

Cell Cycle and Cell Division

Case Study Based Questions

Read the following passages and answer the questions that follow:

1. In a poster-making competition a group of students got the topic of meiotic cell division in human germ cells.



M phase has its role to play in the body of the organism. The meiotic cell division of human germ cells was studied by the group and all visible changes in meiosis I and meiosis II were observed. Students made notes of what they observed. They came across various events and understood cell cycle to its depth.

(A) Write the meiosis events in the correct sequence.

- (I) Disjunction of genomes
- (II) Crossing over
- (III) Terminalisation of chiasmata
- (IV) Synapsis

(B) What is the number of chromosomes in metaphase II of meiosis in a human germ cell?

(C) Meiosis occurs in which tissues of animals and plants?

Ans. (A) The correct sequence is (IV) Synapsis →

(II) Crossing Over → (III) Terminalisation of chiasmata (1) Disjunction of genomes.

(B) The meiosis II is similar to mitosis where chromosome number does not get reduced. Thus, in meiosis II the total number of chromosomes is 23.

(C) Only the tissues that form gametes go through meiosis. Meiosis occurs in animals

within the reproductive cells, which include the testes and ovaries. In plants, androecium (male reproductive) and gynoecium (female reproductive) portions of the plant undergo meiosis.

2. 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 cell cycle. Cell cycle is divided into interphase and M phase. In the interphase, though called the resting phase, cell is preparing for division by undergoing both cell growth and DNA replication. Interphase is divided into three phases- G_1 phase, S phase and G_2 phase. In G_1 phase, cell prepares proteins and enzymes. In S phase, DNA replication and centriole duplication take place. After S phase, chromosome number of the cell does not change but the amount of DNA becomes double ($4C$). In G_2 phase, synthesis of protein especially tubulin, which is used in the formation of spindle fibres, occurs. During M phase, cell division occurs through karyokinesis and cytokinesis.

(A) How many chromosomes and DNA content will the onion cell have in G_1 phase, after completing S phase and after M phase respectively, if onion plant possesses 14 chromosomes initially?

- (a) $14/2C$, $28/4C$ and $14/4C$
- (b) $14/2C$, $14/4C$ and $14/2C$
- (c) $14/2C$, $14/2C$ and $14/2C$
- (d) $28/4C$, $28/4C$ and $14/2C$

(B) Choose the correct option for a human cell before it enters prophase?

	Number of Chromatids	Number of Chromosomes
(a)	46	92
(b)	46	46
(c)	92	46
(d)	92	92

(C) Non-dividing cells like muscles and neurons.phase

- (a) G_1
- (b) G_2
- (c) G_0
- (d) M

(D) How many mitotic divisions are required to form 128 cells from a single onion

root tip cell (mitosis)?

- (a) 14
- (b) 21
- (c) 6
- (d) 7

(E) Assertion (A): Interphase is called resting stage.

Reason (R): In interphase, the cell is metabolically inactive.

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false but R is true.

Ans. (A) (b) 14/2C, 14/4C and 14/2C

Explanation: Replication of DNA takes place at the S phase of the cell cycle.

At G_1 phase it will have 14 chromosomes. At S phase also, it will have 14 chromosomes. G_2 phase also has 14 chromosomes. After M phase, 7 chromosomes were there. The content will be 2C at G_1 phase and it will be 4C at G_2 and S phase.

(B)

	Number of Chromatids	Number of Chromosomes
(c)	92	46

Explanation: There are a total of 92 sister chromatids present in 46 chromosomes. Each chromosome has a pair of identical sister chromatids attached together in the centromere, giving the chromosome its distinctive X-shaped structures.

(C) (c) Go phase

Explanation: Cells that do not divide further exit G_1 and enter the quiescent stage (G_0) of the cell cycle, which is an inactive state. The cells at this stage are still metabolically active, but they no longer multiply unless they are triggered by an appropriate signal based on the organism's needs.

(D) (d) 7

Explanation: In mitosis, each cell divides into two. So starting from a single cell, the increase in a number of cells will occur as per the following progression:

1→2→4→8→16→32→64→128.

Thus a total of 7 divisions is required to produce 128 cells starting from a single cell or $2n$ times the division.

(E) (c) A is true but R is false.

Explanation: Three subphases make up the interphase (G_1 , G_2 and S). S phase is when DNA synthesis takes place. Between the end of mitosis and the beginning of S phase lies the growth phase known as G_1 . Between S phase and the beginning of mitosis is G_2 . We can infer that the interphase is metabolically active because DNA synthesis happens in S phase and the cell actively synthesised chemicals needed for division during the growth phases (G_1 and G_2).