

Cell Cycle and Cell Division

Very Short Answer Type Questions

1. **Between a prokaryote and a eukaryote, which cell has a shorter cell division time?**

A: Prokaryotes have shorter cell division time.

2. **Among prokaryotes and eukaryotes, which one has a shorter duration of cell cycle.**

A: Prokaryotes have shorter duration of cell cycle.

3. **Which of the phases of a cell cycle is of longest duration?**

A: 'Interphase' is the longest phase in a cell cycle.

*4. **Which tissue of animals and plants exhibits meiosis?**

A: In plants: Sporogenous tissue of the microsporangium and megaspore mother cell (MMC).

In animals: Male germ cells in testis and gamete mother cells (oogonia) of ovaries.

5. **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?**

A: 80 minutes or 1 hour 20 minutes.

($B \cdot 2^n$: B= initial number of bacteria; n =number of generations. $2 \cdot 2^n = 32$. So n= 4. After 4 generations ie 4x 20 min)

*6. **Which part of the human body should one use to demonstrate stages in mitosis?**

A: Diploid cells of animal cells with exception of heart and nerve cells divide mitotically.

(Human cells are never used in demonstrating mitotic division)

7. **What attributes does a chromatid require to be classified as a chromosome?**

A: Presence of a centromere and arms in each chromatid.

8. **Which of the four chromatids of a bivalent at prophase-I of meiosis can involve in cross over?**

A. Non-sister chromatids of homologous pair of chromosomes participate in crossing over.

9. **If a tissue has at a given time 1024 cells. How many cycles of mitosis had the original parental single cell undergone?**

A: Ten cycles. ($N \cdot 2^n = 1024$; n=10 ie $1 \cdot 2^{10} = 1024$)

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

A: 300 pollen mother cells.

(Each meiotic division results in 4 cells)

11. At what stage of a cell cycle does DNA synthesis occurs?

A: 'S' phase of Interphase.

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

A: Interphase of the cell cycle occupies more.

13. 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.

A: G_1 ; G_0

14. Identify the sub stages of prophase-I in meiosis in which synapsis and desynapsis are formed.

A: Synapsis ---- Zygotene.
Desynapsis ---Diplotene.

15. Name the stage of meiosis in which actual reduction in chromosome number occurs.

A: Anaphase –I (Bivalents separate to reduce chromosome number)

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

A: During nuclear division cytoplasmic division also takes place. Cell organelles like mitochondria and plastids get distributed between the daughter cells.

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

A: During metaphase the chromosome number is 32. DNA content is also same. (2C).

18. 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 give in this difference in chromosome number? Do you think cells with 16 chromosomes could have arisen from cells with 32 chromosomes or vice versa?

A: Reasons: 1. All the cells are not at the same stage of division. During telophase of mitosis, before cell plate formation, a single cell will have 32 chromosomes. After cell plate formation two cells each with 16 chromosomes appear.

2. Mutations results in multiplication of chromosomes.

3. Error in counting.

Cells with 16 chromosomes never arise from cells with 32 chromosomes in mitotic division.

19. The following events occur during various phases of the cell cycle. Fill the blanks with suitable answer against each.

a. Disintegration of nuclear membrane-----

b. Appearance of nucleolus-----

c. Division of centromere-----

d. Replication of DNA-----.

A: a. Disintegration of nuclear membrane-----end of Prophase

b. Appearance of nucleolus----- Telophase

c. Division of centromere----- Anaphase

d. Replication of DNA-----‘S’phase of cell cycle.

20. Two key events take place during ‘S’ phase in animal cells. DNA replication and duplication of centriole. In which parts of the cell do these events occur?

A: DNA replication in nucleus.

Centriole duplication in cytoplasm.

*21. Name a cell that is found arrested in diplotene stage for months and years. Comment in two or three sentences.

A: Oocyte cells of human beings. Oocyte or primary oocyte within the follicle undergo first meiotic division. The division is unequal forming small polar body and a large secondary oocyte.

Short Answer type Questions

1. 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 a 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 meiosis II, (6) Telophase I / after meiosis**

- A. a) Synaptonemal complex = Zygotene
b) Recombination nodules = Pachytene
c) Appearance/activation of a enzyme recombinase = Pachytene
d) Termination of chiasmata = Diakinesis
e) Interkinesis = The stage between the two meiotic divisions
(After telophase I / before meiosis II)
f) Formation of dyad of cells = Telophase I / after meiosis I

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

- a) Nuclear membrane fails to disintegrate b) Duplication of DNA does not occurs
c) Centromere does not divide d) Cytokinesis does not occur

- A. a) Nuclear membrane fails to disintegrate: The nuclear division's takes place
b) Duplication of DNA does not occurs: Of two daughter cells, one cannot get DNA
c) Centromere does not divide: Chromosomes are not distributed to daughter cells
d) Cytokinesis does not occur: Multinucleate condition arises leading to the formation of syncytium (liquid endoplasm of coconut)

3. Comment on the statement – Meiosis enables the conservation of specific chromosome number of each species even though the process per sec results in reduction of chromosome number.

- A. Meiosis is the mechanism by which conservation of specific chromosome number in each species is achieved across generations in sexually reproducing organisms, even though the process per sec periodically results in the reproduction 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.

4. How does cytokinesis in plant cells differ from that in animal cells?

- A. In animal cells, 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, are enclosed by a relatively inextensible cell wall. 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 cell plate that represents the middle lamella between the walls of two adjacent cells.

5. Which division is necessary to maintain constant chromosome number in all body cell of multicellular organism and why?

A. Mitosis is necessary to maintain constant number of chromosomes in all body cells in multicellular organisms because mitosis results in the production of diploid daughter cells with genetic employment usually identical to that of the parent cell. The growth of multicellular organisms is due to mitosis. Cell growth results in distributing the ratio between the nucleus and cytoplasm. It is therefore, essential for the cell division to restore the nucleo cytoplasmic ratio. A very significant contribution of mitosis is cell repair. Mitotic divisions in the meristematic tissues, the apical and the lateral meristems, results in a continuous growth of plants throughout their life.

6. Though redundantly described as a resting phase, interphase does not really involve rest. Comment.

A. The interphase also called phase of non – apparent division through called the resting phase is the time during which the cell is preparing for division by involving both cell growth and DNA replication. The interphase is divided into three further phases. They are:

i) ' G_1 ' **phase:** It corresponds to the interval between mitosis and initiation of DNA replication. In this the cell is metabolically active and continuously grows.

ii) '**S'** **phase:** Synthesis phase marks the period during which DNA synthesis or replication takes place. The amount of DNA per cell doubles. However, there is no increase in the number of chromosomes.

iii) ' G_2 ' **phase:** Proteins are synthesized.

LONG ANSWER TYPE QUESTIONS

1. Discuss on the statement – Telophase is reverse of prophase.

A. Telophase is the final stage of mitosis in which the chromosomes that have reached their respective poles decondenses and lose their individually. Chromosomes cluster at opposite spindle poles and their identity is lost as discrete elements. Nuclear membrane assimilates around the chromosome clusters. Nucleolus, golgi complex and endoplasmic reticulum reform where as in prophase, chromosomal material condenses and organizes to form

compact chromosome. Nuclear membrane, nucleolus, golgi complexes, endoplasmic reticulum disappears. That's why telophase is the reverse phase to prophase.

2. What are the various stages of meiotic prophase – I? Enumerate the chromosomal events during each stage?

A. Meiosis I is longer phase and consists of 5 sub phases namely Leptotene, Zygotene, Pachytene, Diplotene and Diakinesis.

a) Leptotene : The nucleus increases in size by absorbing water from the cytoplasm. The chromatin material organizes into a constant number of chromosomes. The chromosomes are long, slender and show bead like structures called chromomeres. The ends of the chromosomes converge towards one side in the nucleus, where the centrosome lies. This arrangement is called Bouquet stage.

b) Zygotene : The chromosomes become shorter and thicker. They approach each other and form pairs. This homologous pair is called bivalent and the process of pairing is called synapsis. It is accompanied by the formation of synaptonemal complex. The synapsis occurs at proterminal point or procentric or random means.

c) Pachytene : Bivalent chromosomes now clearly appear as tetrads. This stage is characterized by the presence of recombination modules, the sites of which crossing over occurs between the non – sister chromatids of the homologous chromosomes. Crossing – over is the exchange of genetic material between the two homologous chromosomes. It is also an enzyme mediated process by 'recombinase' crossing over leads to recombination of genetic material on the two chromosomes.

d) Diplotene : The homologous chromosomes of a bivalent begin to separate from each other except at the sites of cross overs to dissolution of synaptonemal complex. The 'X' shaped structures are called chiasmata. The chromatids undergo condensation, contraction and thickening.

e) Diakinesis : It is marked by terminalisation of chiasmata. In this phase, the chromosomes are fully condensed and the meiotic spindle is assembled to prepare the homologous chromosomes for separation. By the end of this phase, the nuclear membrane breaks down the nucleolus disappears.

3. Differentiate between the events of mitosis and meiosis.

A.

Mitosis	Meiosis
<ol style="list-style-type: none"> 1. It occurs in both haploid and diploid organisms 2. It occurs in somatic cells 3. Nucleus divides once 4. Daughter cells are identical 5. Two daughter cells are formed 6. Prophase is simple 7. Pairing of chromosomes does not occur 8. Both chiasmata and crossing over are absent 9. Centromeres undergo division in anaphase 10. Daughter chromosomes move to the opposite poles 11. The chromosome number of daughter nuclei is unchanged 12. Duration of time is less 	<ol style="list-style-type: none"> 1. It occurs only in diploid organisms 2. It occurs in the reproductive cells 3. Nucleus divides twice 4. Daughter cells are not identical 5. Four daughter cells are formed 6. Prophase is complicated and shows five sub – stages 7. Homologous chromosomes pair to form bivalents 8. Crossing over occurs between non – sister chromatids and chiasmata are formed 9. Centromeres do not divide in anaphase – I, but divide in anaphase – II 10. Bivalents are separated. They move to opposite poles 11. The chromosome number of daughter nuclei is reduced to half 12. Duration of time is more

4. Write brief note on the following:

(a) Synaptonemal complex

(b) Metaphase plate

A. **a) Synaptonemal complex:** The homologous chromosomes approach each other and form pairs called bivalents and the process is called synapsis. The synapsis occurs at the both ends and progresses towards their centromeres called proterminal or the synapsis starts from their centromeres and the pairing progresses towards the end of the chromosomes called procentric or the pairing occurs at various points of homologous chromosomes called Random synapsis.

The paired homologous chromosomes are joined by a thick protein containing frame work called synaptonemal complex (Sc), Sc stabilizes the pairing of homologous chromosomes and facilitates crossing over and recombination.

b) Metaphase plate: Metaphase chromosome is made up of two sister chromatids which were held together by the centromere. Small disc shaped structures at the surface of the centromeres are called Kinetochores. These serve as the sites of attachment of spindle fibres to the chromosomes that are moved into centre of the cell. Hence all chromosomes 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. It is called 'Metaphase Plate'.

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

A. Significance of mitosis

- 1) Growth in organisms is caused by mitosis.
- 2) The daughter cells formed by mitosis are identical with the mother cell in characters. Hence it is important in conserving the genetic diversity of the organisms.
- 3) In unicellular organisms, mitosis helps in reproduction.
- 4) The old dead and decaying cells of body are replaced with the help of mitosis
- 5) It is useful in regeneration of lost parts and for grafting in vegetative reproduction.

Significance of meiosis

- 1) Meiosis helps in the maintenance of a constant chromosome number from one generation to the next.
- 2) Due to crossing over, genetic recombinations are caused which help in the origin of new species and lead to evolution.
- 3) It helps in the formation of gametes and is thus useful in sexual reproduction.