Chapter 10 (CELL CYCLE AND CELL DIVISION)

Multiple Choice Questions

Q1. 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
Ans: (d)' Meiosis in diploid organisms results in production of gametes, reduction in the number of chromosomes and introduction of variation.

Q2. At which stage of meiosis does the genetic constitution of gametes is finally decided? –
(a) Metaphase-I (b) Anaphase-II (c) Metaphase-II (d) Anaphase-I
Ans: (d) At anaphase-I, stage of meiosis the genetic constitution of gametes is finally decided.

Q3. Meiosis occurs in organisms during
(a) Sexual reproduction
(b) Vegetative reproduction
(c) Both sexual and vegetative reproduction
(d) None of these
Ans: (a) Meiosis occurs in organisms during sexual reproduction. The production of offspring by sexual reproduction includes the fusion of two gametes, each with a complete haploid set of chromosomes. Gametes are produced through meiosis.

Q4. During anaphase-I of meiosis
(a) Homologous chromosomes separate
(b) Non-homologous chromosomes separate
(c) Sister chromatids chromosomes separate
(d) Non Sister chromatids chromosomes separate
Ans: (a) The homologous chromosomes separate, while sister chromatids remain associated at their centromeres. Separation of homologous chromosomes at anaphase is called disjunction.

Q5. Mitosis is characterised by
(a) Reduction division
(b) Equal division
(c) Both reduction and equal division
(d) Pairing of homologous chromosomes
Ans: (b) Mitosis is the most dramatic period of the cell cycle, involving a major reorganisation of virtually all components of the cell. Since the number of chromosomes in the parent and progeny cells is the same, it is also called as equational division.

Q6. A bivalent of 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.
Ans: (c) A bivalent of meiosis-I consists of four chromatids and two centromeres.

Q7. Cells which are not dividing are likely to be at
(a) G, (b) G2 (C) G0 (d) S phase
Ans: (c) These cells that do not divide further exit G{ phase to enter an inactive stage is called quiescent stage (G0) of the cell cycle. G0 stage of cell denotes exit "of cell from cell cycle. During G0 stage of cell cycle, cell decides to undergo differentiation. Cells in G0 stage remain metabolically active but no longer proliferate unless called on to do so depending on the requirement of the organism.

Q8. Which of the events listed below is not observed during mitosis?
(a) Chromatin condensation
(b) Movement of centrioles to opposite poles
(c) Appearance of chromosomes with two chromatids joined together at the centromere
(d) Crossing over
Ans: (d) Crossing over occurs in pachytene (it is a phase of meiosis-I). Crossing over is the exchange of genetic material (genes) between two homologous chromosomes. Crossing over is also an enzyme-mediated process and the enzyme involved is called recombinase. Crossing over leads to recombination of genetic material on the two chromosomes. Exchange of paternal and maternal chromosome material during pachytene is called crossing over.

Q9. Identify the wrong statement about meiosis.
(a) Pairing of homologous chromosomes

(b) Four haploid cells are formed
(c) At the end of meiosis number of chromosomes are reduced to half
(d) Two cycles of DNA replication occur.
Ans: (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.

Q10. Select the correct statement about G1 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.
Ans: (b) During Gj phase the ceil is metabolically active and continuously grows but does not replicate its DNA but proteins and RNA are synthesized.

Very Short Answer Type Questions
Q1. Between a prokaryote and an eukaryote, **which cell has a shorter cell division time?**
Ans: Prokaryotic cells has shorter cell division time than eukaryotic cells. A typical eukaryotic cell cycle is illustrated by human cells in culture. These cells divide once in approximately every 24 hours. In bacteria (E.coli) cell cycle is of 20 minutes.

Q2. Which of the phases of cell **cycle is of longest duration?**
Ans: Interphase

Q3. Name a stain commonly used to colour chromosomes.
Ans: Basic fuchsin, acetocarmine etc.

Q4. Which tissue of animals and plants exhibits meiosis?
Ans: Gohads (testes and ovary) in animals and sporangium in plants.

Q5. Given that the average duplication time of E.coli is 20 minutes, how much time will two E.coli cells take to become 32 cells?

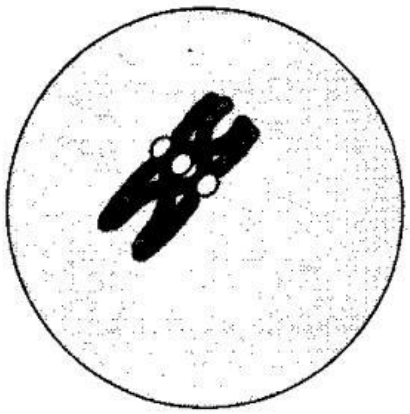
Ans. $2 \xrightarrow{I} 4 \xrightarrow{II} 8 \xrightarrow{III} 16 \xrightarrow{IV} 32$

For formation of 32 cells, two E.coli cells takes 4 cycles. So total time will be 4 x 20 = 80 minutes

Q6. Which part of the human body should one use to demonstrate stages in mitosis?
Ans: Nail base or any somatic cell (diploid cell).

Q7. What attributes does a chromatid require to be classified as a chromosome?
Ans: Centromere

Q8. The diagram shows a bivalent at prophase-I of meiosis. Which of the four chromatids can cross over?



Ans: Sister chromatids of homologous chromosome.

Q9. If a tissue has at a given time 1024 cells, how many cycles of mitosis had the original parental single cell undergone?

Ans. $1024 = (2)^n$

n = No. of cycles

$1024 = 2^{10} = 2^n \Rightarrow n = 10$

Thus, 10 cycles of mitosis are there in the original parental single cell.

Q10. An anther has 1200 pollen grains. How many pollen mother cells (pmc**) must have been there to produce them?**

Ans: 4 pollen grains are produced by 1 pmc

1200 pollen grains are produced by = 1200/4

= 300 pmc

Q11. At what stage of cell **cycle does DNA synthesis take place?**

Ans: S-phase (interphase)

Q12. It is said that the one cycle of cell division in human cells (eukaryotic cells) takes 24 hours. Which phase of the cycle, do you think occupies the maximum part of cell **cycle?**

Ans: It is significant to note that in the 24 hour average duration of cell cycle of a human cell, cell division proper lasts for only about an hour. The interphase lasts more than 95% of the duration of cell cycle.

Q13. It is observed that heart cells do not exhibit cell division. Such cells do not divide further and exit phase to enter an inactive stage called of cell **cycle. Fill in the blanks.**

Ans: It is observed that heart cells do not exhibit cell division. Such cells do not divide further and exit Gt phase to enter an inactive stage called G0 of cell cycle.

Q14. In which phase of meiosis are the following formed? Choose the answers from hint points given below.

a. Synaptonemal complex

b. Recombination nodules

c**. Appearance/activation of enzyme** recombinase

d**. Termination of** chiasmata

e**.** Interkinesis

f**. Formation of** dyad **of cells**

[Hints: (1) Zygotene, (2) Pachytene, (3) Pachytene, (4) Diakinesis, (5) After Telophase-I /before Meosis-**II, (6) Telophase-I /after Meiosis-I]**

Ans: a. Synaptonemal complex: zygotene

b. Recombination nodules: pachytene

c. Appearance/activation of enzyme recombinase: pachytene

d. Termination of chiasmata: diakinesis
e. Interkinesis: after Telophase-I /before Meosis-II
f. Formation of dyad of cells: Telophase-I /after Meiosis-I.

Short Answer Type Questions

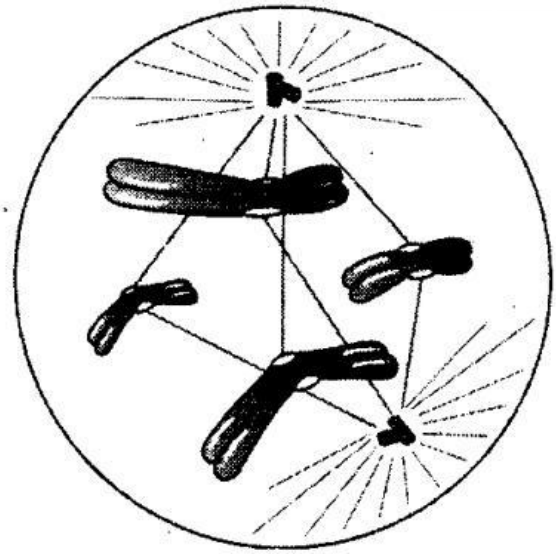
Q1. State the role of centrioles other than spindle formation.

Ans: The centrioles form the basal body of cilia or flagella.

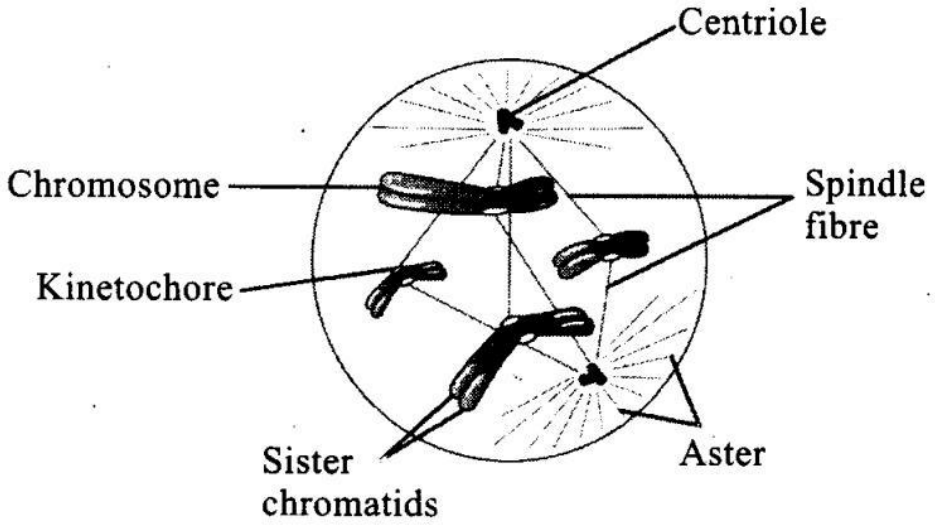
Q2. Mitochondria and plastids have their own DNA (genetic material). What is known about their fate during nuclear division like mitosis?

Ans: At the time of cytoplasmic division, organelles like mitochondria and plastids get distributed between the two daughter cells.

Q3. Label the diagram and also determine the stage at which this structure is visible.



Ans: This is a transition to metaphase



Q4. A cell has 32 chromosomes. It undergoes mitotic division. What will be the chromosome number (TV) during metaphase? What would be the DNA content (Q during anaphase?

Ans: Chromosome number (N) during metaphase = 32 (N)
DNA content (C) during anaphase = 2C

Q5. While examining the mitotic stage in a tissue, one finds some cells with 16

chromosomes and some with 32 chromosomes. What possible reasons could you assign to this difference in chromosome number? Do you think cells with 16 chromosomes could have arisen from cells with 32 chromosomes or vice versa?

Ans: Cells with 16 chromosomes are produced by meiosis while that with 32 chromosomes are produced by mitosis.

• Cells with 16 chromosomes could have arisen from cells with 32 chromosomes through meiosis.

• Cells with 32 chromosomes could have arisen from cells with 16 chromosomes through fertilisation or syngamy.

Q6. The following events occur during the various phases of the cell cycle. Name the phase against each of the events.

a. Disintegration of nuclear membrane _____

b. Appearance of nucleolus _____

c. Division of centromere _____

d. Replication of DNA _____

Ans: a. Disintegration of nuclear membrane: Late prophase

b. Appearance of nucleolus: Telophase

c. Division of centromere: Anaphase

d. Replication of DNA: S-phase

Q7. Mitosis results in producing two cells which are similar to each other. What would be the consequence if each of the following irregularities occur **during mitosis?**

a. Nuclear membrane fails to disintegrate

b. Duplication of DNA does not occur

c. Centromeres do not divid

d. Cytokinesis does not occu**;**

Ans: a. Nuclear membrane fails to disintegrate: In this condition, mitosis takes place within nucleus. This is called endoduplication.

b. Duplication of DNA does not occur: There will be no mitosis

c. Centromeres do not divide: Polyploidy appears

d. Cytokinesis does not occur: In some organisms karyokinesis is not followed by cytokinesis as a result of which multinucleate condition arises leading to the formation of syncytium (e.g., liquid endosperm in coconut)

Q8. Both unicellular and multicellular organisms undergo mitosis. What are the differences, if any, observed in the process between the two?

Ans:

• The growth of multicellular organisms is due to mitosis.

• The reproduction of unicellular organisms is due to mitosis.

Q9. Name the pathological condition when uncontrolled cell division occurs.

Ans: Cancer

Q10. Two key events take place, during S phase in animal cells, DNA replication and duplication of centriole**. In which parts of the cell do events occur?**

Ans: In animal cells, during the S phase, DNA replication begins in the nucleus, and the centriole duplicates in the cytoplasm.

Q11. Comment on the statement—Meiosis enables the conservation of specific chromosome number of each species even though the process per se, results in a reduction of chromosome number.

Ans: Meiosis is the mechanism by which conservation of specific chromosome number of each species is achieved across generations in sexually reproducing organisms, even though

the process, per se, paradoxically, results in reduction of chromosome number by half. But fertilisation restores the chromosome number.

Q12. Name a cell that is found arrested in diplotene stage for months and years. Comment in 2-3 lines how it completes cell cycle?
Ans: In oocytes of some vertebrates, diplotene can last for months or years.
• Lampbrush chromosomes or diplotene chromosome are found in diplotene stage of most animal oocytes of frog or amphibians.
• Lampbrush chromosomes are observed in meiotic prophase. These chromosomes become normal after growth and thus completing the cell cycle.

Q13. How does cytokinesis in plant cells differ from that in animal cells?
Ans: 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 dividing the cell cytoplasm into two.
Plant cells however, are enclosed by a relatively inexte'nsible cell wall, therefore they undergo cytokinesis by a different mechanism. In plant cells, wall formation starts in the centre of the cell and grows outward to meet the existing lateral walls. The formation of the new cell wall begins with the formation of a simple precursor, called the cell-plate that represents the middle lamella between the walls of two adjacent cells.

Long Answer Type Questions
Q1. Comment on the statement— Telophase is reverse **of prophase.**
Ans: Prophase is marked by the initiation of condensation of chromosomal material. The chromosomal material becomes untangled during the process of chromatin condensation. At the beginning of the final stage of mitosis, i.e. telophase, the chromosomes that have reached their respective poles decondense and lose their individuality.
Cells at the end of prophase, when viewed under the microscope, do not show golgi complexes, endoplasmic reticulum, nucleolus and the nuclear envelope. In the telophase stage nuclear envelope assembles around the chromosome clusters. Nucleolus, golgi complex and ER reform.

Q2. What are the various stages of meiotic prophase-I? Enumerate the chromosomal events during each stage?
Ans: Meiosis-I:
Prophase-I: Prophase of the first meiotic division is typically longer and more complex when compared to the prophase of mitosis. It has been further subdivided into the following five phases based on chromosomal behaviour, i.e. Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis. During leptotene stage, the chromosomes become gradually visible under the light microscope.
• The compaction of chromosomes continues throughout leptotene. This is followed by the second stage of prophase-I called zygotene. During this stage chromosomes start pairing together and this process of association is called synapsis. Such paired chromosomes are called homologous chromosomes. Electron micrographs of this stage indicate that chromosome synapsis is accompanied by the formation of complex structure called synaptonemal complex.
• The complex formed by a pair of synapsed homologous chromosomes is called a bivalent or a tetrad. However, these are more clearly visible at the next stage. The first two stages of prophase-I are relatively short-lived compared to the next stage that is pachytene. During this stage bivalent
. chromosomes now clearly appears as tetrads. This stage 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.

• Crossing over is also an enzyme-mediated process and the enzyme involved is called recombinase. Crossing over leads to the recombination of genetic material on the two chromosomes. Recombination between homologous chromosomes is completed by the end of pachytene, leaving the chromosomes linked at the sites of crossing over.
• The beginning of diploteneis recognised by the dissolution of the synaptonemal complex and the tendency of the recombined homologous chromosomes of the bivalents to separate from each other except at the sites of crossovers. These X-shaped structures, are called chiasmata. In oocytes of some vertebrates, diplotene can last for months or years.
• The final stage of meiotic prophase-I is diakinesis. This is marked by terminalisation of chiasmata. During this phase the chromosomes are fully condensed and the meiotic spindle is assembled to prepare the homologous chromosomes for separation. By the end of diakinesis, the nucleolus disappears and the nuclear envelope also breaks down.

Q3. Differentiate between the events of mitosis and meiosis

	Mitosis		Meiosis
1.	Take place in the somatic cells of the body.	1.	Take place in the germ cells
2.	Occurs in both sexually as well as asexually reproducing organisms.	2.	Occurs only in sexually reproducing organisms.
3.	Mitosis involves only one cycle of nuclear and cell division.	3.	Meiosis involves two sequential cycles of nuclear and cell division called meiosis-I and meiosis-II.
4.	The DNA replicates once for one cell division.	4.	The DNA replicates once for two cell divisions.
5.	The prophase is shorter.	5.	Prophase is typically longer
6.	Prophase is comparatively simple.	6.	Prophase of the first meiotic division is more complex when compared to prophase of mitosis.
7.	The cell divides only once and the chromosomes also divide only once. .	7.	There are two cell divisions but the chromosomes divide only once.
8.	Mitosis does not involves pairing of homologous chromosomes and recombination between them.	8.	Meiosis involves pairing of homologous chromosomes and recombination between them.
9.	Two cells are formed at the end of mitosis.	9.	Four haploid cells are formed at the end of meiosis.

Q4. Write brief **note on the following:**

a. Synaptonemal complex

b. Metaphase plate

Ans: a. Synaptonemal complex: During zygotene stage chromosomes start pairing together and this process of association is called synapsis. Such paired chromosomes are called homologous chromosomes. Electron micrographs of this stage indicate that chromosome synapsis is accompanied by the formation of complex structure called synaptonemal complex. The complex formed by a pair of synapsed homologous chromosomes is called a bivalent or a tetrad. However, these are more clearly visible at the next stage.

b. Metaphase plate: At this stage, metaphase chromosome is made up of two sister chromatids, which are held together by the centromere. Small disc-shaped structures at the surface of the centromeres are called kinetochores. These structures serve as the sites of attachment of spindle fibres (formed by the spindle fibres) to the chromosomes that are moved into position at the centre of the cell. Hence, the metaphase is characterised by all the chromosomes coming to lie at the equator with one chromatid of each chromosome connected by its kinetochore to spindle fibres from one pole and its sister chromatid connected by its kinetochore to spindle fibres from the opposite pole. The plane of alignment of the chromosomes at metaphase is referred to as the metaphase plate.

Q5. Write briefly the significance of mitosis and meiosis in multicellular **organism.**

Ans: Significance of Mitosis:

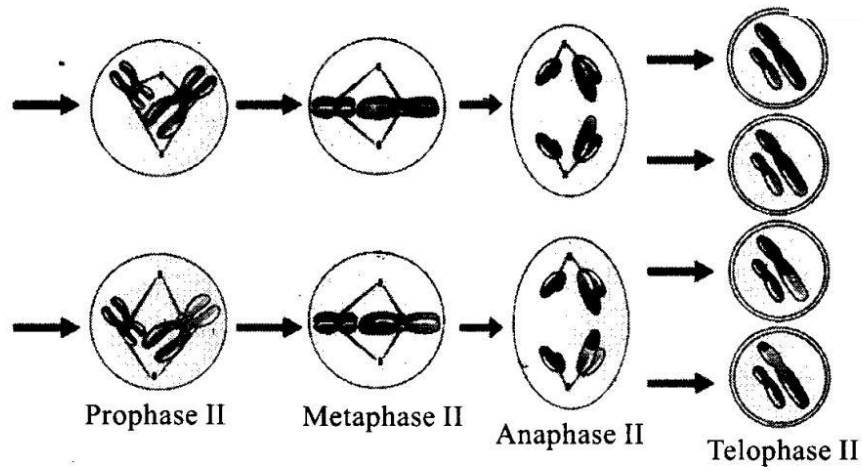
Mitosis or the equational division is usually restricted to the diploid cells only. However, in some lower plants mitosis usually results in the production of diploid daughter cells with identical genetic complement. The growth of multicellular organisms is due to mitosis. A very significant contribution of mitosis is cell repair. The cells of the upper layer of the epidermis, cells of the lining of the gut, and blood cells are being constantly replaced. Mitotic divisions in the meristematic tissues —the apical and the lateral cambium, result in a continuous growth of plants throughout their life.

Significance of Meiosis:

Meiosis is the mechanism by which conservation of specific chromosome number of each species is achieved across generations in sexually reproducing organisms, even though the process, per se, paradoxically, results in reduction of chromosome number by half. It also increases the genetic variability in the population of organisms from one generation to the next. Variations are very important for the process of evolution.

Q6. An organism has two pair **of chromosomes (i.e., chromosome number = 4). Diagrammatically represent the chromosomal arrangement during different phases of meiosis-II.**

Ans.



Stages of Meiosis II