

Chapter No.5

Cell Cycle

Q1: What is cell cycle? Describe various phases of interphase of cell cycle with diagram.

Ans: Cell cycle:

The Series of events that take place in a eukaryotic cell leading to its division is called cell cycle.

Periods of cell cycle:

There are two broad periods of cell cycle

A. Interphase

B. M-Phase (division phase)

I-Interphase:

The period between the end of one mitosis and the start of next mitosis is called interphase.

Typically, interphase lasts for at least 90% of the total time required for the cell cycle therefore interphase is called the longest phase/ resting phase/ or growth phase of the cell cycle.

Sub Phase of interphase: -

Interphase has three sub phases.

i. G₁-Phase:

It is the first sub phase of interphase.

Main events:

- In this phase newly produced cells grow in size.
- Internal chemical changes occur in cell.
- Internal chemical changes prepare the daughter cells for DNA replication.
- tRNA and mRNA are synthesized
- Ribosome and several enzymes are synthesized in G₁ Phase.

ii. S-Phase (S-Synthesis):

It is the second phase of interphase

Main events:

- Cell growth continues throughout S-phase.
- The replication of DNA occurs during this phase.
- Both strands of DNA must replicate and new complementary strands are synthesized.
- Once DNA replication is completed the chromosome become duplicated and the cell become ready to enter the next phase called G₂-Phase.

iii. G₂-Phase: -

The gap between the end of S-phase and the start of M-Phase is called G₂ Phase.

Main events:

- Preparation of protein takes place which are essential for next phase (M-Phase) mainly for the formation of spindle fibers.
- Centriole replicate and move to the either end of the nucleus. It indicates the end of interphase.

G₀ Phase:

Cells that have temporarily or permanently stopped dividing called G₀ Phase.

Q2: Define Mitosis? Describe various stages of mitosis in detail?

Ans: Mitosis:

History:

A German Biologist Walther Fleming in the 1880s gave the detailed account of the stages of cell division. He observed that in a dividing cell the nucleus passes through a series of changes which he called mitosis.

Stage of mitosis:

The process of mitosis can be divided into two main stages.

A. Karyokinesis:

It is the division of the nucleus. “Karyo” means nucleus and “kinesis” mean division.

B. Cytokinesis:

It is the division of cytoplasm. “cyto” mean cell and “kinesis” mean division.

Various phases of Karyokinesis:

I. Prophase:

Main events:

- i. Condensation of chromatin network occurs and thread like chromosomes appear.
- ii. Each chromosome consists of two chromatids attached with each other at centromere.
- iii. Nuclear membrane disappears.
- iv. Centrioles move to the opposite poles.
- v. Three sets of spindles fibers arise from each centriole.

a. Astral microtubules:

Microtubules radiate outward and form star shaped structure called aster.

b. Kinetochore Microtubules:

Kinetochore microtubules are attached to the kinetochore of chromosome.

c. Polar microtubules:

Polar microtubules arise from one pole and come in contact with the microtubules of other poles.

ii. Metaphase:

Main events:

- i. During this phase chromosomes arranged itself at the center of cell to form line of chromosome called metaphase plate or equatorial plate.
- ii. Two spindle fibers from both sides attach with one chromosome.

iii. Anaphase:

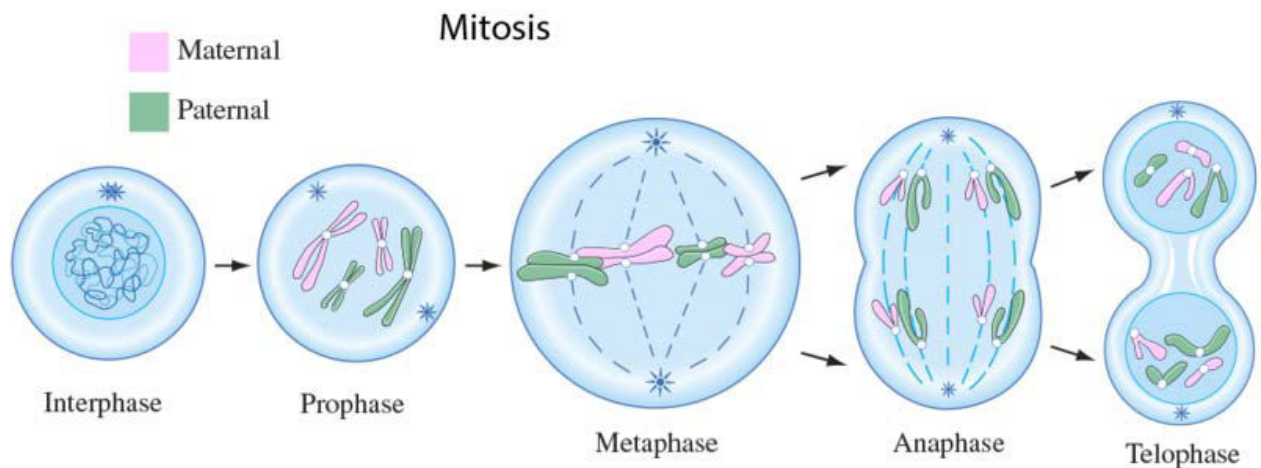
Main events:

- i. The centromere of each chromosome splits into two parts.
- ii. The spindle fibers contract and they pull the chromatids (daughter chromosomes) towards their respective pole.
- iii. Cytokinesis begins in anaphase.

vi . Telophase:

Main events:

- i. In telophase, spindle fibers breakdown.
- ii. Chromosomes reach to the respective pole.
- iii. Chromosomes uncoil to become thin chromatin networks.
- iv. Two daughter nuclei are formed, each with the same number of chromosomes as were present in the parent nucleus.



Q3: Define Cytokinesis? Write the mechanism of cytokinesis in animal and plant cells?

Ans: Cytokinesis in animal's cell:

Mechanism:

The plasma membrane in the center of the cell folds inward. This fold deepens and extends the entire equatorial plate and divides the parent cell into daughter cells.

Cytokinesis in plants.

Mechanism:

In plant cells during cytokinesis vesicles derived from the Golgi bodies move to the middle of the cell and fuse to form a membrane bounded disc called the cell plate or phragmoplast. The plate grows outwards and more vesicles fuse with it. Finally, the membrane of the cell plate fuses with the plasma membrane and then to the cell wall this result two daughter cells. Each bounded by its own plasma membrane and cell wall.

Q4: Write the significance of Mitosis?

Ans: Significance of mitosis:

Importance of mitosis is the maintenance of the chromosomal set.

Following are the occasions in the life of organisms where mitosis happens.

i. Development and Growth:

The number of cells within an organism increases by mitosis and this is the basis of development from a single cell zygote to the multicellular body and the growth.

ii. Cell replacement:

Mitosis ensures proper replacement of lost cells by new cells. For example, each time you brush your teeth and rinse your mouth, hundreds of dead and worn-out cheek cells are being shed into your saliva. These dead cells are constantly being replaced by the process of mitosis.

iii. Regeneration:

It is the process of the renewal of organism or the worn-out cells and tissues. For example, Regeneration of tail in lizard. Other organisms have the ability to regenerate the whole body from a piece of the body, e.g. hydra.

iv. Healing of wound.

Mitosis is also responsible for the healing of wound.

v. Asexual reproduction in plant:

Some plants reproduce through asexual reproduction. Asexual reproducing in plants occurs due to mitosis.

Example:

- In plants cutting, grafting, budding etc.
- In animals' hydra reproduce asexually by budding.

Q5: Define Meiosis? Write the various stages of Meiosis.

Meiosis:

History:

Meiosis was discovered in 1876, by a German biologist Oscar Hartwig.

Definition:

The type of cell division during which a single parent cell divides to form four daughter cells and each daughter cell have half number of chromosomes as parent cell is called meiosis.

It is also called reduction division as the diploid number of chromosomes ($2n$) are reduced to haploid (n).

Stage of meiosis:

There are two stage of meiosis,

A. Meiosis I

B. Meiosis II

Various phases of Meiosis I:

Prophase I:

Main events:

- i. Prophase 1 usually accounts for 90% of the total time spent in meiosis.
- ii. In this phase chromatin materials condenses and chromosomes become visible.
- iii. Homologous chromosomes form pairs. The pairing of homologous chromosome is called synapsis.
- iv. Each pair is called tetrad because each pair has four chromatids.
- v. They are also called bivalent because each pair has two chromosomes.
- vi. The two non-sister chromatids of homologous chromosomes become zipped together, forming complexes known as chiasmata.
- vii. At the chiasmata, the non-sister chromatids exchange their parts called crossing over.
- viii. Centrioles migrate to opposite poles and make spindle fibers.

Metaphase I:

Main events:

- i. The homologous chromosomes form a line called metaphase plate or equatorial plate.
- ii. Spindle fibers from one pole of the cell attaches to one chromosomes of each pair while from the opposite pole attach to other chromosome of the homologous pair.

Anaphase I:

Main events:

- i. During anaphase I spindle fibers shorten and they pull the homologous chromosomes.
- ii. Chromosomes separate and move toward opposite poles of the cell.
- iii. One haploid set of chromosomes is formed at each pole.

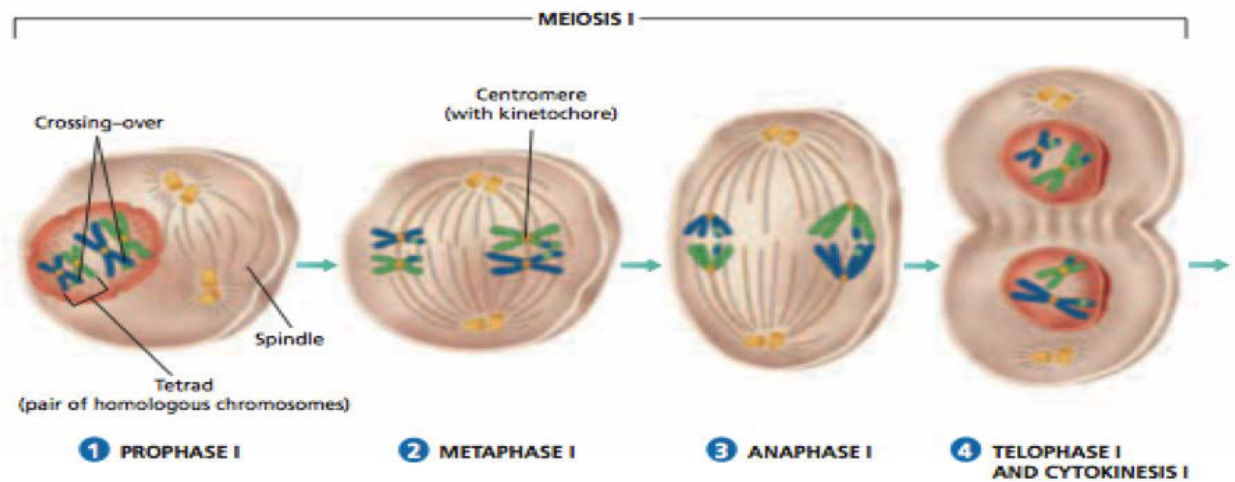
Telophase I.

Main events.

- i. Nuclear membrane and nucleoli reappears around each set of chromosomes.
- ii. Cytoplasm divides to form two daughter cells.
- iii. Each daughter cell has haploid number of chromosomes.

Cytokinesis.

The division of cytoplasm occurs and they form two daughter haploid cells.



Meiosis II:

It is the second part of the meiotic division process. Much of this part is similar to mitosis. However, it differs from mitosis is that, parent cells have haploid numbers of chromosomes and the daughter cells also receive haploid number.

Meiosis II is divided into.

i. Prophase II:

Main events:

- The chromosomes which are already visible become more prominent.
- Each chromosome has two chromatids and centromere.
- Centrioles move to opposite poles and make Spindle Fibers.

ii. Metaphase II:

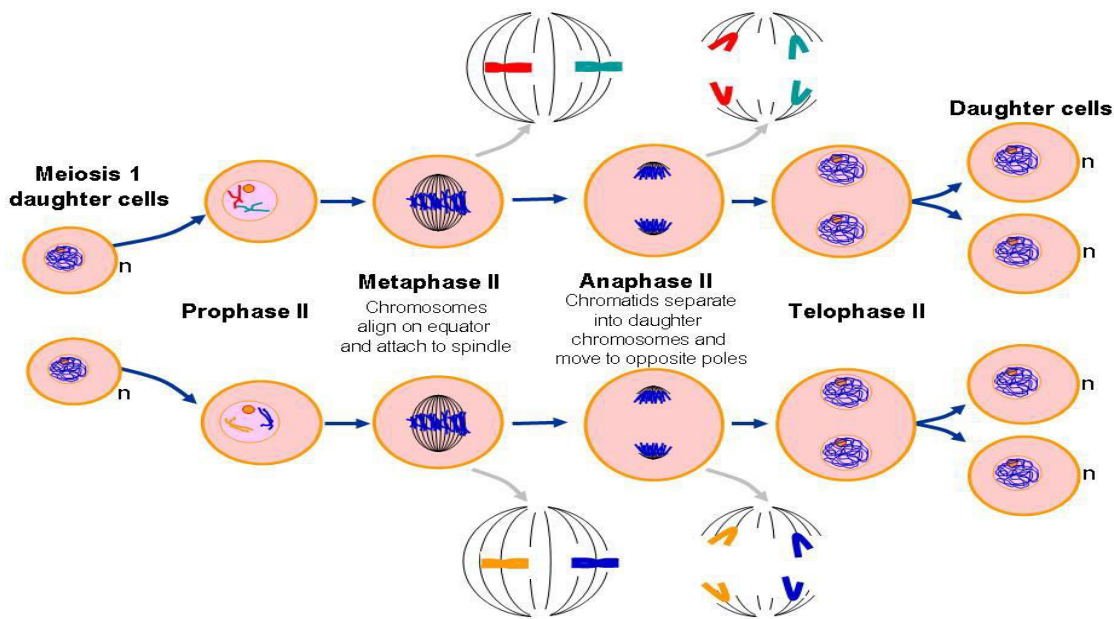
- Chromosomes form a line in the center of cell called metaphase plate or equatorial plate.

iii. Anaphase II:

- Centromere of each chromosome spilt.
- The spindle fibers contract and they pull the chromatids towards respective pole.

vi. Telophase II

- Chromatids reach to their respective poles.
- Nuclei and Nuclear membrane reappear.
- Completion of Cytokinesis occurs in telophase II.
- After the division of cytoplasm four daughter haploid cells are formed.



Q6: What is the significance of meiosis?

Ans: Significance of meiosis:

1-Gametes formation:

Meiosis helps in the formation of male gametes (sperms) and female gametes (ova or eggs)

Animals: -

In animals, the parent cells with diploid number of chromosomes undergo meiosis to produce haploid gametes. The male and female gametes fuse together and make a zygote with diploid number. The zygote undergoes mitosis and develops a new diploid organism.

Plants:

In plants, the spore-mother cells undergo meiosis to make haploid spores. These spores grow into haploid structure which produces haploid gametes by mitosis. The gametes combine to produce the diploid zygote.

The zygote undergoes repeated mitosis to become the diploid plants.

3-Maintain constant number of chromosomes: -

Meiosis maintains constant number of chromosomes in zygote by the union of haploid sperms and haploid egg during sexual reproduction.

4-Genetic variation:

Meiosis helps to create genetic variation among offspring. This variation occurs in chromosomes during genetic recombination.

Q7: Write note on apoptosis and Necrosis?

Ans: i. Apoptosis:

Apoptosis is also called programmed cell death (PCD).

Mechanism:

During apoptosis the cell spilt into small membrane bounded bodies known as apoptotic bodies. Apoptotic bodies cannot damage neighbouring cell. It cannot cause inflammation in neighbouring cells. These apoptotic bodies are engulfed by the neighbouring cells.

Example:

- i. Disappearance of tadpole tail during metamorphosis.

- ii. Disappearance of web present in human hand and formation of fingers.
- iii. In the adult organism, the number of cells is kept relatively constant through apoptosis and division.

ii. Necrosis:

It is also called accidental cell death.

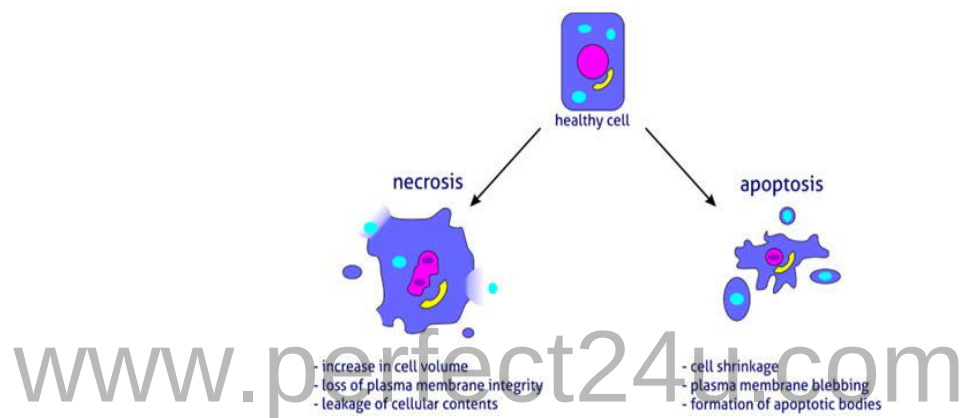
Mechanism:

Necrosis is accompanied by the release of special enzymes from the lysosomes. The lysosomal enzymes break cellular components and may also be released outside the cell to break other surrounding cells. Cells that die by necrosis may also release harmful chemicals that damage other cells.

Causes:

Some physical and chemical events which because necrosis is

- i . Radiation
- ii. Heat
- iii. Trauma
- iv. Lack of oxygen
- v. Blockage of blood flow etc.



SHORT QUESTIONS

B. Write short Answer of the following Questions.

Q1: Define cell cycle and how many phases it is divided?

Ans: It is a series of events that take place in a cell leading to its division and duplication. Cell cycle is divided into two periods.

I. Interphase

It is further divided into three sub-phases.

- i. G₁ - Phase
- ii. S - Phase
- iii. G₂ - Phase

II. Division phase:

In this phase the parent cell divides into two daughter cells.

- i. Prophase
- ii. Metaphase
- iii. Anaphase
- iv. Telophase

Q2: In which type of cell, meiosis takes place and why it is important?

Ans: Meiosis takes place in germ cells or gametes. It involves reduction in numbers of chromosome. This helps to maintain the chromosome number constant generation after generation. Also reshuffling of genetic material takes place during crossing over in meiosis that lead to variation and serve as raw material for evolution.

Q3: How does normal mitosis ensure normal life?

Ans: Normal mitosis ensures normal life because

- i. Mitosis ensures the exact transmission of daughter cells.
- ii. When mitosis occurs in normal way growth of organism takes place.
- iii. Mitosis helps in healing of wounds.
- iv. Daughter cells formed by mitosis receive same genetic materials as in parent cell.
- v. When each cell has normal number of chromosomes, they perform normal life functions.
- vi. Regeneration of lost body parts in some animals and vegetative reproduction in plants occurs by mitosis.

Q4: Give at least four differences between mitosis and meiosis?

Ans: Difference between mitosis and meiosis;

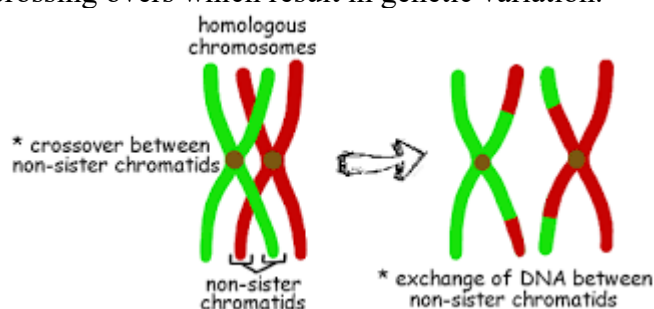
No	Mitosis	Meiosis
1	The process of mitosis occurs in somatic cells.	The process of meiosis occurs in sex cell or gametes.
2	It produces two daughter cells	It produces four daughter cells
3	The daughter cells receive same number of chromosomes from parent cell	The daughter cells receive half number of chromosomes from their parent cell.
4	Pairing of homologous chromosomes does not occur in mitosis	Pairing of homologous chromosomes occur in meiosis

5	Crossing over does not occur in mitosis	Crossing over occur in meiosis.
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Q5: What is chiasma and what is its role in crossing over?

Ans: The point at which two non-sister chromatids of a homologous chromosomes exchange their segments is called chiasma.

At chiasma, the non-sister chromatids of homologous chromosomes exchange their parts. This process is called crossing over which result in genetic variation.



Long Question

C. Give detailed Answers to the following Question.

Q1: Describe various phases of interphase of cell cycle with diagrams.

Ans: See Q No. 1

Q2: Discuss different events of Meiosis-I with the help of diagram?

Ans: See Q No. 5

Q3: Explain different stages of mitosis with diagrams and at what stage, cytokinesis take place?

Ans: See Q.No 2