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XI NEET

04 CELL
CYCLE AND DIVISION

70%

30%
Chemical

MASTERING
NCERT

(15%)
Proteins

BIOLOGY

IIT-JEE
NEET
CBSE

(14%) Small molecules

(6%) RNA

(2%) Phospholipids

(1%) DNA

(2%) Polysaccharides

CELL
THE STRUCTURAL UNIT OF LIFE

03

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NEET KEY NOTES

- Growth and reproduction are characteristics of cells of all living organisms.
- All cells reproduce by undergoing cell division, i.e. division into two equal daughter cells. During the division of a cell, DNA replication and cell growth take place.

Cell Cycle

- The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and then divides into two cells is called as **cell cycle**.
- An average duration of cell cycle in human cells is 24 hours, while that of yeast is 90 minutes.

Phases of Cell Cycle

- The cell cycle is divided into two phases–**Interphase** and **M-phase**.
- During **M-phase**, the cell actually divides. The M-phase starts with nuclear division, i.e. **karyokinesis** and ends with the division of cytoplasm, i.e. **cytokinesis.**
- **Interphase** is the long, undividing phase between two successive M-phase. It was initially known as **resting phase**.
- During interphase, the cell prepares itself for cell division by undergoing both cell growth and DNA replication.
- It is divided into three subphases
  - **Gap 1** or **G_1-phase** The cell is metabolically active and continuously grows but does not replicate its DNA. Cell increases in size and cell organelles (except for mitochondria, chloroplast and centriole) also increase in number.
  - **Synthesis** or **S-phase** DNA replication and centriole duplication take place without any changes in chromosome number. In animal cells, during the S-phase, DNA replication begins in the nucleus and the centriole duplicates in the cytoplasm.
  - **Gap 2** or **G_2-phase** Protein synthesis and cell growth occur. RNA and protein synthesis continue. Cell organelles like mitochondria and chloroplast increase in number by duplication.
- Some cells in adult animals do not divide, e.g. heart cells and many cells divide occasionally, e.g. liver cells. These cells exit the cell cycle at G_1-phase and enter into **quiescent stage** (G_0), where they remain metabolically active, but undividing unless required.

Cell Division

- The phase of actual cell division is the M-phase.
- M-phase represents the most dramatic period of cell cycle involving major recognisation of virtually all components of the cell.
- Depending on the cell type in which division is occurring, it can be mitosis or meiosis.

Mitosis

It starts with the division of nucleus (karyokinesis) followed by the separation of daughter chromosomes and terminates with cytoplasmic division (cytokinesis). It is called **equational division** as chromosome is equally divided between two daughter cells.

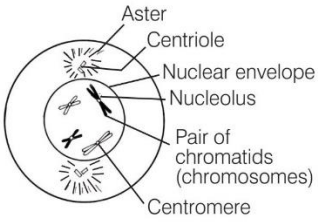
I. Karyokinesis

- It involves the division of the nucleus. In karyokinesis, a nucleus can be divided either through mitosis or through meiosis.

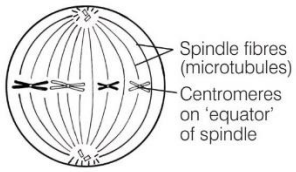
- Mitosis is further divided into four phases

Phases of Mitosis

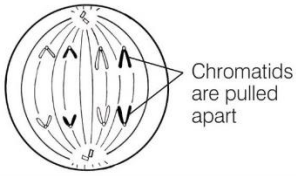
1. **Prophase**
   - Longest phase of division.
   - Condensation of chromosomal material starts.
   - In animal cells, the centrioles move to opposite poles of the cell.
   - Nucleolus and nuclear envelope disappear.
   - Microtubules are assembled to form mitotic spindle.



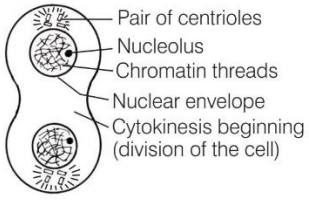
2. **Metaphase**
   - Arrangement of chromosomes at equator and aligns along the **metaphase plate** through spindle fibres.
   - Attachment of spindle fibres to kinetochores of chromosomes.
   - Best stage to observe the shape, size and number of chromosomes.



3. **Anaphase**
   - Splitting of centromere.
   - Movement of chromatids towards the opposite poles.
   - Shortest duration phase, i.e. only of 2-3 min and it is very rapid.



4. **Telophase**
   - Chromosomes condense into long fine filaments.
   - Spindle fibres disappear and centriole replicate.
   - Nuclear envelope reforms around the chromosomes.
   - Reappearance of nucleolus, Golgi complex and ER.



II. Cytokinesis

- Mitosis is accomplished by the division of the parent cell into two daughter cells and by the separation of cytoplasm into each daughter cell *via* a process called **cytokinesis**.
- In animal cells, it occurs by the appearance of a furrow in plasma membrane. The furrow deepens and joins in the centre thus dividing the cell cytoplasm into two.
- In plant cells, due to the presence of inextensible cell wall, cytokinesis is achieved by **cell plate** formation (representing the middle lamella between two adjacent cells). It begins to form in the centre of the cell and grows outwards to meet the lateral walls.
- In some organisms, karyokinesis is not followed by cytokinesis and it results in the formation of multinucleate condition called **syncytium**, e.g. liquid endosperm in coconut.

Significance of Mitosis

- It is restricted to diploid cells only. However, in some plants and social insects, haploid cells also divide by mitosis.
- It results in the production of diploid daughter cells with identical genetic combination usually, resulting in genetic stability.
- The growth of multicellular organisms is due to mitosis. It also restores the nucleocytoplasmic ratio and surface volume ratio of cells.
- Mitosis in meristematic tissues like apical and lateral cambium, results in a continuous growth of plants throughout their life.
- It helps in cell repair and regeneration of injured and lost body parts.
- It forms the basis of asexual reproduction in both plants and animals.

Meiosis

- It is the reductional cell division which results in the production of a haploid set of chromosomes.
- For example, haploid gametes (n) formed from specialised diploid ($2n$) cells. Diploid status of gametes is then restored at the time of fertilisation.
- Meiosis involves two sequential cycles of nuclear and cell division called **meiosis-I** and **meiosis-II**, but only a single cycle of DNA replication.
- During meiosis, pairing of homologous chromosomes and recombination between non-sister chromatids occurs, so as to produce four haploid cells.
- **Meiosis-I** is subdivided into four phases, i.e. prophase-I, metaphase-I, anaphase-I and telophase-I. Prophase-I is the longest phase and it is subdivided into following five phases

Phases of prophase–I	Characteristic features
Leptotene	Compaction of chromosomes
Zygotene	Synapsis of homologous chromosomes to form bivalents, formation of synaptonemal complex.
Pachytene	Bivalents appear as tetrad, crossing over occurs between non-sister chromatids of homologous chromosomes.
Diplotene	Homologous chromosomes separate except at the sites of cross over, so as to form X-shaped structure chiasmata. Synaptonemal complex begins to dissolve and disappears.
Diakinesis	Terminalisation of chiasmata, chromosomes are fully condensed, nucleolus disappears and nuclear membrane breaks down.

- During **metaphase-I**, the bivalent chromosomes align on the equatorial plate. In **anaphase-I**, the homologous chromosomes separate, while sister chormatids remain associated at their centromeres.
- **Telophase-I** is marked by the appearance of nuclear membrane and nucleolus, cytokinesis follows and dyad of cells is formed.
- The stage between two meiotic divisions is called **interkinesis** and is generally short-lived. DNA replication does not occur during this stage.
- **Meiosis-II** is similar to mitosis as they both involve equational division. The parental and progeny cells involved in meiosis-II are haploid. It also involves four substages, i.e. **prophase-II, metaphase-II, anaphase-II** and **telophase-II**, similar to mitosis except that these processes occur in two haploid cells.
- At the end of meiosis, tetrad of cells, i.e. four haploid cells are formed.

Significance of Meiosis

- It is the machanism of conversion of specific chromosome number of each species in sexually reproducing organisms is achieved across generations.
- It leads to the formation of gametes which is important for sexual reproduction.
- It provides chance for the appearance of new gene combinations, owing to crossing over. It increases the genetic variability in the population of organisms from one generation to the next. Variations help in evolution.

Mastering NCERT

MULTIPLE CHOICE QUESTIONS

TOPIC 1 ~ *Cell Cycle*

1 The sequence of events by which a cell duplicates its genome, synthesises 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

2 During cell cycle, the DNA synthesis occurs how many times?
(a) All the time (b) Once
(c) Twice (d) Many times

3 Cell growth is a continuous process in terms of
(a) cytoplasmic increase
(b) increase in DNA content
(c) increase in protein content
(d) increase in total cellular contents

4 The cell cycle of mammalian cell and yeast, respectively, takes about
(a) 24 hrs, 90 min
(b) 60 min each
(c) 30 min, 24 days
(d) 90 min, 24 hrs

5 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

6 The interphase is divided into three phases, namely
(a) G_1-phase, M-phase and G_2-phase
(b) M-phase, S-phase and divisional phase
(c) G_1-phase, synthesis phase and G_2-phase
(d) M-phase, G_2-phase and divisional phase

7 The phase between two succesive M-phase is called
(a) S-phase (b) G_1-phase
(c) G_2-phase (d) Interphase

8 What is the approximate percentage duration of cell cycle that comes under interphase in humans?
(a) 100% (b) 95% (c) 25% (d) 5%

9 In M-phase, the division of nucleus is called as
(a) cytokinesis (b) karyokinesis
(c) nucleokinesis (d) diakinesis

10 In M-phase, the division of cytoplasm is
(a) cytokinesis (b) cytodivision
(c) diakinesis (d) None of these

11 Which of the following phases of cell cycle is also known as the resting phase?
(a) G_1-phase (b) M-phase
(c) S-Phase (d) Interphase

12 In which phase of cell cycle, DNA content gets doubled?
(a) Interphase (b) Anaphase
(c) Prophase (d) Telophase

13 The correct sequence of phases of cell cycle is ***NEET 2019***

(a) $G_1 \rightarrow G_2 \rightarrow S \rightarrow M$ (b) $S \rightarrow G_1 \rightarrow G_2 \rightarrow M$
(c) $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$ (d) $M \rightarrow G_1 \rightarrow G_2 \rightarrow S$

14 Which of the following events occurs during G_1-phase of the cell cycle?

(a) DNA replication
(b) Growth and normal functioning of cell
(c) DNA transcription
(d) Elimination of unwanted cells

15 During the G_1-phase of cell division

(a) RNA and proteins are synthesised for cell growth and subsequent DNA replication
(b) DNA and proteins are synthesised
(c) centriole duplicates in the cytoplasm
(d) cell undergoes duplication

16 During G_1-phase of cell cycle,

(a) DNA content increases to double
(b) DNA content gets reduced to half
(c) Four folds increase in DNA content occur
(d) No change in DNA content occurs

17 During cell growth, DNA synthesis takes place in ***NEET 2016***

(a) S-phase (b) G_1-phase (c) G_2-phase (d) M-phase

18 An onion root tip has 14 chromosomes in each cell. How many chromosomes the cell would have at G_1-phase?

(a) 28 (b) 14 (c) 62 (d) 7

19 What will be the DNA content and number of chromosomes in a cell after S-phase as compared to the gamete of the same organism? ***JIPMER 2019***

(a) Same DNA content, but double chromosome number
(b) Four times DNA content, but double chromosome number
(c) Same DNA content, but half chromosome number
(d) Half DNA content, but double chromosome number

20 During which phase(s) of cell cycle, amount of DNA in a cell remains at 4C level if the initial amount is denoted as 2C? ***CBSE-AIPMT 2014***

(a) G_0 and G_1 (b) G_1 and S
(c) Only G_2 (d) G_2 and M

21 The phase of cell cycle in which the centriole duplicates in the cytoplasm?

(a) S- phase (b) G_1- phase
(c) G_2- phase (d) G_0- phase

22 When cell has stalled DNA replication fork, which checkpoint should be predominantly activated? ***NEET 2016***

(a) G_1/S (b) G_2/M
(c) M (d) Both G_2/M and M

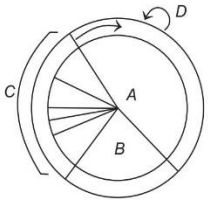
23 Which among the following cells of human body are found in G_0-phase of cell cycle?

(a) Epidermal cells (b) Red blood cells
(c) Heart cells (d) None of these

24 Cells in G_0-phase ***NEET 2019***

(a) enter the cell cycle (b) suspend the cell cycle
(c) terminate the cell cycle (d) exit the cell cycle

25 In the diagrammatic view of cell cycle, the G_0-phase is represented as



(a) A (b) B
(c) C (d) D

26 The plant cells can show mitotic division in

(a) diploid cells (b) haploid cells
(c) polyploid cells (d) Both (a) and (b)

TOPIC 2 ~ *Mitosis*

27 Which of the following types of cell cycle is known as equational division?

(a) Amitosis (b) Mitosis
(c) Meiosis (d) None of these

28 Which of the following is not a characteristic feature during mitosis in somatic cells? ***NEET 2016***

(a) Disappearance of nucleolus
(b) Chromosome movement
(c) Synapsis
(d) Spindle fibres

29 In which stage of cell cycle, initiation of condensation of chromosome takes place?

(a) Anaphase (b) Metaphase
(c) Telophase (d) Prophase

30 The centriole moves to opposite poles of the cell in which stage?

(a) Prophase
(b) Metaphase
(c) Anaphase
(d) Telophase

31 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

32 This is the best stage to count the number and study the morphology of chromosomes.
(a) Prophase (b) Metaphase
(c) Anaphase (d) Telophase

33 Spindle fibres attach on to ***NEET 2016***
(a) kinetochore of the chromosome
(b) centromere of the chromosome
(c) kinetosome of the chromosome
(d) telomere of the chromosome

34 The phase characterised by the alignment of chromosome at the equator is
(a) prophase (b) anaphase
(c) metaphase (d) telophase

35 At which stage of mitosis, the two daughter chromatids separate from each other, migrate towards the opposite poles and are now referred to as chromosomes of the future daughter nuclei?
(a) Prophase (b) Metaphase
(c) Anaphase (d) Telophase

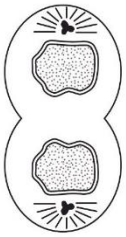
36 Given diagram indicates which of the following phase of mitosis? Choose the correct option.
(a) Interphase
(b) Prophase
(c) Metaphase
(d) Anaphase

37 During anaphasic movements of chromosomes, centromere of each chromosome is directed towards
(a) pole (b) equatorial plate
(c) spindle fibres (d) None of these

38 Anaphase Promoting Complex (APC) is a protein degradation machinery necessary for proper mitosis of animals cells. If APC is defective in a human cells, which of the following is expected to occur? ***NEET 2017***
(a) Chromosomes will not condense
(b) Chromosomes will be fragmented
(c) Chromosomes will not segregate
(d) Recombination of chromosome arms will occur

39 During which phase of mitosis the chromosomes may appear in the V, L, J, or I-shaped structures?
(a) Prophase
(b) Metaphase
(c) Anaphase
(d) Telophase

40 A stage in cell division is shown in the figure. Select the answer, which gives correct identification of the stage with its characteristics. ***NEET 2013***

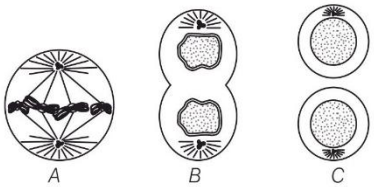


(a) Telophase – Nuclear envelope reforms, Golgi complex reforms
(b) Late anaphase – Chromosomes move away from equatorial plate, Golgi complex not present
(c) Cytokinesis – Cell plate formed, mitochondria distributed between two daughter cells
(d) Telophase – Endoplasmic reticulum and nucleolus not reformed yet

41 Which of the following options gives the correct sequences of events during mitosis ? ***NEET 2017***
(a) Condensation → nuclear membrane disassembly → crossing over → segregation → telophase
(b) Condensation → nuclear membrane disassembly → arrangement at equator → centromere division → segregation → telophase
(c) Condensation → crossing over → nuclear membrane disassembly → segregation → telophase
(d) Condensation → arrangement at equator → centromere division → segregation → telophase

42 Mitotic poisons are chemicals or substances that interfere with normal mitotic division. One such chemical is ……, which interferes with …… formation during …… of mitosis cell division.
The blanks are correctly filled by which of the following options?
(a) colchicine, spindle, prophase
(b) colchicine, centromere, anaphase
(c) colchicine, spindle, metaphase
(d) colchicine, centromere, telophase

43 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

44 Cell furrow appears in the plasma membrane of animal cell during
(a) cytokinesis (b) karyokinesis
(c) interphase (d) interkinesis

45 Cytoplasmic division occurs *via* cell plate formation in
(a) animal cells (b) plant cells
(c) bacterial cells (d) mammalian cells

46 When karyokinesis is not followed by cytokinesis, it results in the formation of
(a) uninucleate cells (b) multinucleate cells
(c) undifferentiated cells (d) diploid cells

47 Mitosis usually results in the
(a) production of diploid daughter cells
(b) growth of multicellular organisms
(c) cell repair
(d) All of the above

48 Which of the following is not a significance of mitosis?
(a) Production of progeny having identical genetic complement
(b) Restoration of nucleocytoplasmic ratio
(c) Replacement of dead tissue
(d) Evolution

TOPIC 3 ~ *Meiosis*

49 The type of division that ensures the production of haploid phase in the life cycle of sexually reproducing organisms is
(a) mitosis (b) meiosis
(c) cytokinesis (d) interphase

50 In meiosis, the chromosome number
(a) reduces by half
(b) increases by twice
(c) increases by four times
(d) reduces by one-fourth

51 The precursor cells of meiosis are
(a) somatic cells (b) diploid sex cells
(c) haploid sex cells (d) Both (a) and (c)

52 Meiosis involves two cycles of
(a) Cell division (b) Nuclear divisions
(c) DNA replication (d) Both (a) and (b)

53 During meiosis, DNA replication occurs
(a) thrice, during interphase, M-phase and cytokinesis
(b) twice, i.e. during interphase and M-phase
(c) once during S-phase
(d) once during prophase

54 At the end of meiosis-II, number of haploid cells formed are
(a) two (b) four (c) eight (d) one

55 Longest phase of meiosis is
(a) prophase-I (b) prophase-II
(c) anaphase-I (d) metaphase-II

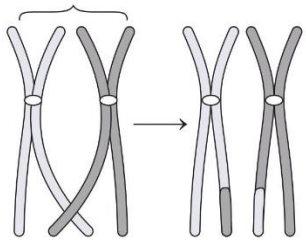
56 The compaction of chromosomes occurs during
(a) pachytene (b) anaphase-I
(c) leptotene (d) telophase-I

57 Synaptonemal complex is formed ***JIPMER 2019***
(a) during anaphase
(b) during metaphase
(c) during prophase-II
(d) during prophase- I of meiosis

58 During meiosis, the homologous chromosomes
(a) pair up during pachytene
(b) are prepared for separation
(c) contain identical genetic information
(d) None of the above

59 Which one of the following events does not occur during zygotene?
(a) Formation of synaptonemal complex
(b) Pairing of chromosomes
(c) Appearance of bivalents
(d) Involvement of recombinase

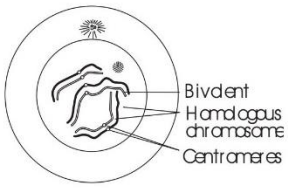
60 Given below is the representation of a certain event at a particular stage of a type of cell division. Which is this stage? ***CBSE-AIPMT 2012***



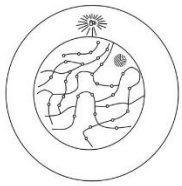
(a) Prophase-I during meiosis
(b) Prophase-II during meiosis
(c) Prophase of mitosis
(d) Both prophase and metaphase of mitosis

61 When paternal and maternal chromosomes exchange their genetic material with each other in cell division, this event is called
(a) bivalent forming
(b) crossing over
(c) synapsis
(d) dyad forming

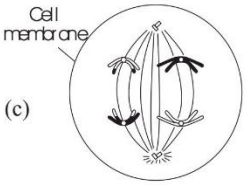
62 The figure given below shows a cell undergoing meiosis.



Identify the option which correctly indicates the stage next to this.

(a) 

(b) 

(c) 

(d) 

63 Crossing over takes place between which chromatids and in which stage of the cell cycle? ***NEET 2019***

(a) Non-sister chromatids of non-homologous chromosomes at zygotene stage of prophase-I
(b) Non-sister chromatids of homologous chromosomes at pachytene stage of prophase-I
(c) Non-sister chromatids of homologous chromosomes at zygotene stage of prophase-I
(d) Non-sister chromatids of non-homologous chromosomes at pachytene stage of prophase-I

64 Select the incorrectly matched pair.

(a) Animal cell — Persistent spindle
(b) Reductional division — Meiosis-I
(c) Equational division — Meiosis-II
(d) Crossing over — Non-homologous chromosomes

65 The enzyme involed in the process of crossing over

(a) crossinase (b) DNA ligase
(c) recombinase (d) DNA polymerase

66 In diploid organisms, phenomenon of crossing over is responsible for

(a) linkages between genes
(b) recombination between homologous genes
(c) segregation between genes
(d) dominance of gene

67 The stage during which separation of the paired homologous chromosomes begins is ***NEET 2018***

(a) diakinesis (b) diplotene
(c) pachytene (d) zygotene

68 Which of the following events occurs during diplotene stage of cell cycle?

(a) Separation of synapsed homologous chromosomes except at the site of cross overs
(b) degeneration of nucleolus
(c) degeneration of chiasmata
(d) All of the above

69 The X-shaped structures observed during diplotene are

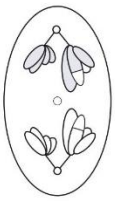
(a) chiasmata (b) synaptonemal complex
(c) bivalent complex (d) None of these

70 Diakinesis is marked by

(a) terminalisation of chiasmata
(b) degeneration of nucleolus
(c) fully condensed chromosomes
(d) All of the above

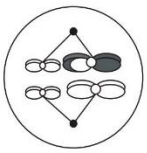
71 Splitting of centromere and hence separation of chromatids occurs during

(a) prophase-II (b) anaphase-I
(c) anaphase-II (d) metaphase-II

72 

Above diagram represents ***JIPMER 2018***

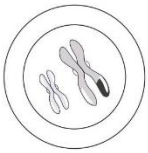
(a) anaphase-I (b) metaphase-I
(c) telophase-I (d) prophase-I

73 

Above diagram represents ***JIPMER 2018***

(a) metaphase-I (b) anaphase-I
(c) metaphase-II (d) anaphase-II

74 Which of the following is correct for the figure given below?



	Number of homologous chromosomes	Number of chromatids	Phase of cell division
(a)	2	4	Telophase-I
(b)	4	8	Telophase
(c)	2	8	Telophase-II
(d)	4	2	Telophase

75 After meiosis-I, the resultant daughter cells have ***NEET (Odisha) 2019***

(a) same amount of DNA as in the parent cell in S-phase
(b) twice the amount of DNA in comparison to haploid gamete
(c) same amount of DNA in comparison to haploid gamete
(d) four times the amount of DNA in comparison to haploid gamete

76 Select the option which correctly identifies the similarity between mitosis and meiosis cell division.

(a) Pairing of homologous chromosomes
(b) Required in all types of cells
(c) S-phase occurs before initiation
(d) Separation of paired chromosomes

77 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

NEET

SPECIAL TYPES QUESTIONS

I. Assertion and Reason

■ **Direction** (Q. No. 78-90) *In each of the following questions, a statement of Assertion (A) is given by corresponding statement of Reason (R). Of the statements, mark the correct answer as*

(a) If both A and R are true and R is the correct explanation of A
(b) If both A and R are true, but R is not the correct explanation of A
(c) If A is true, but R is false
(d) If A is false, but R is true

78 **Assertion** (A) In mitosis, two identical cells are produced from a single cell and karyokinesis is followed by cytokinesis.

Reason (R) Cytokinesis is of two types, i.e. by cell-furrow method and cell-plate method. ***AIIMS 2018***

79 **Assertion** (A) Meiotic division occurs in reproductive cells.

Reason (R) Synapsis occurs during zygotene of meiosis. ***AIIMS 2018***

80 **Assertion** (A) Cell normally proceed to mitosis without interruption, once it enters the G_2-phase.

Reason (R) Replicated chromosomes (DNA) are distributed to daughter nuclei by a complex series of events under genetic control.

81 **Assertion** (A) Mitosis occurs in apical meristems and lateral meristem.

Reason (R) Apical and lateral meristems are responsible for growth of plants.

82 **Assertion** (A) In animal cells, cytokinesis is achieved by the appearance of a furrow in plasma membrane.

Reason (R) In plant cells, the formation of the new cell wall begins with the formation of simple precursor called cell plate.

83 **Assertion** (A) Mitosis restores the nucleocytoplasmic ratio.

Reason (R) It is significant in the life of an organism, especially in the growth of multicellular organism.

84 **Assertion** (A) Meiotic division occurs in reproductive cells.

Reason (R) As a result of meiosis, gametes are formed.

85 **Assertion** (A) Each pollen mother cell produces four haploid pollen grains.

Reason (R) Meiosis takes place in pollen mother cells.

86 **Assertion** (A) Small disc-shaped structures at the surface of the centromeres are called kinetochores.

Reason (R) Kinetochores are proteinaceous structures.

87 **Assertion** (A) In anaphase-II, chromosomes align at the equator.

Reason (R) The centromere of each chromosome splits and chromatids separate.

88 **Assertion** (A) A cell after telophase-II does not enter another interphase.

Reason (R) Gametes or Spores are formed after telophase-II.

89 **Assertion** (A) Diakinesis is the final stage of prophase-I.

Reason (R) Terminalisation of chiasmata occurs in diakinesis.

90 **Assertion** (A) Some cells undergo G_0-phase due to inactivation of cell cycle.

Reason (R) Cells at this stage remain metabolically active, but no longer proliferate.

II. Statement Based Questions

91 Which of the following statements are correct for cell cycle?

(a) Cell cycle is the sequence of events involving growth and division of a cell from the time of its formation to division into daughter cells

(b) DNA synthesis occurs only during one specific stage in the cell cycle

(c) The replicated chromosomes (DNA) are distributed to daughter nuclei during cell division

(d) All of the above

92 Read the following statements and select the incorrect one.

(a) M-phase represents the phase when the actual cell division or mitosis occurs

(b) Mitogens such as auxins inhibit the mitosis division

(c) Mitosis can be best studied in lab using root tip material

(d) Spindle usually presents as phragmoplast during cytokinesis in plants

93 Which one of the following statements is correct for cells in G_0-stage of cell cycle?

(a) Cells in G_0-stage proliferate excessively

(b) Cells are metabolically inactive

(c) Cells are metabolically active, but no longer proliferate in normal condition

(d) Both (a) and (b)

94 Select the incorrect statements regarding S-phase of interphase.

(a) Occurs between G_1 and G_2

(b) DNA replication begins in the nucleus

(c) Centrioles duplicate in the cytoplasm

(d) As DNA is doubled, number of chromosomes also doubles

95 Select the incorrect statement for prophase.

(a) Chromosomal material condenses to form compact mitotic chromosomes

(b) The assembly of mitotic spindle is initiated by the microtubules

(c) Cells at the end of prophase contain membrane bound organelles when viewed under the prophase

(d) The nucleolus or nucleoli degenerates completely

96 Which of the following statements (events) is/are true for mitotic telophase?

(a) Nucleolus, GB and ER reform

(b) Nuclear envelope develops around the chromosome clusters

(c) Arrival of chromosomes cluster at opposite poles and loss of their identity as discrete elements

(d) All of the above

97 Select the correct statement.

(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 divisions of nucleus and cytoplasm occurs at the same time

(d) None of the above

98 Which of the following is incorrect for meiosis cell division?

(a) In meiosis, daughter cells receive a mixture of maternal and paternal chromosomes

(b) The cells undergoing the division may be haploid or diploid in case of plants

(c) It usually represented as $n \rightarrow 2n$

(d) Synapsis of homologous chromosomes takes place during zygotene of prophase-I

99 Choose the correct statements regarding cell cycle.

I. M-phase is also called the resting phase because DNA replication does not occur during this phase.

II. Interphase is the time during which the cell is preparing for division.

III. The interphase is divided into four prominent phases, i.e. G_0, G_1, S and G_2-phases.

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) II and IV

100 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 synthesises RNAs, proteins and other biochemicals 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

101 The DNA content of individual cells and the number of cells in each phase of a 'cell cycle' can be determined using flow cytometry. Which of the following combinations of 'phase of a cell cycle and its corresponding DNA content' can be considered correct?

I. Diploid cells found in the G_0 or G_1-phase.

II. Cell with twice the normal DNA content in the early M-phase.

III. Cells with intermediate amounts of DNA in the S-phase.

IV. Cells with twice the normal DNA content in the G_2-phase.

Codes

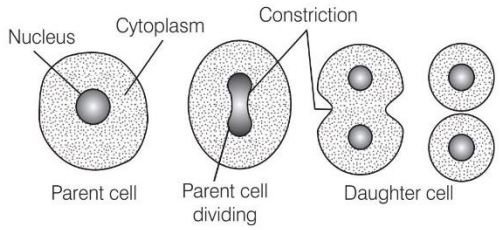
(a) I and II

(b) II and III

(c) III and IV

(d) I, II, III and IV

102 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

103 Which of the following statement(s) is/are 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-II is initiated after the parental chromosome replication, which produces identical sister chromatids at the S-phase.
(a) I and III (b) Only II
(c) II and III (d) I, II, III and IV

104 Arrange the following events of meiosis in correct sequences.
I. Crossing over.
II. Synapsis.
III. Terminalisation of chiasmata.
IV. Disappearance of nucleolus. ***CBSE-AIPMT 2015***
(a) II, I, IV and III
(b) II, I, III and IV
(c) I, II, III and IV
(d) II, III, IV and I

105 I. Thin thread chromosomes with a beaded appearance.
II. Appearance of recombination nodules.
III. Formation of bivalents/tetrads.
IV. Terminalisation of chiasmata.
V. Appearance of chiasmata.
Identify the different stages with respect to the above given features and select the correct option.
(a) I–Leptotene, II–Zygotene, III–Pachytene, IV–Diplotene, V–Diakinesis
(b) I–Leptotene, II–Zygotene, III–Pachytene, IV–Diakinesis, V–Diplotene
(c) I–Leptotene, II–Pachytene, III–Zygotene, IV–Diakinesis, V–Diplotene
(d) I–Leptotene, II–Pachytene, III–Diplotene, IV–Zygotene, V–Diakinesis

106 Consider the following statements.
I. During meiosis, the chromosome number reduces to half in anaphase-II stage.
II. During anaphase-II stage, the amount of DNA in a cell gets reduced to haploid state.
Select the correct option.
(a) Both I and II are true (b) I is true, II is false
(c) I is false, II is true (d) Both I and II are false

107 Consider the following statements.
I. A bivalent consists of four chromatids.
II. Divisions of centromere do not occur during anaphase-I stage of meiosis.
Select the correct option.
(a) Both I and II are true (b) I is true, II is false
(c) I is false, II is true (d) Both I and II are false

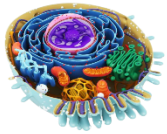
108 Consider the following statements.
I. Cytokinesis in plants occur by cell plate method.
II. Cell plate grows centrifugally in plant cells.
Select the correct option.
(a) Both I and II are true (b) I is true, II is false
(c) I is false, II is true (d) Both I and II are false

109 Consider the following statements.
I. Dyad of cells is formed during the telophase-II stage of meiosis.
II. Interkinesis is the stage between meiosis-I and meiosis-II.
Select the correct option.
(a) Both I and II are true (b) I is true, II is false
(c) I is false, II is true (d) Both I and II are false

III. Matching Type Questions

110 Match the following columns.

	Column I (Features)		Column II (Phases of cell division)
A.	Separation of daughter chromosomes	1.	Interphase
B.	Division of cytoplasm	2.	Karyokinesis
C.	Phase between two successive M-phases	3.	S-phase
D.	Synthesis phase	4.	Cytokinesis



Codes

	A	B	C	D
(a)	2	3	1	4
(b)	4	1	3	2
(c)	2	4	1	3
(d)	4	2	3	1

111 Match the following columns.

	Column I		Column II
A.	Division of nucleus	1.	Undividing cells
B.	Division of cytoplasm	2.	Cytokinesis
C.	Quiescent stage	3.	Formation of syncytium
D.	Karyokinesis not followed by cytokinesis	4.	Karyokinesis

Codes

	A	B	C	D
(a)	2	4	1	3
(b)	4	2	1	3
(c)	4	2	3	1
(d)	3	2	4	1

112 Match the following columns.

	Column I (Features)		Column II (Stages of cell division)
A.	Disintegration of nuclear membrane	1.	Anaphase
B.	Appearance of nucleolus	2.	Prophase
C.	Division of centromere	3.	Telophase
D.	Synthesis of RNA and proteins	4.	G_1-phase

Codes

	A	B	C	D
(a)	2	3	1	4
(b)	2	3	4	1
(c)	3	2	1	4
(d)	3	2	4	1

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

NEET 2016, AIIMS 2018

	Column I (Phases)		Column II (Events)
A.	Pachytene	1.	Pairing of homologous chromosomes
B.	Metaphase-I	2.	Terminalisation of chiasmata
C.	Diakinesis	3.	Crossing over takes place
D.	Zygotene	4.	Chromosomes align at equatorial plate

Codes

	A	B	C	D
(a)	3	4	2	1
(b)	1	4	2	3
(c)	2	4	3	1
(d)	4	3	2	1

114 Match the following columns.

	Column I		Column II
A.	Chromosomes in matching pairs	1.	metaphase plate
B.	In mitosis, each chromosome is copied and	2.	homologous chromosomes
C.	Precursor for cell wall formation that represents the middle lamella between the walls of two adjacent cells is called	3.	cell plate
D.	The plane of alignment of the chromosomes at metaphase is referred to as the	4.	cell divides to give two daughter cells

Codes

	A	B	C	D
(a)	2	4	3	1
(b)	4	3	1	2
(c)	1	4	2	3
(d)	3	2	4	1

115 Select the correct option. ***CBSE-AIPMT 2015***

	Column I (Features)		Column II (Stages of cell division)
A.	Synapsis aligns homologous chromosomes	1.	Pachytene
B.	Synthesis of RNA and protein	2.	Zygotene
C.	Action of enzyme recombinase	3.	G_2-phase
D.	Centromeres do not separate, but chromatids move towards opposite poles	4.	Anaphase-I

Codes

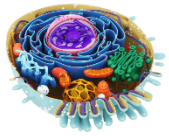
	A	B	C	D		A	B	C	D
(a)	2	3	1	4	(b)	1	2	3	4
(c)	2	3	4	1	(d)	2	1	3	4

116 Match the following columns.

	Column I (Features)		Column II (Stages of cell division)
A.	Appearance of recombination nodule	1.	Metaphase-I
B.	Histone synthesis	2.	Anaphase-I
C.	Disjunction	3.	Pachytene
D.	Interkinesis	4.	Meiosis-II
E.	Double equatorial plate	5.	G_1-phase

Codes

	A	B	C	D	E
(a)	5	2	1	3	4
(b)	3	5	4	2	1
(c)	2	5	4	1	3
(d)	3	5	2	4	1



NCERT & NCERT Exemplar

MULTIPLE CHOICE QUESTIONS

NCERT

117 Why is mitosis called equational division?
(a) Because some equation method is used for dividing the cells
(b) Because chromosome number of daughter cells remains equal to parent cell
(c) Both (a) and (b)
(d) None of the above

118 Name the phases of cell cycle at which one of the following events occur.
I. Chromosomes are moved to spindle equator.
II. Centromere splits and chromatids separate.
III. Pairing between homologous chromosomes takes place.
IV. Crossing over between homologous chromosomes takes place.
(a) I. Metaphase II. Anaphase III. Zygotene IV. Pachytene
(b) I. Metaphase-I II. Anaphase-II III. Diplotene IV. Diakinesis
(c) I. Metaphase II. Anaphase III. Pachytene IV. Diplotene
(d) I. Metaphase-II II. Anaphase-I III. Diakinesis IV. Diplotene

119 How does cytokinesis in plant cells (I) differ from that in animal cells (II)?
(a) I. Cytoplasm division by cleavage
II. Cytoplasm division by cell plate formation
(b) I. Cytoplasm division by cell plate formation
II. Cytoplasm division by cleavage
(c) I. Peripheral divison
II. Central division
(d) Both (b) and (c)

120 Find examples where the four daughter cells from meiosis are equal in size (I) and where they are found unequal is size (II).
(a) I. Microsporogenesis II. Megasporogenesis
(b) I. Spermatogenesis II. Oogenesis
(c) Both (a) and (b)
(d) None of the above

NCERT Exemplar

121 Select the correct statement about G_1-phase.
(a) Cell is metabolically inactive
(b) DNA in the cell does not replicate
(c) It is not a phase of synthesis of macromolecules
(d) Cell stops growing

122 Cells which are not dividing are likely to be at
(a) G_1-phase
(b) G_2-phase
(c) G_0-phase
(d) S-phase

123 Mitosis is characterised by
(a) reduction division
(b) equal division
(c) Both (a) and (b)
(d) pairing of homologous chromosomes

124 Which of the events listed below is not observed during mitosis?
(a) Chromatin condensation
(b) Movement of centrioles to opposite poles
(c) Appearance of chromosomes with two chromosomes joined together at the centromere
(d) Crossing over

125 Identify the incorrect statement about meiosis.
(a) Pairing of homologous chromosomes
(b) Four haploid cells are formed
(c) At the end of meiosis, the number of chromosomes is reduced to half
(d) Two cycles of DNA replication occurs

126 Meiosis occurs in organisms during
(a) sexual reproduction
(b) vegetative reproduction
(c) asexual reproduction
(d) Both (a) and (b)

127 Meiosis in diploid organisms results in
(a) production of gametes
(b) reduction in the number of chromosomes
(c) introduction of variation
(d) All of the above

128 At which stage of meiosis is the genetic constitution of gametes is finally decided?
(a) Metaphase-I (b) Anaphase-II
(c) Metaphase-II (d) Anaphase-I

129 During anaphase-I of meiosis,
(a) homologous chromosomes separate
(b) non-homologous autosomes separate
(c) sister chromatids separate
(d) non-sister chromatids separate

130 A bivalent in meiosis-I consists of
(a) two chromatids and one centromere
(b) two chromatids and two centromeres
(c) four chromatids and two centromeres
(d) four chromatids and four centromeres

Answers

Mastering NCERT with MCQs

1 (b)	2 (b)	3 (a)	4 (a)	5 (a)	6 (c)	7 (d)	8 (b)	9 (b)	10 (a)	11 (d)	12 (a)	13 (c)	14 (b)	15 (a)
16 (d)	17 (a)	18 (b)	19 (b)	20 (c)	21 (a)	22 (a)	23 (c)	24 (d)	25 (d)	26 (d)	27 (b)	28 (c)	29 (d)	30 (a)
31 (b)	32 (b)	33 (a)	34 (c)	35 (c)	36 (d)	37 (a)	38 (c)	39 (c)	40 (a)	41 (b)	42 (c)	43 (a)	44 (a)	45 (b)
46 (b)	47 (d)	48 (d)	49 (b)	50 (a)	51 (d)	52 (d)	53 (c)	54 (b)	55 (a)	56 (c)	57 (d)	58 (b)	59 (d)	60 (a)
61 (b)	62 (b)	63 (b)	64 (d)	65 (c)	66 (b)	67 (b)	68 (a)	69 (a)	70 (d)	71 (c)	72 (a)	73 (a)	74 (a)	75 (b)
76 (c)	77 (d)													

NEET Special Types Questions

78 (b)	79 (b)	80 (d)	81 (a)	82 (b)	83 (b)	84 (a)	85 (a)	86 (b)	87 (d)	88 (a)	89 (a)	90 (b)	91 (d)	92 (b)
93 (c)	94 (d)	95 (c)	96 (d)	97 (b)	98 (c)	99 (d)	100 (b)	101 (d)	102 (d)	103 (a)	104 (b)	105 (c)	106 (c)	107 (a)
108 (a)	109 (c)	110 (c)	111 (b)	112 (a)	113 (a)	114 (a)	115 (a)	116 (b)						

NCERT & NCERT Exemplar Questions

117 (b)	118 (a)	119 (b)	120 (c)	121 (b)	122 (c)	123 (b)	124 (d)	125 (d)	126 (a)	127 (d)	128 (d)	129 (a)	130 (c)

Answers & Explanations

2 (*b*) During cell cycle, DNA synthesis occurs only once, i.e. during synthetic (S) phase. In this phase, the amount of DNA per cell gets doubled.

4 (*a*) Duration of the cell cycle, for mammalian cell is 24 hrs. The cell cycle of yeast occurs in about 90 min. It is the period between two successive cell divisions and is called as generation time. It depends on the type of cell and external factors such as temperature, food and oxygen supplies.

5 (*a*) Cell cycle consists of two basic stages. There is a long non-dividing stage called interphase where the cell prepares for division and a short dividing stage called M-phase/divisional phase.

6 (*c*) Interphase is divided into three phases, namely first gap or G_1-phase, synthetic or S-phase and second gap or G_2-phase.

It involves series of changes which occur in a newly formed cell and its nucleus, before it becomes capable of dividing again.

8 (*b*) In an average 24 hrs duration of cell cycle, interphase lasts more than 95% of the total duration, while cell division (M-phase) completes in about an hour only.

11 (*d*) The interphase is also called the resting phase. This is because it is the time during which the cell prepares for division by undergoing cell growth and DNA replication in an orderly manner.

12 (*a*) Interphase is divided into G_1, S and G_2-phases, out of which in S-phase, duplication of chromosomal material occurs. Thus, DNA content gets doubled in the S-phase of interphase.

13 (*c*) The correct sequence of phases of cell cycle is $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$

Here, G_1 and G_2 represent first and second growth phases, respectively. S-phase represents synthesis phase during which DNA replicates takes place between the two growth phases. M-phase is mitotic phase during which a cell begins to divide.

14 (*b*) In the G_1-phase, a cell remains metabolically active and continues to grow, i.e. there is an increase in its cytoplasmic content and function normally. The proteins required for DNA replication are synthesised during this phase.

15 (*a*) During the G_1-phase of cell cycle (the longest phase of cell cycle), cell synthesises RNAs, proteins and other biochemicals for cell growth and subsequent replication of DNA.

16 (*d*) DNA replication does not occur in G_1-phase of cell cycle. Thus, the amount of DNA in the given cell remains the same.

18 (*b*) If the onion root tip cell has 14 chromosomes initially, the number would remain the same in G_1-phase also, i.e. 14.

During G_1-phase only cell growth occurs. Also, the number of chromosomes remain the same in a cell during this phase.

19 (*b*) The DNA content will be four times and the chromosomes will be double in number in a cell after S-phase as compared to the gamete of the same organism.

During S- phase of cell division, only the DNA content of cell gets doubled from 2C to 4C while number of chromosomes remains same in the dividing cell.

20 (*c*) During G_2-phase of the cell cycle, the cell would contain 4C amount of DNA if the initial amount was 2C. During M-phase, the cell divides into two daughter cells and each cell will receive 2C amount of DNA.

22 (*a*) As the cell has stalled the DNA replication fork, G_1 / S-phase check point should be predominantly activated. This check point ensures the entry of cells into S-phase for DNA replication. Which is essential for further division of cells. If this check point gets stalled a cell will not enter S-phase and no DNA replication will occur.

23 (*c*) In human body, heart cells do not exhibit division. Therefore, these cells exit the cell cycle at G_1-phase to enter an inactive quiescent stage (G_0).

24 (*d*) G_0-phase is the stage in which the cells permanently or temporarily exit the cell cycle. It is the resting or quiescent phase in which the cells do not divide unless needed. It is the permanent state for some cells, e.g. neurons.

27 (*b*) Mitosis is called as the equational division because it divides the parent cell into two identical daughter cells, each with a nucleus having the same chromosomal content as in the parent cell.

28 (*c*) Synapsis is not characteristic feature of mitosis. It is described as the pairing of homologous chromosomes. It occurs during zygotene substage of prophase of meiosis.

29 (*d*) Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material becomes untangled during the process of chromatin condensation.

31 (*b*) The complete disintegration of the nuclear envelope marks the initiation of the second phase of mitosis, i.e. metaphase. By this stage, condensation of chromosomes is completed and these can be observed clearly under the microscope.

32 (*b*) Metaphase is the best stage to count the total number of chromosomes and conduct a detailed study of the morphology of chromosomes. Idiogram (arrangement of chromosomes in a series of decreasing length) can be drawn in this stage as chromosomes are maximally condensed and aligned on the metaphasic plate.

33 (*a*) Spindle fibres attach to the kinetochores present on the surface of the chromosome.
It is a disc-shaped structure made up of proteinaceous microtubules.

35 (*c*) During anaphase, the centromeres of chromosomes split into two to form daughter chromosomes. These daughter chromosomes are repulsive and hence they migrate towards opposite poles.
Spindle fibres attached to the centromeres shorten and pull the chromosomes to the opposite poles.

37 (*a*) During anaphasic movements, the centromeres are directed towards the poles and thus, lead to the movement of chromosomes towards opposite poles of the cell.

38 (*c*) If Anaphase Promoting Complex (APC) is defective in a human cell, the chromosomes will not segregate during the anaphase stage of mitosis. APC triggers the transition from metaphase to anaphase by tagging specific proteins for degradation.

39 (*c*) During the anaphase stage of mitosis, the chromosomes may assume V, L, J or I-shaped structures. During the migration of chromosomes, the centromeres lead the path toward the poles, while the arms trail behind which results in different shapes of these chromosomes.

40 (*a*) Option (a) gives the correct identification of the stage with its characteristics. Telophase is reverse of prophase. The chromosomes that have reached their respective poles decondenses, nucleolus, nuclear envelope and cell organelles including Golgi complex reforms.

41 (*b*) During mitosis following sequence of events occurs condensation of chromosomal material, which takes place at an early prophase stage. During late prophase nuclear membrane disintegrates. Then chromosomes get arranged at equator in the metaphase stage. After that splitting of centromere and segregation of chromosomes occur in the anaphase stage. In telophase stage, chromosomes move to opposite poles of the cell. It is last stage of mitosis. Thus, option (b) gives the correct sequence of events which occur during mitosis.

42 (*c*) Option (c) is the series of that correctly fills the given blanks. Colchicine is an alkaloid in a mitotic division which interferes with the spindle formation by preventing assembly of microtubules during the metaphase of mitosis cell division.

44 (*a*) In an animal cell, cell furrow occurs on the plasma membrane during cytokinesis. This furrow gradually deepens and ultimately joins the centre, thus dividing the cell cytoplasm into two.

45 (*b*) Cytoplasmic division or cytokinesis in plant cells occurs *via* cell plate formation because these cells are enclosed by an inextensible or flexible cell wall.

46 (*b*) In some organisms, when karyokinesis is not followed by cytokinesis, it results multinucleate condition which leads to the formation of syncytium.

47 (*d*) 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 disturbed the ratio between the nucleus and the cytoplasm. It therefore, becomes essential for the cell to divide to restore this disturbed nucleocytoplasmic ratio. A very significant contribution of mitosis is cell repair, i.e. upper epidermis, gut lining, etc., exposed to constant wear and tear.

48 (*d*) Mitosis does not contribute to evolution because the genetic make up of organisms remains the same throughout generations. Evolution mainly occurs due to the variations among individuals and these variations occur through meiosis.

50 (*a*) During meiosis, the chromosome number gets reduced by half. Thus, it leads to the production of haploid daughter cells. The sperm and the egg are haploid cells and when they fuse during fertilisation, they produce a diploid cell called zygote.

52 (*d*) Meiosis involves two sequential cycles of nuclear and cell division called meiosis-I and meiosis-II, but only a single cycle of DNA replication (during S-phase of interphase).

54 (*b*) Meiosis starts with one diploid cell containing copies of chromosomes, one from the female parent and one from the male parent. The cell divides twice, so as to produce four haploid cells containing one copy of each chromosome.

55 (*a*) Longest phase of meiosis is prophase-I because it involves major events like synapsis and crossing over of chromosomes. These events occur in five substages namely leptotene, zygotene, pachytene, diplotene and diakinesis. Prophase-I is more complex than mitotic prophase stage.

57 (*d*) Synaptonemal complex is formed during zygotene stage of prophase-I of meiosis. This is a complex zipper-like nucleoprotein complex formed between homologous chromosomes. It functions as mediator in chromosome pairing, synapsis and recombination.

59 (*d*) During zygotene stage, recombinase enzyme does not play any role. This enzyme helps in crossing over during the pachytene stage of prophase-I of meiosis-I.

62 (*b*) The figure given shows the zygotene substage of prophase-I of meiosis-I. During this stage, chromosomes start pairing together by the process called synapsis. In case of other options, (a) shows leptotene, (c) is anaphase-I and (d) is telophase-I.

63 (*b*) Crossing over takes place between the non-sister chromatids of homologous chromosomes during the pachytene stage of prophase-I. This stage is characterised by the appearance of recombination nodules, the site at which crossing over occurs.

66 (*b*) In diploid organisms, recombination of genes present on the homologous chromosome is accomplished by crossing over. It is the process by which parts of homologous chromosomes are interchanged leading to variations in progeny. Thus, crossing over is responsible for recombination between homologous genes.

67 (*b*) The separation of the paired homologous chromosomes begins in the diplotene stage. In this phase, the dissolution of synaptonemal complex begins. The recombined homologous chromosomes of the bivalents separate from each other except at the sites of cross overs.

70 (*d*) Diakinesis is the final stage of prophase-I of meiosis-I. It is characterised by the shortening and thickening of the paired chromosomes so as to form fully condensed chromosomes. Formation of the spindle fibres, disappearance of the nucleolus, degeneration of the nuclear membrane and terminalisation of chiasmata all occur during this stage.

71 (*c*) During anaphase-II, the centromere splits and the sister chromatids of homologous chromosomes separate. This event is similar to the anaphase stage of mitosis. But during anaphase-I, the homologous chromosomes separate without the splitting of centromere.

72 (*a*) The figure given is showing anaphase-I of meiosis. It begins when the two chromosomes of each bivalent separate and start moving towards opposite poles of the cell. Unlike the anaphase of mitosis, the sister chromatids remain attached at their centromeres and move together toward the poles.

73 (*a*) The given diagram represents metaphase-I of meiosis. This stage is more or less similar to the metaphase stage of mitosis. The only difference is appearance of paired homologous chromosomes at the metaphasic plate.

75 (*b*) After meiosis-I, the resultant daughter cells contain twice the amount of DNA in comparison to haploid gametes. Meiosis-I causes segregation of homologous pairs of chromosomes. However, each chromosome is double-stranded, having two sister chromatids due to DNA replication before the beginning of meiosis.

76 (*c*) Both the types of cell division, i.e. mitosis and meiosis are preceded by DNA replication which occurs in S-phase of interphase. Without replication of DNA, cell division cannot proceed as equal distribution of DNA, is an essential function of cell division.

78 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

Mitosis is the process by which a cell nucleus divides (karyokinesis) to produce two daughter nuclei containing identical sets of chromosomes to the parent cell. It is usually followed immediately by division of cytoplasm (cytokinesis) to form two daughter cells. In plants, cytokinesis occurs by cell-plate formation whereas in animals, it occurs by cell furrow formation.

79 (*b*) Both Assertion and Reason are true, but Reason is not the correct explanation of Assertion.

Meiotic division is a reductional division. It occurs in reproductive cells as it helps to maintain the fixed number of chromosomes in sexually reproducing organisms. Prophase-I of meiotic division is a long phase, which is divided into five subphases, i.e. leptotene, zygotene, pachytene, diplotene and diakinesis. Synapsis or Pairing of chromosomes occurs during the zygotene stage.

80 (*d*) Assertion is false, but Reason is true. Assertion can be corrected as

Cells normally proceed to mitosis without any interruptions once, it enters to the S-phase. This is because in S-phase, DNA replication occurs which is an essential process, since parental DNA is equally distributed into daughter cells at the end of division process. If this step does not occur, parent cell cannot undergo division.

81 (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

The apical and lateral meristems of a plants are the regions which contribute to the overall (primary and secondary) growth of plants. This growth occurs by rapid mitotic division in these regions.

82 (*b*) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

In an animal cell, cytokinesis is achieved by the appearance of a furrow in the plasma membrane. The furrow gradually deepens and ultimately joins in the centre thus, dividing the cell cytoplasm into two. This mode of cytokinesis is called cell-furrow method.

Plants cells however, are enclosed by a relatively inextensible cell wall, therefore they undergo cytokinesis by a different mechanism. The formation of the new cell wall begins with the formation of a simple precursor called the cell plate. It represents the middle lamella between the walls of two adjacent cells. This mode of cytokinesis is called cell plate method.

83 (*b*) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

Cell growth in multicellular organisms disturbs the ratio between the nucleus and the cytoplasm.

Since, mitosis is an equational division, it restores this nucleocytoplasmic ratio and produces daughter cells with genetic complement identical to their parents.

84 (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Meiotic division is a reductional division. It occurs in reproductive cells and maintains a fixed number of chromosomes in sexually reproducing organisms. During sexual reproduction, meiosis contributes to gametogenesis, as a result of which haploid gametes are formed.

85 (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Meiosis takes place in pollen mother cells. All pollen mother cells are diploid and produce haploid pollen grains after meiosis.

86 (*b*) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

Kinetochores are small disc-shaped proteinaceous structures at the surface of centromeres. These structures serve as the sites of attachment of spindle fibres to the chromosomes that are positioned at the centre of the cell.

87 (*d*) Assertion is false, but Reason is true and Assertion can be corrected as

In metaphase-II, the chromosomes align at the single equatorial plate.

88 (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Telophase-II results in the formation of two groups of chromosome enveloped by a nuclear membrane. Since, gametes or spores are formed after telophase-II phase, the cell involved does not enter another interphase.

89 (*a*) Both Assertion and Reason are correct and Reason is the correct explanation of Assertion.

Prophase-I ends with terminalisation of chiasmata during diakinesis. It represents the transition of dividing cells from prophase to metaphase.

Thus, diakinesis is the final stage of prophase-I as terminalisation of chiasmata occurs in this stage.

90 (*b*) Both Assertion and Reason are correct, but Reason is not the correct explanation of Assertion.

G_0-phase is the permanent or temporary exit from the G_1-phase. Cells in this phase remain metabolically active but do not proliferate unless called on to do so depending on the requirement of the organism.

92 (*b*) Statement in option (b) is incorrect. It can be corrected as

Mitogens such as auxins, are mitosis promoting substances.

Rest of the statements are correct for G_0 stage of cell cycle.

93 (*c*) Stataement in option (c) is correct.

During the G_0-phase of cell cycle, cells are metabolically active, but no longer proliferate in normal condition.

94 (*d*) Statement in option (d) is incorrect and can be corrected as

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, no increase in the chromosome number occurs during S-phase.

Rest of the statements are correct.

95 (*c*) Statement in option (c) is incorrect and can be corrected as

At the end of prophase, nucleolus, nuclear membrane and all membrane bound organelles disappear.

Thus, when cells at the end of prophase are observed under microscope, only highly condensed chromosomes and centrioles would be seen.

Rest of the statements are correct.

97 (*b*) Statement in option (b) is correct.

During cell division, a parent cell first undergoes karyokinesis, i.e. the division of nucleus which is then followed by division of cytoplasm, i.e. cytokinesis to form two complete daughter cells.

98 (*c*) Statement in option (c) is incorrect for meiosis cell division and it can be corrected as

A meiosis is a reductional type of division, in which diploid ($2n$) parent cells divide to form haploid (n) daughter cells, i.e. $2n \rightarrow n$.

Rest of the statements are correct.

99 (*d*) Statements II and IV are correct, while statements I and III are incorrect. These statements can be corrected as

- M-phase is known as the dividing phase during which the DNA which was replicated in interphase undergoes division so as to form new progeny cells.
- The interphase consists of three stages *viz*., G_1, S and G_2. G_0 represents the quiescent stage in which the cell which do not undergo division are present. These cells exit the cell cycle at G_1-stage.

100 (*b*) Statements II and IV are correct. Statements I and II are incorrect and can be corrected as

- 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 negligible.

- It synthesises RNAs, proteins and other biochemicals required for cell growth and subsequent replication of DNA during S-phase.

103 (*a*) Statements I and III are correct, while II and IV are incorrect. The correct form of these statements are

- At the end of meiosis-II, four haploid daughter cells are formed from a single diploid cells.
- Meiosis-I (not II) is intiated after the parental chromosomes replication, which produces identical sister chromatids at the S-phase.

106 (*c*) Statement I is false, but statement II is true. Statement I can be corrected as

During anaphase-I stage the chromosomes become half in number. Chromosomes split and move to opposite poles of the cell, both in anaphase-I and anaphase-II. The difference is that in anaphase-I, homologous pairs of chromosomes are separated and centromere splits forming two separate chromatids, while in anaphase-II, sister chromatids are separated.

109 (*c*) Statement I is false and II is true. Statement I can be corrected as

During telophase-II stage of meiosis, tetrad of haploid cells is formed. Dyad of cells is formed during the telophase-I stage of meiosis.

117 (*b*) Mitosis is called as an equational division, since, the chromosome number of daughter cells remains equal to that of parent cells.

119 (*b*) The difference between cytokinesis in plants and animal cells is that

Cytokinesis in plant cell takes place by cell plate formation. The cell plate formation starts at the centre of the cell and grows outward, towards the lateral walls.

Cytokinesis in animal cell takes place by cleavage or cell furrowing. Cleavage starts at the periphery and then moves inward, thus dividing the cell into two parts.

120 (*c*) Option (c) is correct.

During microsporogenesis (plants) and spermatogenesis (human), four daughter cells are formed from meiosis and they are equal in size. While in megasporogenesis (plants) and oogenesis (human), four daughter cells formed are of unequal size.

121 (*b*) The statement in option (b) is correct for G_1-phase. Rest of the statements are incorrect and can be corrected as

- Cell is metabolically active.
- It is the phase of synthesis of macromolecules.
- It continuously grows.

123 (*b*) Mitosis is characterised by equal division because the chromosome numbers in the daughter cells remains the same as that of parent cell. While reduction division is the characteristic of meiosis in which chromosomes gets reduced to half in daughter cells.

124 (*d*) Crossing over is not observed during mitosis. It is the phenomenon of genetic exchange between homologous pair of chromosomes and it is a characteristic feature of meiotic cell division.

Rest of the options represent stages in mitosis.

125 (*d*) The statement in option (d) is incorrect for meiosis. It can be corrected as

Two cycles of DNA replication do not occur in meiosis. DNA replication occurs only once during S-phase before the meiosis-I starts.

Rest of the statements are correct for meiosis.

126 (*a*) Meiosis occurs in sexually reproducing organisms to reduce the chromosome number to half before their gametes unite, so as to maintain the constant chromosome number ($2n$) in the progeny, i.e. zygote.

128 (*d*) The genetics of gametes is decided at the anaphase-I after which each cell receives half the initial chromosome number.

129 (*a*) During anaphase-I, homologous chromosomes separate, while sister chromatids remain associated at their centromeres.

130 (*c*) The complex formed by a pair of synapsed homologous chromosome is called a bivalent or a tetrad. A bivalent chromosome in meiosis-I consists of two centromeres and four chromatids.