**Chapter 4 - Cell Cycle**

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**MCQs.**

1. C
2. A
3. B
4. D
5. C
6. C
7. D
8. A
9. A
10. B
11. B
12. B
13. B
14. A
15. B

**Short Questions:**

1. The **spindle apparatus** is a microtubule structure that separates the chromosomes and moves them to the opposite poles during cell division in both mitosis and meiosis. In animal cells, it originates from centrioles, while in plant cells, the microtubules organise themselves to form a spindle. During metaphase, they align all chromosomes in the middle (to the equatorial plane) by attaching to their centromeres. In anaphase, they pull sister chromatids to the opposite poles of the cell, ensuring that each cell receives an identical set of chromosomes.
2. **Crossing over** leads to genetic recombination, increasing genetic diversity by exchanging the genetic material between homologous chromosomes during meiosis 1. It causes genetic variability, allowing for adaptation and evolution of favourable features.
3. The **G1 phase** or the Growth 1 phase, is the first phase of interphase, which involves cell growth, organelle production, protein synthesis and preparation for DNA replication. The enzymes and nucleotides required for the replication process (in the S phase) are produced in this stage. The key events are cell growth (cell increases in size), protein synthesis (for DNA replication), normal metabolic activities and preparation for DNA replication (nucleotides and enzymes are produced here)
4. **- Cell A:** Since it has continued the cycle after formation, it will synthesise the material needed for cell division, such as DNA and proteins.

**Cell B:** Since it stopped dividing further and entered the G0 phase, it will not synthesise any DNA needed for replication. However, it will continue producing and synthesising material needed for its cell functions, like proteins for organelles and RNA for ribosomal activities. Its main focus would be on cell repair and maintenance of normal functions.

1. **Epithelial cells** are found in the skin and lining of the gut. Hence, they divide continuously as they are the most exposed to tissue damage and require the most repair and protection. They are in a constant wear and tear process and need constant replacement for damaged cells. Skin also serves as the body’s first line of defence; hence, new cells are required to ensure that the barrier remains intact at all times. Skin is also the most exposed to external damage, like injuries and wounds, therefore, this **regeneration** is a crucial step for the recovery of lost cells.
2. Meiosis I and Meiosis II are two distinct stages of the process of meiosis, which is responsible for reducing the chromosome number by half to produce the gametes (sperm and egg cells) required in sexual reproduction. In **Meiosis I**, homologous chromosomes are separated into two haploid cells, reducing the chromosome number from diploid (2n) to haploid (n). Key events include crossing over in prophase I, which increases genetic diversity, and the separation of homologous chromosomes during anaphase I. **Meiosis II,** however, is similar to mitosis. The two haploid cells from Meiosis I divide again without DNA replication. Sister chromatids are separated during anaphase II, resulting in four haploid cells.
3. In **rapidly dividing cells**, the **G1 phase** of the cell cycle is often reduced or even eliminated. This is because the cell skips certain checkpoints or shortens phases to increase the rate of division. The cell spends less time in G1 and may rapidly proceed to the S phase (DNA replication), G2 phase (preparation for mitosis), and M phase (mitosis). In some rapidly dividing cells, like in embryonic development or cancer cells, the G1 phase is either shortened or bypassed entirely, causing the cell cycle to accelerate. This allows for quicker division and faster growth but also increases the likelihood of errors in DNA replication or chromosome segregation.
4. **Cytokinesis** is the last step of cell division, causing the cytoplasm to divide between two distinct cells. In **animal** cells, cell division occurs through the formation of the cleavage furrow, which forms at the centre of the cell, pinching the cell into two. In **plant** cells, however, a cell plate is formed in the middle of the newly formed cells. This cell plate is made up of vesicles containing material for the cell wall; they fuse and start forming a new wall, which eventually separates the two daughter cells.
5. Both **skin cells and cancer cells** divide rapidly, but their being harmful or not depends on **when and why they divide**. Skin cells divide rapidly to maintain a healthy surface layer on the skin and replace cells when they are shed from the surface. Cancer cells divide uncontrollably due to mutations in cell regulatory genes, causing them to divide without any checks and balances. Skin cells have a function to perform when they divide, whereas cancerous cells do not have any specialised function; therefore, they cause harm and dysfunction in the body, leading to complications.
6. Haploid organisms already have a single set of chromosomes (n), which means they do not need to undergo reduction division like diploid organisms. These organisms produce gametes through mitosis, as their body cells and gametes are both haploid. Since no chromosome reduction is needed, mitosis ensures the gametes have the same haploid number of chromosomes as the parent organism.
7. Individuals with Down syndrome have 47 chromosomes instead of the usual 46 because of a condition called trisomy 21. This occurs when there is an extra copy of chromosome number 21 due to improper separation of chromosomes during the formation of gametes—a process called nondisjunction. As a result, one of the parents contributes an egg or sperm with two copies of chromosome 21 instead of one, leading to a total of three copies in the zygote. This extra chromosome causes developmental and physical features associated with Down syndrome.

**Extensive Questions:**

1. If meiosis 1 is completed but meiosis II does not occur, the following anomalies are likely to appear:

* Meiosis II is responsible for separating the **sister chromatids** of each chromosome. If meiosis II doesn't happen, the two daughter cells formed at the end of meiosis I will still contain **homologous chromosomes** (not separated into individual chromatids). This will result in **gametes with the wrong number of chromosomes**.
* Since meiosis II is essential for halving the chromosome number, failure to undergo this stage means that the **chromosome number won't be reduced**. Therefore, both daughter cells from meiosis I will each have the **full diploid set** of chromosomes instead of the haploid set. This can lead to an abnormal number of chromosomes in the offspring when these gametes fuse during fertilisation.

1. A cell is shown in the diagram
2. The cell is a typical animal cell, without a cell wall and having centrioles which extend spindle fibres for division.
3. The stage shown here is the **Anaphase**
4. The **sister chromatids have separated** and are being pulled toward opposite poles of the cell. **Spindle fibres** are clearly attached to the centromeres and pull the chromatids apart. This separation of chromatids is the key characteristic of **anaphase**, as it follows metaphase (where chromosomes align in the centre) and precedes telophase (where two nuclei start to form).
5. Meiosis II is identical to mitosis because both processes involve the division of sister chromatids. Both processes go through the same 4 stages: prophase, metaphase, anaphase and telophase. Both processes ensure that genetic material is evenly distributed between the two daughter cells. In mitosis, the resulting cells are genetically identical to the parent cell, while in meiosis II, the genetic material is halved, and the daughter cells are genetically unique but still carry a full set of chromosomes (haploid). In both processes, no crossing-over takes place, which does happen in meiosis 1.



