10 Cell Cycle and Cell Division

Question: Doubling of the number of chromosomes can be achieved by disrupting mitotic cell division soon after:

NEET 2023 Manipur

A Anaphase

B Telophase

C Prophase

D Metaphase

Answer: D

Explanation

The doubling of the number of chromosomes can be achieved by disrupting mitotic cell division soon after DNA replication has occurred and before the separation of sister chromatids. This stage of mitosis is the metaphase, where chromosomes align in the center of the cell, prior to separation in anaphase.

If mitosis is disrupted after this point, sister chromatids cannot separate, leading to a doubling of the chromosome number in the resulting cells.

So, the correct answer is :

Option D : Metaphase.

Question: During which stages of mitosis and meiosis, respectively does the centromere of each chromosome split ?

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A Mataphase, Metaphase II

B Prophase, Telophase I

C Telophase, Anaphase I

D Anaphase, Anaphase II

Answer: D

Explanation

The centromere of each chromosome splits during the anaphase stage of both mitosis and meiosis.

In mitosis, this happens during anaphase, when sister chromatids separate and move to opposite poles of the cell.

In meiosis, the centromere splits during anaphase II, which is similar to anaphase of mitosis, and sister chromatids separate.

So, the correct answer is :

Option D : Anaphase, Anaphase II.

Question: Which one of the following is the quiescent stage of cell cycle?

A M

B G_2

C G_1

D G_0

Answer: D

Explanation

The cell cycle comprises several stages through which a cell passes during its life, from its formation to its division into two daughter cells.

Option A : M (Mitotic phase) - This is the phase where the cell divides.

Option B : G2 (Gap 2) - This is the phase of the cell cycle following DNA replication (S phase) and preceding mitosis (M phase). During this time, the cell will continue to grow and produce proteins necessary for cell division.

Option C : G1 (Gap 1) - This phase follows cell division (M phase) and precedes DNA replication (S phase). In this phase, the cell grows and monitors its environment to determine whether it should initiate DNA synthesis.

Option D : G0 (Gap 0) - This is a stage where cells are neither dividing nor preparing to divide. Instead, they are performing their designated functions and are in a state of dormancy or quiescence.

So, the quiescent stage of the cell cycle is :

Option D : G0.

Question: The process of appearance of recombination nodules occurs at which sub stage of prophase I in meiosis?

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A Pachytene

B Diplotene

C Diakinesis

D Zygotene

Answer: A

Explanation

Recombination nodules appear during the pachytene stage of prophase I in meiosis. These nodules are thought to be involved in crossing over, a process where homologous chromosomes exchange genetic material. This leads to genetic recombination, which is a significant source of genetic variation in sexually reproducing organisms.

So, the correct answer is :

Option A : Pachytene.

Question: Which of the following stages of meiosis involves division of centromere?

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A Metaphase II

B Anaphase II

C Telophase

D Metaphase I

Answer: B

Explanation

The correct answer is Option B : Anaphase II.

During meiosis, the division of the centromere occurs in Anaphase II. At this stage, the sister chromatids of each chromosome (which are attached at the

centromere) are pulled apart and move toward opposite poles of the cell. This is similar to what happens in anaphase of mitosis. In contrast, during Anaphase I of meiosis, homologous chromosomes are separated but the centromeres do not divide, meaning the sister chromatids stay together.

Question: Among eukaryotes, replication of DNA takes place in :

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A S phase

B G_1 phase

C G_2 phase

D M phase

Answer: C

Explanation

In eukaryotes, DNA replication takes place during the S phase (Synthesis phase) of the cell cycle. During this phase, the entire genome is replicated, resulting in two copies of each chromosome to ensure that both daughter cells receive a complete set of genetic information during cell division.

Question: Match List I with List II:

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	List I		List II
(A)	M Phase	(I)	Proteins are synthesized
(B)	G_2 Phase	(II)	Inactive phase
(C)	Quiescent stage	(III)	Interval between mitosis and initiation of DNA replication
(D)	G_1 Phase	(IV)	Equational division

Choose the correct answer from the options given below :

A A-IV, B-II, C-I, D-III

B A-IV, B-I, C-II, D-III

C A-II, B-IV, C-I, D-III

D A-III, B-II, C-IV, D-I

Answer: B

Explanation

M phase or mitosis is the phase where the actual cell division occurs. Mitosis is also called equational division.

During G2 phase DNA synthesis stops but cell synthesis RNA, proteins, etc. for next phase.

Quiescent stage is inactive phase in which non-dividing cells enters.

G1 phase is the interval between mitosis and initiation of DNA replication.

Therefore, option (B) is correct.

Question: Select the correct statements.

A. Tetrad formation is seen during Leptotene.

B. During Anaphase, the centromeres split and chromatids separate.

C. Terminalization takes place during Pachytene.

D. Nucleolus, Golgi complex and ER are reformed during Telophase.

E. Crossing over takes place between sister chromatids of homologous chromosome.

Choose the correct answer from the options given below:

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A. B and D only

B. A, C and E only

C. B and E only

D. A and C only

Answer: A

Explanation

1. Tetrad formation is seen during the Zygotene stage : During the Zygotene stage of Prophase I in meiosis, homologous chromosomes pair up, forming tetrads or bivalents.

2. During Anaphase, the centromeres split and chromatids separate : In Anaphase, the centromeres divide, and the sister chromatids are pulled apart towards opposite poles of the cell.

3. Terminalization of chiasmata takes place during Diakinesis : Diakinesis is the final stage of Prophase I in meiosis. During this stage, terminalization occurs, which is the process in which chiasmata, the points of crossing over between non-sister chromatids, move toward the ends of the chromosomes.

4. Nucleolus, Golgi complex, and ER are reformed during Telophase : During Telophase, the nuclear envelope starts to reassemble around the separated chromosomes, and the nucleolus, Golgi complex, and endoplasmic reticulum (ER) are reformed.

5. Crossing over takes place between non-sister chromatids of homologous chromosomes : This process occurs during the Pachytene stage of Prophase I in meiosis, leading to the exchange of genetic material between the non-sister chromatids, which increases genetic diversity in the resulting gametes.

Question: Given below are two statements:

Statement I : During G0 phase of cell cycle, the cell is metabolically inactive.

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

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

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A Both Statement I and Statement II are incorrect.

B Statement I is correct but Statement II is incorrect.

C Statement I is incorrect but Statement II is correct.

D Both Statement I and Statement II are correct.

Answer: c

Explanation

Statement I is incorrect. The G0 phase is a state in the cell cycle in which cells exist in a quiescent or dormant stage. However, this does not mean that the cell is metabolically inactive. Rather, the cell maintains its normal functions but is not preparing for cell division.

Statement II is correct. During the S phase (synthesis phase) of interphase, DNA replication occurs, and the centrosome, which plays a key role in cell division, also duplicates. This prepares the cell for the later stages of the cell cycle, where the cell divides into two daughter cells.

2022

MCQ (Single Correct Answer)

Q.1. Which stage of meiosis can last for months or years in the oocytes of some vertebrates?

A Diakinesis

B Leptotene

C Pachytene

D Diplotene

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Ans. (D)

Explanation

In oocytes of some vertebrates, diplotene lasts for months or years. This stage is referred as dictyotene stage.

Q.2. Identify the correct sequence of events during Prophase I of meiosis:

(a) Synapsis of homologous chromosomes

(b) Chromosomes become gradually visible under microscope

(c) Crossing over between non-sister chromatids of homologous chromosomes

(d) Terminalisation of chiasmata

(e) Dissolution of synaptonemal complex

Choose the correct answer from the options given below:

A (a), (c), (d), (e), (b)

B (a), (b), (c), (d), (e)

C (b), (c), (d), (e), (a)

D (b), (a), (c), (e), (d)

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Ans. (D)

Explanation

Correct sequence of events during Prophase I of meiosis is : (b) → (a) → (c) → (e) → (d)

(b) Chromosomes become gradually visible under microscope.

(a) Synapsis of homologues chromosomes.

(c) Crossing over between non-sister chromatids of homologous chromosomes.

(e) Dissolution of synaptonemal complex.

(d) Terminalisation of chiasmata.

Q.3. Bivalent or Tetrad formation is a characteristic feature observed during

A Chiasmata in zygotene stage

B Synaptonemal complex in zygotene stage

C Chiasmata in Diplotene stage

D Synaptonemal complex in Pachytene stage

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Ans. (B)

Explanation

Bivalent or tetrad formation is called synapsis which is accompanied by the formation of complex structure called synaptonemal complex.

Q.4. With respect to metaphase, which of the following statements is incorrect?

A Chromosomes lie at the equator of the cell

B Complete disintegration of nuclear envelope takes place

C Chromosomes are highly condensed

D Metaphase chromosomes are made up of four sister chromatids held together by centromere

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Ans. (D)

Explanation

The question asks which statement is incorrect with respect to the metaphase stage of cell division.

Option D is incorrect because metaphase chromosomes are not made up of four sister chromatids held together by the centromere. Instead, metaphase chromosomes consist of two sister chromatids held together by the centromere. The sister chromatids are identical copies of a single chromosome that have been replicated during the S phase of the cell cycle.

Now, let's look at the other options, which are correct:

Option A : Chromosomes lie at the equator of the cell - During metaphase, the chromosomes align along the equatorial plane (also known as the metaphase plate) in the middle of the cell. This arrangement ensures that each daughter cell will receive an equal number of chromosomes during cell division.

Option B : Complete disintegration of the nuclear envelope takes place - In both mitosis and meiosis, the nuclear envelope breaks down during prophase and is completely disintegrated by the time the cell reaches metaphase. This allows the spindle fibers to attach to the chromosomes and facilitate their alignment at the equator.

Option C : Chromosomes are highly condensed - During metaphase, the chromosomes are at their highest level of condensation, which allows them to be more easily visualized under a microscope. This condensation also aids in the proper alignment and segregation of chromosomes during cell division.

Q.5. Which one of the following never occurs during mitotic cell division?

A Spindle fibres attach to kinetochores of chromosomes

B Movement of centrioles towards opposite poles

C Pairing of homologous chromosomes

D Coiling and condensation of the chromatids

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Ans. (C)

Explanation

Pairing of homologous chromosomes occurs during prophase I of meiosis.

Coiling and condensation of chromatids, spindle fibres attachment to the kinetochores and movement of centrioles towards opposite poles occur in both mitosis and meiosis.

Q.6. The appearance of recombination nodules on homologous chromosomes during meiosis characterizes:

A Synaptonemal complex

B Bivalent

C Sites at which crossing over occurs

D Terminalization

NEET 2022 Phase 1

Ans. (C)

Explanation

Pachytene stage of meiosis is characterized by the appearance of recombination nodules, the sites at which crossing over occurs between non sister chromatids of homologous chromosomes.

Q.7. Match List I with List II.

	List - I		**List - II**
(a)	Metacentric chromosome	(i)	Centromere situated close to the end forming one extremely short and one very long arms
(b)	Acrocentric chromosome	(ii)	Centromere at the terminal end
(c)	Submetacentric	(iii)	Centromere in the middle forming two equal arms of chromosomes
(d)	Telocentric chromosome	(iv)	Centromere slightly away from the middle forming one shorter arm and one longer arm

Choose the correct answer from the options given below:

A (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)

B (a)-(i), (b)-(iii), (c)-(ii), (d)-(iv)

C (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

D (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

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Ans. (A)

Explanation

In metacentric chromosome, centromere is in the middle of the chromosomes. Acrocentric chromosome has centromere close to the end of the chromosome. In submetacentric chromosome, centromere is slightly away from the middle of the chromosome. Telocentric chromosome has terminal centromere.

Q.8. Regarding Meiosis, which of the statements is incorrect?

A There are two stages in Meiosis, Meiosis-I and II

B DNA replication occurs in S phase of Meiosis-II

C Pairing of homologous chromosomes and recombination occurs in Meiosis-I

D Four haploid cells are formed at the end of Meiosis-II

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Ans. (B)

Explanation

Meiosis involves two sequential cycles of nuclear and cell division called meiosis-I and meiosis-II but only single cycle of DNA replication.

The stage between two meiotic divisions is called interkinesis and is generally short lived and involves no DNA replication.

Q.9. Select the incorrect statement with reference to mitosis :

A All the chromosomes lie at the equator at metaphase

B Spindle fibres attach to centromere of chromosomes

C Chromosomes decondense at telophase

D Splitting of centromere occurs at anaphase

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Ans. (B)

Explanation

Spindle fibres attach to the kinetochores of chromosomes.

Kinetochores are the disc shaped structures present on sides of primary constriction or centromere of chromosomes.

TOPIC 1
The Cell Cycle

01 The centriole undergoes duplication during **[NEET 2021]**

(a) S-phase (b) prophase
(c) metaphase (d) G_2-phase

Ans. *(a)*

During S phase or synthesis phase of interphase replication of DNA and synthesis of histone protein, centromere and centrioles occur. During the S phase, DNA replication begins in the nucleus, and the centriole duplicates in the cytoplasm of the cell.

02 Match the List-I with List-II. **[NEET 2021]**

	List-I		List-II
A.	S-phase	1.	Proteins are synthesised
B.	G_2-phase	2.	Inactive phase
C.	Quiescent stage	3.	Interval between mitosis and initiation of DNA replication
D.	G_1-phase	4.	DNA replication

Choose the correct answer from the options given below.

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

Ans. *(c)*

(A)-(4), (B)-(1), (C)-(2), (D)-(3)

During DNA replication, the unwinding of strands leaves a single strand vulnerable. In the eukaryotic cell cycle, chromosome duplication occurs during 'S phase' (the phase of DNA synthesis) and chromosome segregation occurs during 'M phase' (the mitosis phase).

During the G_2 phase, extra protein is often synthesised, and the organelles multiply until there are enough for two cells. Other cell materials such as lipids for the membrane may also be produced.

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

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 does not replicate its DNA.

03 Attachment of spindle fibres to kinetochores of chromosomes becomes evident in **[NEET (Oct.) 2020]**

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

Ans. *(d)*

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

04 Identify the correct statement with regard to G_1-phase (Gap 1) of interphase. **[NEET (Sep.) 2020]**

(a) Reorganisation of all cell components, takes place.
(b) Cell is metabolically active, grows but does not replicate its DNA
(c) Nuclear division takes place
(d) DNA synthesis or replication takes place

Ans. *(b)*

The statement in option (b) is correct with regard to G_1- phase of interphase because during G_1-phase the cell is metabolically active and continuously grows but does not replicate its DNA. DNA synthesis takes place in S-phase. Nuclear division occurs during karyokinesis.

Reorganisation of all cell components takes place in M-phase.

05 Some dividing cells exist the cell cycle and enter vegetative inactive stage. This is called quiescent stage (G_0). This process occurs at the end of **[NEET (Sep.) 2020]**

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

Ans. *(d)*

Some dividing cells exit the cell cycle and enter vegetative inactive stage, called quiescent stage (G_0). This process occurs at the end of M-phase

and beginning of G_1-phase. Cells enter G_0 for varying amounts of time, and some cells enter the G_0-phase and stay there forever. This is because once they reach maturity, like nerve and heart cells they do not divide again, so they stay in the G_0-phase.

06 Cells in G_0 phase

[NEET (National) 2019]

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

Ans. *(d)*

G_0 phase is the stage in which the cells exit the cell cycle. It is the resting or quiescent phase in which the cells do not divide. It is the permanent state for some cells, e.g., neurons.

07 The correct sequence of phases of cell cycle is

[NEET (National) 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) $M \rightarrow G_1 \rightarrow G_2 \rightarrow S$

Ans. *(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 phase, respectively. S-phase represents synthesis phase during which DNA replicates. M-phase is mitotic phase during which cell begins to divide.

08 When cell has stalled DNA replication fork, which checkpoint should be predominantly activated? **[NEET 2016, Phase II]**

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

Ans. *(a)*

Stalled forks activate checkpoint signaling and pause replication. Since, G_1/S checkpoint checks DNA damage, cells size prior to S-phase (i.e. DNA replication phase), this checkpoint would be activated by stalled DNA replication fork.

09 During cell growth, DNA synthesis takes place in **[NEET 2016, Phase II]**

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

Ans. *(a)*

In the cycle of cell division,interphase is the longest phase consisting of G_1, S, G_2-phases. In this phase cell prepares itself for cell division. In S or synthetic phase DNA duplication (synthesis) takes place.

10 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

Ans. *(d)*

During the S or synthetic phase, the DNA content doubles, i.e., from 2C to 4C for all diploid cells. The G_2 phase follows the S-phase and is called second growth phase or pre mitotic gap phase. In G_2 phase the synthesis of DNA stops therefore, the DNA level remains 4C if initial was 2C.

However, the formation of RNA and protein continue as they are required for the multiplication of cell organelles, spindle formation and cell growth. This amount becomes half (i.e.) 2C only during anaphase (in mitosis) when chromosomes separate.

11 In S-phase of the cell cycle

[CBSE AIPMT 2014, 2000, 1996]

(a) amount of DNA doubles in each cell
(b) amount of DNA remains same in each cell
(c) chromosome number is increased
(d) amount of DNA is reduced to half in each cell

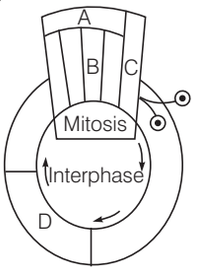
Ans. *(a)*

S-phase is the synthesis phase in which the cell synthesise a replica of its genome, i.e. DNA replication occurs by DNA polymerase.

DNA replication along with the synthesis of histone proteins results in the duplication of chromosomal material, i.e., amount of DNA doubles in each cell.

Amount of DNA remains unchanged during G_1-phase or post mitotic gap and/or G_2-phase or pre mitotic phase.

12 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?

[CBSE AIPMT 2009]

(a) B-metaphase
(b) C-karyokinesis
(c) D-synthetic phase
(d) A-cytokinesis

Ans. *(c)*

Cell cycle completes in two steps, i.e. interphase and M-phase. Interphase is completed in three successive stages G_1-phase (post mitotic phase), S-phase (synthetic phase) and G_2-phase (premitotic or post synthetic phase). In the given figure, D is representing the S-phase (synthetic phase) of cell cycle.

13 At what stage of the cell cycle are histone proteins synthesised in a eukaryotic cell?

[CBSE AIPMT 2005]

(a) During G_2-stage of prophase
(b) During S-phase
(c) During entire prophase
(d) During telophase

Ans. *(b)*

During S-phase of cell cycle synthesis of histone proteins takes place because at this stage the amount of DNA per cell get double to that of somatic number. Histone proteins are basic proteins and are used in packing of eukaryotic (absent in prokaryotes) DNA. DNA and histones together comprise chromatin, forming bulk of the eukaryotic chromosomes. Histones are of five major kinds H1, H2A, H2B, H3 and H4. H1 histones link neighbouring nucleosomes.

14 In the somatic cell cycle

[CBSE AIPMT 2004]

(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

Ans. *(b)*

DNA replication occurs during S-phase of the mitotic cycle where it gets doubled as compared to that in the original cell.

15 Which of the following occurs more than one and less than five in a chromosome? **[CBSE AIPMT 2002]**

(a) Chromatid
(b) Chromosome
(c) Centromere
(d) Telomere

Ans. *(d)*

A chromosome has one centromere, may have many chromomeres, two chromatids; but four telomeres (two each at the opposite ends of each chromatid).

16 During cell division in apical meristem the nuclear membrane appears in **[CBSE AIPMT 1997]**

(a) metaphase (b) anaphase
(c) telophase (d) cytokinesis

Ans. *(c)*

During telophase, nuclear envelope initially reforms around each chromosome individually which later on fuse to form complete nuclear envelope.

Metaphase Chromosomes are arranged on equatorial plate.

Anaphase Chromosomes split longitudinally. Chromatids migrate towards opposite poles.

Cytokinesis Division of cytoplasm.

TOPIC 2
Mitosis

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

(a) 8 (b) 16 **[NEET 2021]**
(c) 4 (d) 32

Ans. *(a)*

During S phase or synthetic phase of interphase, replication of DNA and synthesis of histone protein, centromere and centrioles occur, but the number of chromosomes remains same from beginning till the end of S phase.

Hence, number of chromosome will remain 8 after the S phase in fruitfly.

18 In a mitotic cycle, the correct sequence of phases is **[NEET (Oct.) 2020]**

(a) S, G_1, G_2, M
(b) G_1, S, G_2, M
(c) M, G_1, G_2, S
(d) G_1, G_2, S, M

Ans. *(b)*

In a mitotic cycle, the correct sequence of phases is G_1, S, G_2, M. The first three phases, i.e. G_1, S, G_2 occurring during interphase whereas the M-phase is the period of actual cell division. The major event occurring in each phase is tabulated below

Phases	Activities
G_1-phase	Cell becomes metabolically active, enzymes and proteins required for replication are synthesised.
S-phase	Synthesis or replication of DNA occurs so that amount of DNA per cell gets doubled.
G_2-phase	Proteins required for mitosis are synthesised while the growth of cell continues.
M-phase	Cell divides to form daughter cells.

19 Match the following (Columns) events that occur in their respective phases of cell cycle and select the correct option from the codes given below. **[NEET (Oct.) 2020]**

Column I	Column II
A. G_1-phase	1. Cell grows and organelle duplication
B. S phase	2. DNA replication and chromosome duplication
C. G_2-phase	3. Cytoplasmic growth
D. Metaphase in M-phase	4. Alignment of chromosomes

Codes

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

Ans. *(d)*

20 After karyogamy followed by meiosis, spores are produced exogenously in **[NEET 2018]**

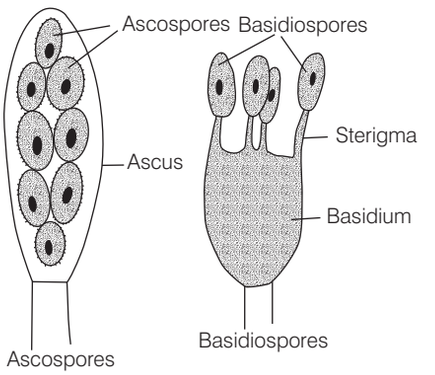
(a) *Agaricus* (b) *Alternaria*
(c) *Neurospora* (d) *Saccharomyces*

Ans. *(a)*

Agaricus Meiospores are produced exogenously after karyogamy and meiosis. It belongs to Basidiomycetes.

Alternaria belongs to the Deuteromycetes class of fungi. The fungi of this class lack sexual reproduction. Therefore, sexual spores are not formed.

Neurospora and *Saccharomyces* belong to Ascomycetes class of fungi. They produce ascopores as meiospores. Their ascospores are produced endogenously.



21 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

Ans. *(c)*

If anaphase promoting complex is defective in a human cell, the chromosomes will not segregate during anaphase of mitosis. APC triggers the

transition from metaphase to anaphase by tagging specific proteins for degradation.

Concept Enhancer Anaphase stage of mitosis is characterised by two events

(a) Splitting of centromeres and segregation of chromosomes.

(b) Movement of chromatids towards the opposite poles.

22 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

Ans. *(b)*

During mitosis following events occurs as follows

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.

23 Which of the following is not a characteristic feature during mitosis in somatic cells? **[NEET 2016, Phase I]**

(a) Disappearance of nucleolus

(b) Chromosome movement

(c) Synapsis

(d) Spindle fibres

Ans. *(c)*

Synapsis is pairing of homologous chromosomes. It occurs during zygotene stage of meiosis. The homologous chromosomes come closer leading to cross over in the next stage called pachytene. These are not observed during mitosis.

24 Spindle fibres attach on to **[NEET 2016, Phase I]**

(a) kinetochore of the chromosome

(b) centromere of the chromosome

(c) kinetosome of the chromosome

(d) telomere of the chromosome

Ans. *(a)*

Spindle fibres attach to kinetochores of chromosomes during cell division. They help the chromosomes/chromatids to get separated to the two daughter cells, towards opposite poles.

25 The complex formed by a pair of synapsed homologous chromosomes is called **[NEET 2013]**

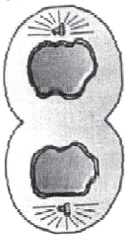
(a) equatorial plate (b) kinetochore

(c) bivalent (d) axoneme

Ans. *(c)*

The process of pairing of homologous chromosomes is called synapsis. Each pair of synapsed homologous chromosome called bivalent.

26 A stage in cell division is shown in the figure. Select the answer which gives correct identification of the stage with its characteristic mentioned. **[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

Ans. *(a)*

Telophase is reverse of prophase. The chromosome that have reached their respective poles decondense, i.e., nuclear envelop reforms, Golgi complex reforms, etc. In late anaphase centromeres split and chromatid separate and chromatid move to opposite poles. Cytokinesis is process in which cell itself is divided two daughter cells.

27 Select the correct option with respect to mitosis. **[CBSE AIPMT 2011]**

(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

Ans. *(c)*

In metaphase of mitosis, spindle fibres attach to kinetochore of chromosomes. Chromosomes are moved to spindle equator and get aligned along metaphasic plate through spindle fibres to both pole.

28 During mitosis ER and nucleolus begin to disappear at **[CBSE AIPMT 2010]**

(a) late prophase

(b) early metaphase

(c) late metaphase

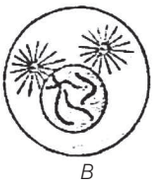
(d) early prophase

Ans. *(d)*

In mitosis, prophase is the longest phase of karyokinesis. In early prophase, nuclear membranes, nucleolus start disintegrating. Cells cytoskeleton, Golgi complex, ER, etc. disappear.

29 Which stages of cell division do the following figures A and B represent respectively? **[CBSE AIPMT 2010]**

A



B

(a) Metaphase – Telophase
(b) Telophase – Metaphase
(c) Late anaphase – Prophase
(d) Prophase – Anaphase

Ans. *(c)*

In the given figures

A. Late anaphase is characterised by following events

(i) Centromeres split and chromatids separate.

(ii) Chromatids move to opposite poles.

B. Prophase is characterised by centriole separation.

30 Centromere is required for **[CBSE AIPMT 2005]**

(a) movement of chromosomes towards poles
(b) cytoplasmic cleavage
(c) crossing over
(d) transcription

Ans. *(a)*

The arms of chromosome are known as chromatids. These arms are held together at a point called the centromere (or primary constriction). Centromere occurs any where along the length of chromosome. During cell division spindle fibres are attached to centromere and help in the movement of chromosomes towards the poles.

31 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? **[CBSE AIPMT 2004]**

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

Ans. *(a)*

At metaphase, the chromosomes are clearly visible as composed of two closely associated halves (chromatids) and the chromosomes have undergone maximum contraction so, these can be counted conveniently. In metaphase chromosome align in the equator of the cell before being separated into each of the two daughter cells.

32 Which one of the following precedes reformation of the nuclear envelope during M-phase of the cell cycle? **[CBSE AIPMT 2004]**

(a) Decondensation from chromosomes and reassembly of the nuclear lamina
(b) Transcription from chromosomes and reassembly of the nuclear lamina
(c) Formation of the contractile ring and formation of the phragmoplast
(d) Formation of the contractile ring and transcription from chromosomes

Ans. *(a)*

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

33 Mitotic spindle is mainly composed of which protein? **[CBSE AIPMT 2002]**

(a) Actin (b) Myosin
(c) Actomyosin (d) Myoglobin

Ans. *(a)*

Spindles formed during mitosis and meiosis are nothing but microtubule complex. Microtubules are made up of small units of tubulin which has amino acid composition similar to actin.

34 Best material for the study of mitosis in laboratory is **[CBSE AIPMT 2002]**

(a) anther (b) root tip
(c) leaf tip (d) ovary

Ans. *(b)*

Root tips have active meristematic zone where cells divide mitotically leading to increase in the length of the roots. This is the best site for the study of mitosis, e.g. onion root tips.

35 During cell division, the spindle fibres attach to the chromosome at a region called **[CBSE AIPMT 2000]**

(a) Chromocentre (b) kinetochore
(c) centriole (d) chromomere

Ans. *(b)*

During late prophase, specialised structures called kinetochores develop on either surface of the centromere. Chromosomal fibres get attached to kinetochore.

Chromomeres are beaded structures on the chromosomes which are found particularly at the prophase-I (particularly at leptotene) of meiosis-I.

Chromocentre is developed due to the fusion of centromeric regions of all the chromosomes of a cell.

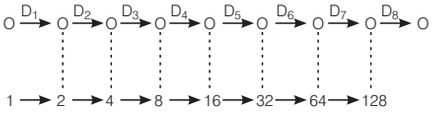
Centrosome is found in animal cells (absent in higher plant cells). It is found near the nucleus. Each centrosome is made up of two centrioles and each centriole is a cylindrical structure with a diameter of 1500-1800 Å and is made up of nine fibrils.

36 How many mitotic divisions are needed for a single cell to make 128 cells? **[CBSE AIPMT 1997]**

(a) 7 (b) 14
(c) 28 (d) 64

Ans. *(a)*

A single mitotic division results in the production of two cells from single cell.



37 Which one of the following structures will not be common to mitotic cells of higher plants? **[CBSE AIPMT 1997]**

(a) Cell plate (b) Centriole
(c) Centromere (d) Spindle fibres

Ans. *(b)*

Centrosome is found in animals, *Euglena, Nitella,* some fungi and members of dinoflagellate. It is found near the nucleus.

Centriole is not common to mitotic cell of higher plants. Main function of centrosome is at the time of cell division when the two centrioles separate and move on two poles. Aster and spindle are formed from it which

help in the movement of chromatids. They form basal body, cilia, flagella, etc.

Centriole is rich in tubulin and ATPase.

Centrioles replicate in G_2-phase of interphase of cell cycle but do not initiate cell division.

38 The point, at which polytene chromosomes appear to be attached together, is called **[CBSE AIPMT 1995]**

(a) centriole (b) centromere
(c) chromomere (d) chromocentre

Ans. *(d)*

Polytene chromosomes are infact formed by pairing of two somatic homologous chromosomes which undergo repeated endomitosis, forming a number of strands. These strands remain attached to a common large chromocentre of all polytene chromosomes and are rich in heterochromatin.

39 Best stage to observe shape, size and number of chromosomes is **[CBSE AIPMT 1994]**

(a) interphase (b) metaphase
(c) prophase (d) telophase

Ans. *(b)*

Metaphase can be characterised by the chromosomes that are least coiled which show maximum condensation and are shortest in length. It is the best stage to study the structure, size and number of chromosome in a cell.
Idiogram/karyotype of chromosomes is prepared at metaphase.

40 In salivary gland chromosomes/polytene chromosomes pairing is **[CBSE AIPMT 1993]**

(a) absent
(b) occasional
(c) formed between non-homologous chromosomes
(d) formed between homologous chromosomes

Ans. *(d)*

Polytene chromosomes/salivary gland chromosomes was reported by Balbiani (1881) from cells of salivary glands of *Chironomus* larva (insect of Diptera group). The polytene chromosomes become giant due to the endoduplication, i.e., repeated replication of chromatids without their separation and cytokinesis. In fact, each polytene chromosome is formed by pairing of two somatic homologous chromosomes which undergo repeated endomitosis to form numerous strands attached to a common large chromocentre.

41 Number of chromatids at metaphase is **[CBSE AIPMT 1992]**

(a) two each in mitosis and meiosis
(b) two in mitosis and one in meiosis
(c) two in mitosis and four in meiosis
(d) one in mitosis and two in meiosis

Ans. *(a)*

In metaphase, chromosomes are thick, shortest least coiled and minimum in size. Each chromosome has its both chromatids attached at centromere, oriented at the equator of spindle apparatus.

In meiotic metaphase, each chromosome with two chromatids in a bivalent is connected to the spindle pole of its side by a kinetochore microtubule instead of two as in metaphase of mitosis.

42 Mitotic anaphase differs from metaphase in possessing **[CBSE AIPMT 1991]**

(a) same number of chromosomes and same number of chromatids
(b) half number of chromosomes and half number of chromatids
(c) half number of chromosomes and same number of chromatids
(d) same number of chromosomes and half number of chromatids

Ans. *(d)*

Mitotic metaphase is the best stage to observe the structure, size and number of chromosomes in a cell. Centromeres of all chromosomes lie closely at equator and their arms in different directions towards poles.
Chromosomes are shortest in metaphase but thickest in anaphase.

In anaphase, centromere of each chromosome divides so that each sister chromatid now has its own centromere. Thus, mitotic anaphase differs from metaphase in possessing same number of chromosomes and half number of chromatids.

43 A bivalent consists of **[CBSE AIPMT 1989]**

(a) two chromatids and one centromere
(b) two chromatids and two centromeres
(c) four chromatids and two centromeres
(d) four chromatids and four centromeres

Ans. *(c)*

Each pair of homologous chromosome carrying one maternal and one paternal chromosome of similar type is called **bivalent**. Each chromosome has two sister chromatids and a centromere. Thus, bivalents possesses four chromatids, two centromeres. This bivalent with four chromatids is called pachytene tetrad (quadrivalent).

TOPIC 3
Meiosis

44 Which stage of meiotic prophase shows terminalisation of chiasmata as its distinctive feature? **[NEET 2021]**

(a) Leptotene (b) Zygotene
(c) Diakinesis (d) Pachytene

Ans. *(c)*

Diakinesis is the final stage of meiotic prophase 1. In this stage the two homologous chromosomes do not separate completely but remain attached together at one or more points as indicated by '*X*' arrangement known as chiasmata. The displacement of chiasmata is termed as terminalisation of chiasmata which is completed in diakinesis phase.

45 Which of the following stages of meiosis involves division of centromere? **[NEET 2021]**

(a) Metaphase-I (b) Metaphase-II
(c) Anaphase-II (d) Telophase-II

Ans. *(c)*

During **anaphase** II, each pair of chromosomes is separated into two identical, independent chromosomes. The chromosomes are separated by a structure called the mitotic spindle made up of many long proteins called microtubules, which are attached to a chromosome at one end and to the pole of a cell at the other end. The sister chromatids are separated simultaneously at their centromeres. The separated chromosomes are then

pulled by the spindle to opposite poles of the cell. Thus, the centromere splits, freeing the sister chromatids from each other. Other options can be explained as:

In **metaphase I**, the homologous pair of chromosomes align on either side of the equatorial plate.

During **metaphase II**, the centromeres of the paired chromatids align along the equatorial plate in both cells.

During **telophase II**, the two groups of chromosome once again get enclosed by nuclear envelope.

46 During meiosis 1, in which stage synapsis takes place?

[NEET (Oct.) 2020]

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

Ans. *(b)*

During zygotene stage of meiosis-I, chromosomes start pairing together and this process of association is called synapsis. Such paired chromosomes are called homologous chromosomes.

47 Dissolution of the synaptonemal complex occurs during

[NEET (Sep.) 2020]

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

Ans. *(b)*

Dissolution of the synaptonemal complex occurs during diplotene stage of prophase-I of meiosis-I. Prophase of meiosis-I is long and complex. It is comprised of leptotene, zygotene, pachytene, diplotene and diakinesis. During diplotene, at most places synaptonemal complex dissolves.

48 Match the following columns with respect to meiosis.

[NEET (Sep.) 2020]

	Column I		Column II
A.	Zygotene	1.	Terminalisation
B.	Pachytene	2.	Chiasmata
C.	Diplotene	3.	Crossing over
D.	Diakinesis	4.	Synapsis

Select the correct option.

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

Ans. *(a)*

The correct option is (a). It can be explained as follows

During zygotene phase the homologous chromosomes pair or come together and forms synapsis.

Crossing over takes place during pachytene stage and at each point of crossing over a chiasma is formed between non-sister chromatids of homologous chromosomes.

Chiasmata is the point of contact between the two non sister chromatids of homologous chromosomes, chiasmata becomes visible during diplotene stage.

Terminalisation of chiasmata gets completed during diakinesis phase where chromosomes gets freely distributed in the cytoplasm.

49 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

Ans. *(b)*

After meiosis-I, the resultant daughter cells have twice the amount of DNA in comparison to haploid gamete. Meiosis-I causes segregation of homologous pairs of chromosomes. However, each chromosome is double-stranded, having two sister chromatids due to DNA replication before meiosis began.

50 In meiosis crossing over is initiated at **[NEET 2016, Phase I]**

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

Ans. *(d)*

Leptotene — Condensation of chromatin

Zygotene — Synapsis of homologous chromosomes

Pachytene — Crossing over

Diplotene — Dissolution of synaptonemal complex and appearance of chiasmata

Diakinesis — Terminalisation of chiasmata

51 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, Phase II]**

	Column I		Column II
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

Ans. *(a)*

Various phases of meiosis and their characteristic features are

Pachytene — Crossing-over takes place

Metaphase-I — Chromosomes align at equatorial plate

Diakinesis — Terminalisation of chiasmata

Zygotene — Pairing of homologous chromosomes

52 Arrange the following events of meiosis in correct sequences.

[CBSE AIPMT 2015]

I. Crossing over
II. Synapsis
III. Terminalisation of chiasmata
IV. Disapperance of nucleolus

(a) II, I, IV, III (b) II, I, III, IV
(c) I, II, III, IV (d) II, III, IV, I

Ans. *(b)*

The correct sequence of events of meiosis are

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

53 The enzyme recombinase is required at which stage of meiosis? **[CBSE AIPMT 2014]**

(a) Pachytene (b) Zygotene
(c) Diplotene (d) Diakinesis

Ans. *(a)*

Crossing over is an enzymatic process occurring during the pachytene stage of prophase-I. The enzyme involved in this process is called recombinase which aids in the recombination of genes between homologous chromosomes.

During zygotene stage, homologous chromosomes pair up by a process called synapsis and form a complex bivalent structure. Diplotene is marked by the dissolution of synaptonemal complex and chaisma formation. While diakinesis is marked by terminalisation of chiasmata (i.e. chiasmata shifts towards periphery of chromosome).

54 Meiosis takes place in **[NEET 2013]**

(a) meiocyte (b) conidia
(c) gemmule (d) megaspore

Ans. ***(a)***

In diploid organisms, specialised cells called meiocytes (gamete mother cell) undergo meiosis. Conidia and gemmules are asexual reproductive structures found in *Penicillium* and sponge respectively. Megaspores are female gametes in plants which undergo sexual reproduction.

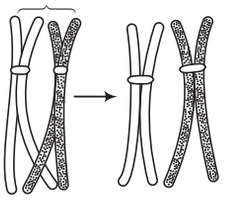
55 During gamete formation, the enzyme recombinase participates during **[CBSE AIPMT 2012]**

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

Ans. ***(c)***

The pachytene stage of prophase-I of meiosis-I is characterised by the appearance of recombination nodules, the sites at which crossing over occurs between non-sister chromatids of the homologous chromosomes. Crossing over is the exchange of genetic material between two homologous chromosomes. It is also an enzyme mediated process and the enzyme involved is called recombinase.

56 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

Ans. ***(a)***

During zygotene stage of prophase-I of meiosis-I, bivalent chromosomes clearly appear as tetrads. Pachytene stage is characterised by the appearance of recombination nodules, the sites at which crossing over (exchange of genetic material) occurs between non-sister chromatids of the homologous chromosomes.

57 Synapsis occurs between **[CBSE AIPMT 2009]**

(a) a male and a female gamete
(b) *m*RNA and ribosomes
(c) spindle fibres and centromere
(d) two homologous chromosomes

Ans. ***(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 one from the female parent.

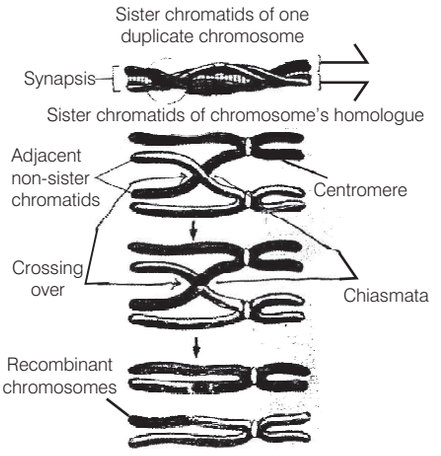
58 Crossing over that results in genetic recombination in higher organisms occur between **[CBSE AIPMT 2004]**

(a) sister chromatids of bivalent
(b) non-sister chromatids of a bivalent
(c) two daughter nuclei
(d) two different bivalents

Ans. ***(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.

The process of crossing over is depicted



Crossing Over Process

59 The exchange of genetic material between chromatids of paired homologous chromosomes during first meiotic division is called **[CBSE AIPMT 1996]**

(a) transformation (b) chiasmata
(c) crossing over (d) synapsis

Ans. ***(c)***

In pachytene stage of prophase-I of meiosis, there is breakage and reunion of chromatids, it results in exchange of segments between non-sister chromatids of a bivalent, known as crossing over. It leads to recombination of linked genes/alleles and is a major source of continuous type of genetic variations in sexually reproducing organisms.

60 Lampbrush chromosomes occur during **[CBSE AIPMT 1995]**

(a) prophase of mitosis
(b) diplotene of meiosis
(c) metaphase of meiosis
(d) interphase

Ans. ***(b)***

Lampbrush chromosomes were reported by W Flemming (1882) and described by Ruckert (1892) from nuclei of yolk rich primary oocytes of newts and frog (amphibians). These are also found in spermatocytes of many animals. These are found in permanent diplotene stage of meiosis and do not undergo cell cycle.

Each such chromosome has a double main axis made up of DNA and histones. The chromosomes are coiled and held at many places forming cross like structure called chiasmata. Loops arising laterally has uncoiled DNA which helps in rapid transcription and yolk synthesis.

61 Meiosis has evolutionary significance because it results in **[CBSE AIPMT 1994]**

(a) genetically similar daughters
(b) four daughter cells
(c) eggs and sperms
(d) recombinations

Ans. ***(d)***

Recombination takes place in meiosis but still Meiosis maintains the chromosome number constant. It produces haploid gametes by reducing the chromosome number to half. Crossing over produces new combination of linked genes and is major source of genetic variation.

Also, distribution of bivalents which is at random in metaphase-I provides the secondary source of genetic variation in the organisms and is essential for speciation and evolution.

62 Meiosis-II performs **[CBSE AIPMT 1993]**

(a) separation of sex chromosomes
(b) synthesis of DNA and centromeres
(c) separation of homologous chromosomes
(d) separation of chromatids

Ans. *(d)*

Meiosis-II is homotypic or equational division similar to mitosis but occurs in haploid nuclei. Meiosis-II is essential to separate out the chromatids of diad chromosomes to bring real haploidy in amount of DNA. It also increases the number of daughter cells though the chromosome number remains the same in daughter cells as produced after meiosis-I.

63 In meiosis, the daughter cells differ from parent cell as well as amongst themselves due to **[CBSE AIPMT 1991]**

(a) segregation, independent assortment and crossing over
(b) segregation and crossing over
(c) independent assortment and crossing over
(d) segregation and independent assortment

Ans. *(b)*

The daughter cells differ from parent cell as well as amongst themselves due to the segregation and crossing over taking place in them. Meiosis-I brings gene recombinations and haploidy of number of chromosomes. Crossing over during pachytene produces new combination of genes and is the major source of new genetic variations in the sexually reproducing organisms.

64 Meiosis-I is reductional division. Meiosis-II is equational division due to **[CBSE AIPMT 1988]**

(a) pairing of homologous chromosomes
(b) crossing over
(c) separation of chromatids
(d) disjunction of homologous chromosomes

Ans. *(c)*

Meiosis-I is called heterotypic division as the two chromatids of a chromosome became genetically different due to the crossing over. Number of chromosomes is reduced to half, hence, called reduction division. Meiosis-II is just like mitosis but occurs in haploid nuclei, it is called homotypic or equational division as the chromosomes are distributed equally into daughter cells and chromosome number remains the same in daughter cells.