two centrosome or centriole pairs lying close together. These two centrides begins to move towards the opposite sides of the microtubules, surrounding each pair of centrioles (diplosome). It look like a star-shaped body called aster
IV. Shortening of chromosome during prophase is must for their equal distribution during anaphase. Each chromosome appears to have two longitudinal threads called chromatids or sister chromatids, attached to each other by means of a narrow point called centromere

176 **(a)**
At **metaphase**, the chromosome are clearly visible as composed to two closely associated halves (chromatids) and the chromosomes have undergone maximum contraction, so these can be counted conveniently.

177 **(a)**
Metaphase in both mitosis and meiosis is characterised by the orientation of chromosomes themselves on the spindle fibres at the equatorial plate.

178 **(b)**
Sporophyte is a diploid generation while gametophyte is haploid. Meiosis cause the

reduction of chromosome number to half, *i. e.*, from diploid to haploid.

179 **(d)**
The first meiotic division leads to reduction of chromosome number of half and the second meiotic division to segregate the replicated chromosomes.

180 **(b)**
There are two main ways of cell division *i.e.,* mitosis and meiosis. In each case, division of the nucleus, called karyokinesis, occurs before the division of the cytoplasm, termed as cytokinesis

181 **(a)**
In meiotic cell division, homologous chromosomes pair up during zygotene stage of prophase-I, this phenomena is called synapsis. During anaphase-I, homologous chromosomes of each bivalent start migrating towards opposite pole of the spindle, ultimately each pole receives a haploid group of regregated chromosomes.

182 **(c)**
During pachytene substage of prophase-I of meiosis, the non-sister chromatids of homologues exchange segments between themselves. This exchange of chromatid segments is called **crossing over**, which involves proper breakage and then fusion of broken ends oppositely and hence, results in the recombination.

183 **(c)**
The zygote is formed by the fusion of male and female gametes. The male and female gametes are formed by meiosis in diploid organism. A diploid living organism develops from zygote by repeated **mitotic divisions**.

184 **(d)**
Synapsis of homologous chromosomes takes place during zygotene stage of meiosis-I. Division of centromere takes place during anaphase-II of meiosis.

185 **(d)**
Egg is haploid and has 5 pg (pico gram) DNA. Its animal, which is diploid will be having 10 pg DNA. In S-phase, DNA doubles and therefore, in G_2amount of DNA will be 20 pg.

186 **(d)**
Meiosis occurs in a diploid cell. It is a double division which gives rise to four haploid cells, each having half the number of chromosomes as compared to the parent cell. The term 'meiosis' was coined by **Farmer** and **Moore** in 1905

187 **(a)**
Chromosomes that results from the separation of sister chromatids during cell division are called daughter chromosomes. During anaphase of mitosis, paired chromosomes (sister chromatids) separates to form daughter chromosomes.
Each daughter chromosome migrates to centromere, toward the opposite ends of the cell.
At the end of cell division, two distinct daughter cells are formed from a single cell

188 **(b)**
In G_2-phase of interphase stage of cll cycle, the proteins required for spindle formation are synthesized. In G_1-phase, enzymes required for protein and DNA replication are synthesized.
In S-phase, DNA replication process takes place.
In anaphase, chromosomes split longitudinally at the centromere.

189 **(d)**
Meiosis is a double division, which occurs in a diploid cell (nucleus) and gives rise to four haploid cells (nuclei), each having half the number of chromosomes as compared to the parent cell. In meiosis-I, bivalent is an association of four chromatids and two centromeres.

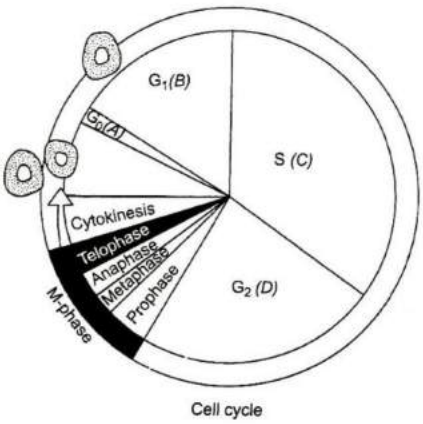
190 **(d)**
Drug colchicines is obtained from*Colchicum autumnale*. It arrests the polymerization of microtubules from tubulin protein, *i. e.*, arrests spindle formation at **metaphase**.

191 **(b)**
Replication of DNA takes place at S-phase of cell cycle. The number of chromosomes reduced only in meiosis. So, the number remain 14, 14, and 14 in G_1 after S and after M-phase.

192 **(a)**
During diplotene substage of meiotic division, the force of attraction between homologous chromosomes reduced and later on they move apart.

193 **(d)**
The beginning of diplotene stage is marked by chiasma formation. The chiasma formation is the indication of crossing over and the beginning of separation of chromosomes.
The chiasma formation is associated with the process of terminalisation

194 **(a)**



Cell cycle

A typical eukaryotic cell in a culture divides once in approximately 24 hrs. The duration of cell cycle can vary from organism to organism and also from cell to cell type

196 **(c)**
Interphase of cell cycle is divided into three phases-G_1, S and G_2-phase. The, S-phase comes in between $G_1$and G_2phase.

197 **(a)**
Synapsis is the pairing of homologous chromosomes during meiosis. While autosomes undergoes synapsis during meiosis, sex chromosomes often remain unpaired. A consequence of recombinant synapsis is to increase genetic variability within both the offsprings and population

198 **(c)**
In prokaryotes and unicellular eukaryotic organisms, cell division is a method of multiplication but in multicellular eukaryotic organism, it is a method of growth.

200 **(b)**
M-phase (mitosis) is the most important period of cell cycle. It involves a major recognisation of virtually all components of the cell. Since, the number of chromosomes in the parent and progeny cells is the same, it is also called as equal division

201 **(a)**
There are two main events in mitosis, karyokinesis or duplication of the nucleus, followed by division of the cytoplasm called cytokinesis. This is followed by the separation of the daughter cells

202 **(a)**
III - Prophase
IV - Metaphase
I - Anaphase-I
II - Telophase-I
V - Telophase-II

203 **(a)**
Reduces by half.
Meiosis start with one diploid containing copies of chromosome, one from mother and one from father. The cell divides twice, producing up to four haploid cells containing one copy of each chromosome

205 **(c)**
Anaphase is characterised by **splitting of the centromeres** and separation of chromatids. Chromatids move to opposite poles from the equatorial plates.

206 **(c)**
Chiasma is an attachment of two non-sister chromatids in a bivalent in diplotene stage of prophase-I of meiosis. Each chiasma results in the exchange of genetic material between non-sister chromatids, *i. e.*, **crossing over**.

207 **(b)**
One of the main functions of centromere is the **cell plate formation**.

208 **(d)**
The duration of cell cycle of yeast is 90 min

209 **(d)**
Synapsis is the pairing of homologous chromosomes during zygotene stage of prophase-I of meiotic division-I. These homologous chromosomes come from mother and father.

210 **(a)**
DNA content becomes double in interphase. Interphase is divided into G_1, S and G_2 -phase. Out of which in S-phase, the cell synthesizes a replica of its genome, *i. e.*, DNA replication occurs during this phase, which ultimately results in the duplication of chromosomal material.

211 **(a)**
Colchicine is an antimitotic drug (alkaloid) which is obtained from *Colchicum* (family-Lilliaceae). It binds to one tubulin molecule and prevents its polymerization. The depolymerisation of tubulin results in disappearance of mitotic spindle, blocking the cells mitotic chromosomal division of metaphase and anaphase

212 **(b)**
The correct sequence is:
Synapsis→Crossing over→Terminalization→ Disjunction of genomes

213 **(a)**

'Tubulin' is a cytoskeletal globular protein that polymerizes to form **microtubules**. During cell division, the microtubules radiate from each end of the cell and form a basket like arrangement (the spindle), which helps in the movement of chromosomes to poles.

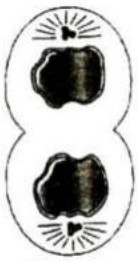
214 **(d)**
Diakinesis is the final stage of the prophase in meiosis. It is characterized by shortening and thickening of the paired chromosomes, formation of the spindle fibres, disappearance of the nucleolus and degeneration of the nuclear membrane

215 **(c)**
In cleavage, there is no spindle develops to guide the chromosomal movement.

216 **(c)**
In G_2-phase chromosome number remains same, so the right answer is 12 chromosomes.

217 **(b)**
Meiosis occurs in organisms during sexual reproduction

218 **(d)**
At the beginning of the final stage of mitosis, *i.e.,* telophase, the chromosomes that have reached their respective poles, decondense and lose their individuality. The individual chromosomes can no longer be seen and chromatin material tends to collect in a mass in the two poles (Fig.). *This is the stage which shows the following key events*


Telophase

219 **(a)**
Interphase has three phases-G_1, S and G_2. Replication of centriole occurs during G_1-phase of interphase. DNA replication takes place in S-phase of interphase.

220 **(a)**
Genetic recombination occurs due to **fertilization** and **meiosis** crossing over.

221 **(a)**
During mitosis, DNA replicates once for one cell division and in meiosis also the DNA replicates once for two cell divisions so, the chromosome number becomes half in meiosis.
Mitosis occurs in both sexually and asexually reproducing organisms, while meiosis occurs only in sexually reproducing organisms.

222 **(a)**
Interphase of cell cycle is composed of G_1-phase, G_2-phase and S-phase. During S-phase, DNA replicates in semi conservative manner so, each chromosome is formed of two chromatids joined at centromere.

223 **(b)**
Meiosis is a special type of division in which the chromosomes duplicate only once but cell divides twice. So, one parent cell produces 4 daughter cells. It is found in diploid germ cells. The first division in meiosis is reduction or heterotypic.

224 **(c)**
Post reproductive stage of a cell includes cell growth. The term cell growth is used in the contexts of cell development and cell division. As we are concerned about growth (development) only, it refers to the growth of cell that is to increase in cytoplasmic and organelle volume that is in G_1-phase

225 **(a)**
Interphase is the period between the end of one cell division to the beginning of next cell division. During this phase, the cell is metabolically very active and prepares itself for the next division.

226 **(a)**
The term 'mitosis' was coined by **Flemming**

227 **(d)**
During telophase, the chromatids have reached the poles of the cell, uncoil and lengthen to form chromatin again. The spindle fibres disintegrate and centriole replicate. Nucleoli and nuclear envelope reappear and hence, two daughter nuclei are formed at each pole.