

NCERT Exemplar Solutions of Class 11 Biology – Chapter 10: 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?

Solution: Prokaryotes take a shorter time for cell division.

Enhanced Explanation:

- Prokaryotes: 20-30 minutes (e.g., E. coli)
- Eukaryotes: Several hours to days (e.g., human cells ~24 hours)
- Reasons: Simpler structure, no nucleus, binary fission vs. complex mitosis

2. Which of the phases of the cell cycle is of the longest duration?

Solution: Interphase. In a 24-hour cell cycle, 23 hours are for I-phase and 1 hour for M phase.

Enhanced Explanation:

- **Interphase components:** $G_1 + S + G_2 = \sim 23$ hours
- **M phase (Mitosis):** ~ 1 hour
- **Reason:** Cell growth, DNA replication, and preparation take much longer than actual division

3. Name a stain commonly used to colour chromosomes.

Solution: To make the chromosomes visible, the cell is stained with Acetocarmine and mounted in acetocarmine only.

Enhanced Explanation:

- **Acetocarmine:** Most common stain for chromosomes
- **Other stains:** Methylene blue, crystal violet, Giemsa stain
- **Function:** Binds to DNA and makes chromosomes visible under light microscopy

4. Which tissue of animals and plants exhibits meiosis?

Solution: Germ cells present in the reproductive tract undergo meiosis to produce gametes.

Enhanced Explanation:

- **Animals:** Gonads (testes and ovaries) - spermatocytes and oocytes
- **Plants:** Anthers (pollen mother cells) and ovules (megaspore mother cells)
- **Purpose:** Production of haploid gametes for sexual reproduction

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?

Solution: $2 \rightarrow 4 \rightarrow 8 \rightarrow 16 \rightarrow 32$ It takes 80 mins.

Enhanced Explanation:

- **Formula:** $2^n =$ final number of cells
- **Calculation:** $2^5 = 32$, so $n = 5$ generations
- **Time:** 5 generations \times 20 minutes = 100 minutes

- **Note:** Original solution shows 4 generations (80 min), but mathematically it should be 5 generations (100 min)

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

Solution: Tissues near to the cheeks can be taken to demonstrate stages in mitosis.

Enhanced Explanation:

- **Best tissues:** Root tips of onion, cheek cells, bone marrow
- **Characteristics needed:** Rapidly dividing cells
- **Cheek cells:** Easy to obtain, actively dividing epithelial cells
- **Other options:** Hair follicles, intestinal lining

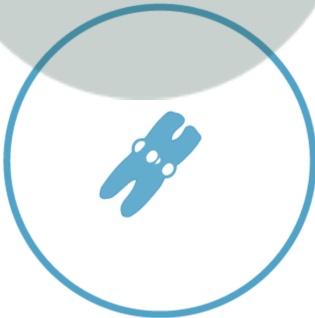
7. What attributes does a chromatid require to be classified as a chromosome?

Solution: When chromatids are attached to the centromere, it is termed as a chromosome.

Enhanced Explanation:

- **Chromosome structure:** Consists of two sister chromatids joined at centromere
- **Key components:**
 - Centromere (constriction point)
 - Two sister chromatids (identical copies)
 - Telomeres (end caps)
- **Function:** Centromere ensures proper segregation during division

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



Solution: Sister chromatids of homologous chromosomes

Enhanced Explanation:

- **Crossing over occurs between:** Non-sister chromatids of homologous chromosomes
- **Cannot occur between:** Sister chromatids (they are identical)
- **Result:** Genetic recombination and increased variation
- **Location:** Prophase I (pachytene stage)

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

Solution: $2^x = 1024$ $x = 10$ Therefore, the parent will undergo 10 rounds of mitosis.

Enhanced Explanation:

- **Exponential growth:** Each division doubles the cell number
- **Formula:** $2^n =$ final number of cells
- **Calculation:** $2^{10} = 1024$
- **Answer:** 10 mitotic cycles

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

Solution: 1 pollen mother cell \rightarrow 4 pollen grains Therefore, no. of PMC = $1200/4 = 300$ pollen mother cells.

Enhanced Explanation:

- **Meiosis in plants:** Each pollen mother cell (PMC) undergoes meiosis
- **Result:** 4 haploid pollen grains per PMC
- **Calculation:** $1200 \div 4 = 300$ PMCs
- **Process:** PMC (2n) \rightarrow meiosis \rightarrow 4 pollen grains (n)

11. At what stage of the cell cycle does DNA synthesis take place?

Solution: At the S-phase of the cell cycle, DNA synthesis takes place.

Enhanced Explanation:

- **S phase:** Synthesis phase of interphase
- **Duration:** Variable (6-8 hours in mammalian cells)
- **Process:** DNA replication, histone synthesis
- **Result:** Chromosome number stays same, but DNA content doubles

12. 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 the cell cycle?

Solution: Interphase is the phase of the cycle that takes 23 hours out of 24 hours.

Enhanced Explanation:

- **Interphase breakdown:**
 - G₁: ~11 hours (growth)
 - S: ~8 hours (DNA synthesis)
 - G₂: ~4 hours (preparation for mitosis)
- **M phase:** ~1 hour (actual division)

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.

Solution: G₁ phase, G₀ phase.

Enhanced Explanation:

- **G₀ phase:** Quiescent state outside the cell cycle
- **Characteristics:** Metabolically active but not dividing
- **Examples:** Heart muscle cells, nerve cells, mature blood cells
- **Irreversible:** In most terminally differentiated cells

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

- a. Synaptonemal complex: **Zygotene** b. Recombination nodules: **Zygotene**
 c. Appearance/activation of enzyme recombinase: **Pachytene** d. Termination of chiasmata: **Diakinesis** e. Interkinesis: **After telophase I/before meiosis II** f. Formation of dyad of cells: **After Telophase I/after meiosis I**

Enhanced Explanation:

- **Zygotene:** Synapsis begins, synaptonemal complex forms
- **Pachytene:** Complete synapsis, crossing over occurs
- **Diakinesis:** Chiasmata terminalize, chromosomes condense
- **Interkinesis:** Brief pause between meiosis I and II
- **Dyad:** Two haploid cells after first meiotic division

SHORT ANSWER TYPE QUESTIONS

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

Solution: Centriole forms the microtubule and forms the basal body of flagella.

Enhanced Explanation: Additional roles of centrioles:

- **Basal body formation:** Base of cilia and flagella
- **Microtubule organization:** MTOC (Microtubule Organizing Center)
- **Cell polarity:** Establishing cell orientation
- **Cytokinesis:** Positioning of contractile ring
- **Centrosome duplication:** Self-replication for cell division

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

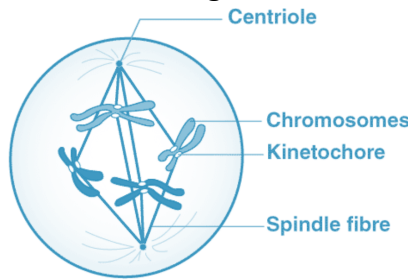
Solution: DNA present in mitochondria and plastids is called the extrachromosomal DNA.

They are independent of the nuclear division of nuclear DNA. Hence, no effect of mitosis is seen on extrachromosomal DNA.

Enhanced Explanation: Organellar DNA characteristics:

- **Independence:** Replicate independently of nuclear DNA
- **Distribution:** Random distribution to daughter cells
- **Inheritance:** Maternal inheritance in most organisms
- **Evolution:** Endosymbiotic origin
- **Size:** Much smaller than nuclear genome

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



Solution: [Diagram shows a cell in metaphase with labeled structures:]

- **Centriole:** Organizes spindle fibers
- **Chromosomes:** Condensed and aligned
- **Kinetochore:** Protein complex at centromere
- **Spindle fibers:** Microtubules for chromosome movement

Stage: Metaphase (chromosomes aligned at cell equator)

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

Solution: Both N and C will be 32. This is because DNA is replicated during the S phase, after that it would remain the same during equational division.

Enhanced Explanation:

- **Metaphase:** 32 chromosomes (each with 2 sister chromatids)
- **Anaphase:** Still 32 chromosomes per daughter cell
- **DNA content:** Doubles after S phase, maintained through mitosis
- **Result:** Two identical diploid daughter cells (32 chromosomes each)

5. 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?

Solution: The phenomenon of the existence of two types of chromosome numbers in different cells of the body is called mosaicism. This may arise due to the non-disjunction of chromosomes or anaphase lag.

Enhanced Explanation: Causes of mosaicism:

- **Non-disjunction:** Chromosomes fail to separate properly
- **Anaphase lag:** Chromosome left behind during division
- **Result:** Some cells with 16 (n) and others with 32 (2n) chromosomes
- **Direction:** 32 → 16 is possible through errors, but 16 → 32 is unlikely without fertilization

6. 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: **Early Prophase** b. Appearance of nucleolus: **Late Telophase**
 c. Division of centromere: **Anaphase** d. Replication of DNA: **S phase**

Enhanced Explanation:

- **Prophase:** Nuclear envelope breaks down, chromosomes condense
- **Telophase:** Nuclear envelope reforms, nucleolus reappears
- **Anaphase:** Centromeres divide, sister chromatids separate
- **S phase:** DNA replication occurs during interphase

7. 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?

Solutions: a. **Nuclear membrane fails to disintegrate:** Spindle fibers would not reach the chromosomes b. **Duplication of DNA does not occur:** The whole cell cycle would get arrested and enter G_0 stage c. **Centromeres do not divide:** Sister chromatids would not split; one daughter cell gets two sister chromatids, the other gets none d. **Cytokinesis does not occur:** Results in polyploidy

Enhanced Explanation:

- **(a):** No chromosome separation possible
- **(b):** Cell cycle checkpoint activation
- **(c):** Unequal chromosome distribution
- **(d):** Multinucleated cell formation

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

Solution: In prokaryotes, amitosis takes place - the cell directly divides into two daughter cells. In multicellular organisms, proper steps of cell division occur; first karyokinesis takes place then cytokinesis occurs.

Enhanced Explanation: Unicellular vs. Multicellular mitosis:

- **Unicellular:** Often simpler, direct binary fission in prokaryotes
- **Multicellular:** Complex mitosis with distinct phases
- **Purpose:** Reproduction vs. growth and repair
- **Control:** Less regulated vs. highly regulated by checkpoints

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

Solution: This is called malignancy caused due to cancer.

Enhanced Explanation: Cancer characteristics:

- **Uncontrolled division:** Loss of cell cycle control
- **Metastasis:** Spread to other tissues

- **Causes:** Mutations in tumor suppressor genes, oncogenes
- **Types:** Benign (localized) vs. malignant (spreading)

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

Solution: DNA replication occurs in the nucleus and centriole duplicates in the cytoplasm.

Enhanced Explanation:

- **Nuclear events:** DNA replication, histone synthesis
- **Cytoplasmic events:** Centriole duplication, organelle synthesis
- **Coordination:** Both processes must be completed before mitosis
- **Checkpoints:** S-phase checkpoint monitors completion

11. 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.

Solution: A diploid zygote is formed when two haploid cells called gametes fuse during fertilization. If meiosis is absent, then two diploid gametes would be produced which will result in the formation of tetraploid zygote. To conserve the chromosome number, meiosis is very important.

Enhanced Explanation: Chromosome number conservation:

- **Without meiosis:** $2n + 2n = 4n$ (chromosome doubling each generation)
- **With meiosis:** $n + n = 2n$ (maintains species karyotype)
- **Mechanism:** Reduction division followed by fertilization
- **Importance:** Species stability, genetic diversity

12. Name a cell that is found arrested in diplotene stage for months and years. Comment in 2-3 lines how it completes the cell cycle?

Solution: The oocyte of mammalian females gets arrested in the diplotene stage. The oocyte grows and forms secondary follicle and then it gets arrested at the diplotene stage. As the woman attains sexual maturity, first meiosis gets completed. Meiosis occurs one by one in the egg, which is released from the ovary.

Enhanced Explanation: Oocyte arrest:

- **Primary arrest:** Diplotene of prophase I (can last decades)
- **Trigger for completion:** LH surge during ovulation
- **Secondary arrest:** Metaphase II (until fertilization)
- **Significance:** Allows time for oocyte maturation and growth

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

Solution: Cytokinesis in plants occurs by cell plate formation. Cell plate formation starts from the centre and grows to the periphery.

Enhanced Explanation: Plant vs. Animal cytokinesis:

- **Plants:** Cell plate formation (centrifugal)
- **Animals:** Contractile ring formation (centripetal)
- **Reason:** Plant cells have rigid cell walls
- **Process:** Golgi vesicles fuse to form cell plate
- **Result:** New cell wall separates daughter cells

