UNIT 04

Cell Cycle

Descriptive Questions

Cell Cycle

09404001

Q.1. Define cell cycle. Enlist its phases.

Ans. Definition

It is the series of events that take place in a eukaryotic cell from its formation to its division into two daughter cells.

Phases of Cell Cycle

The cell cycle can be divided in two main phases i.e., interphase and the mitosis phase.

09404002

Q.2. Define interphase. Explain the stages of interphase.

Ans. Introduction

This phase lasts for about 90% of the total time of cell cycle. During interphase, the cell performs the life functions according to its specialty and prepares itself for next division.

Stage of Interphase

Interphase consists of the following three phases:

G1 Phase (First Gap Phase): It starts from the end of the Mitosis phase. It is also called the growth phase. During this phase cell makes proteins and organelles and so grows in size. Cell also makes enzymes that are required in S phase for the replication of DNA.

S Phase (Synthesis Phase): During this phase, the DNA of each chromosome is replicated (copied). It results in the duplication of chromosomes (each chromosome consists of two sister chromatids). The total number of chromosomes in cell remains the same.

G2 Phase (Second Gap Phase): In this phase, the cell continues to grow and produces proteins necessary for cell division. The cell checks for any DNA damage that may have occurred during replication and makes necessary repairs. It also begins to reorganize its contents in preparation for mitosis.

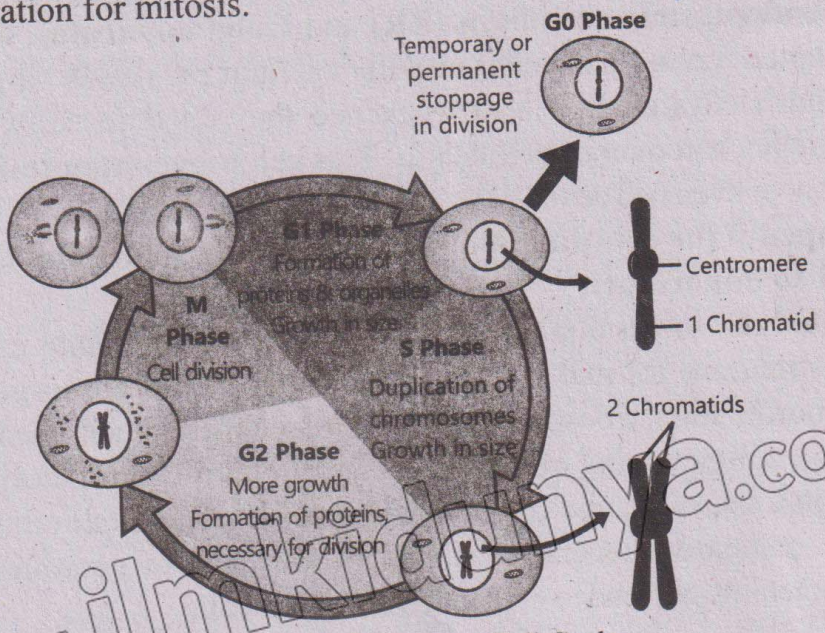


Figure 4.1: Eukaryotic Cell Cycle

G0 Phase

1. Many cells stop dividing and start performing their specific functions. This phase is called G0 phase. It is a so called non-dividing phase.
2. Many cells (e.g. neurons) remain in G0 for indefinite periods.
3. Some cells (e.g. cells of liver and kidney) remain in G0 phase temporarily.
4. Other cells (e.g. epithelial cells) do not enter G0 and continue to divide throughout life.

Division Phase

After interphase, the cell enters the division phase and divides into the two daughter cells. The events of cell cycle are controlled by special genes. All phases occur in a sequence.

Table 4.1: Main Phases in Eukaryotic Cell Cycle

Phase	Description
Interphase	The cell prepares for division and goes through growth in size and DNA replication.
Gap (G1) Phase	The cell grows and carries out normal functions, preparing for DNA replication.
Synthesis(S) Phase	The cell replicates its DNA, making an exact copy of its genetic material.
Gap 2 (G2) Phase	The cell grows further, ensuring all preparations are complete for division.
Gap 0 (G0) Phase	The cell exits the cycle and stops dividing, often to carry out specialized functions (not all cells enter this phase).
M phase	The cell divides its genetic material equally into two new, identical cells.

Mitosis

Q.3.Define the events occur during the phases of mitosis. **09404003**

Ans. Definition

Mitosis is the type of cell division in which a cell divides into two daughter cells, each with the same number of chromosomes as were present in the parent cell.

Occurrence

Mitosis occurs in the somatic cells of eukaryotes. Prokaryotes also divide to make identical cells. But the events of their division are different from mitosis. That is why we call it **binary fission.**

Phases of Mitosis

The German biologist, Walther Flemming discovered the events of mitosis in 1880s. There are 2 major phases of mitosis i.e. karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm).

A. Karyokinesis

Karyokinesis means the division of the nucleus. It is further divided into four phases.

i. Prophase

a) Condensation of Chromatin

During prophase, the thread-like chromatin material condenses and makes thick chromosomes. Each chromosome consists of 2 sister chromatids with a single centromere.

b) Disappearance of Nucleolus and Nuclear Membrane

The nuclear envelope and nucleolus break down during prophase.

c) Duplication of Centrosome and Spindle Fibres

The centrosome of cell duplicates into two. The two centrosomes migrate to opposite side of the nucleus. When they are migrating, they make a network of microtubules called spindle fibres (complete set is called **mitotic spindle**). In plant cells, there is no centrosome. Their mitotic spindle is formed by the aggregation of spindle fibres present in cytoplasm.

ii. Metaphase

i. Binding of Spindle Fibres with Chromosomes

During this phase, some spindle fibres bind with chromosomes. They attach at the point of centromere where special kinetochore proteins are present.

ii. Formation of Interphase Plate (Metaphase plate)

Two spindle fibres from both sides bind with one chromosome. The chromosomes attached with spindle fibres arrange themselves along the equator of the cell. In this way a plate is formed called metaphase plate.

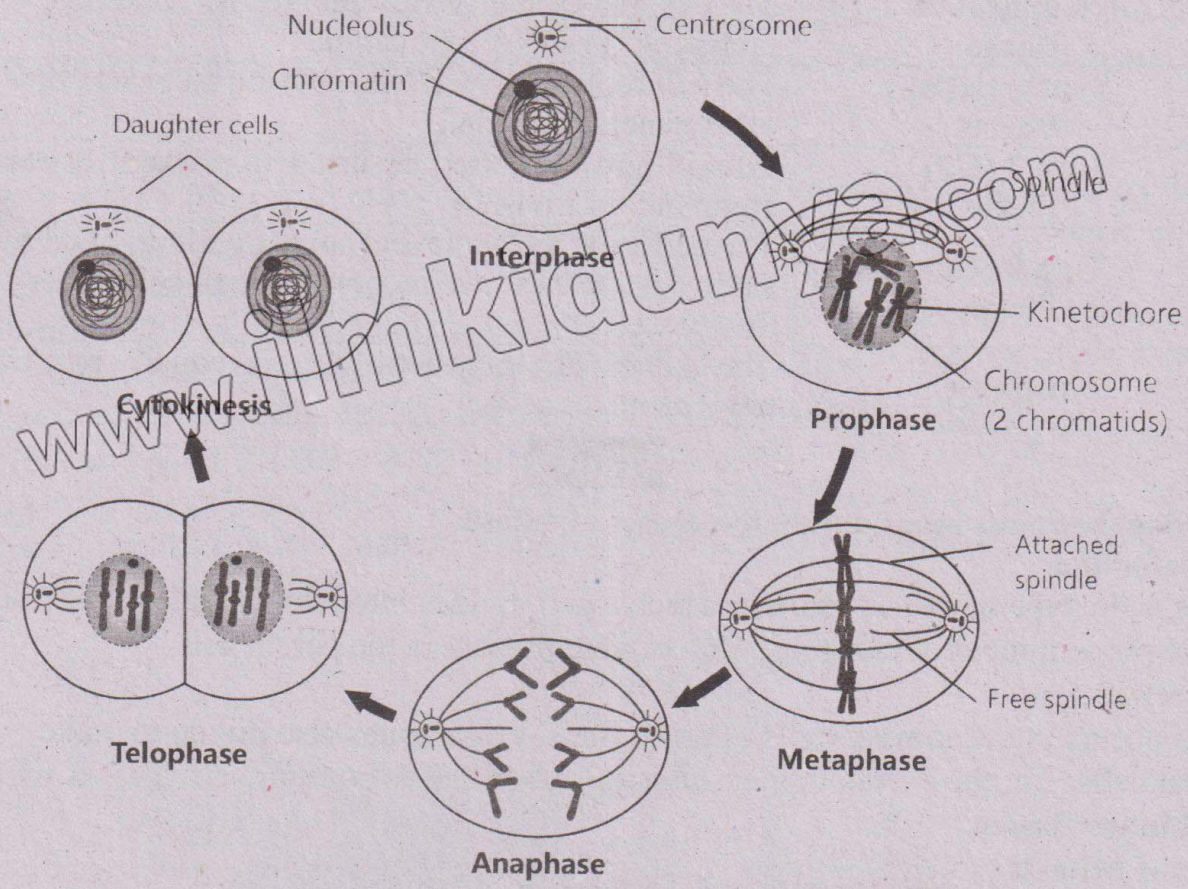


Figure 4.2: Phases of mitosis **(HQ picture is available on Pg # 210)**

iii. Anaphase

The spindle fibres attached with chromosomes pull toward the poles. Due to this pulling, the chromosome's sister chromatids separate. In this way, there are two similar sets of chromatids, which move towards the poles of the cell.

iv. Telophase

In this phase, new nuclear envelope forms around each set of separated chromosomes. Both sets of chromosomes unfold back into chromatin.

B. Cytokinesis / Describe cytokinesis in animal and plant cells.

a) Cytokinesis in Animal Cells

It is the division of cytoplasm. In animal cells, a furrow develops at the equator: At this furrow, the cytoplasm has a ring of **microfilaments**. The ring contracts and the furrow moves inward. In this way parent cell is pinched into two.

b) Cytokinesis in Plant Cell

In plant cells, Golgi apparatus makes vesicles. These vesicles move to the middle and fuse to form a plate called **phragmoplast.** The plate grows outward and its membranes fuse with the cell membrane. The result is two daughter cells.

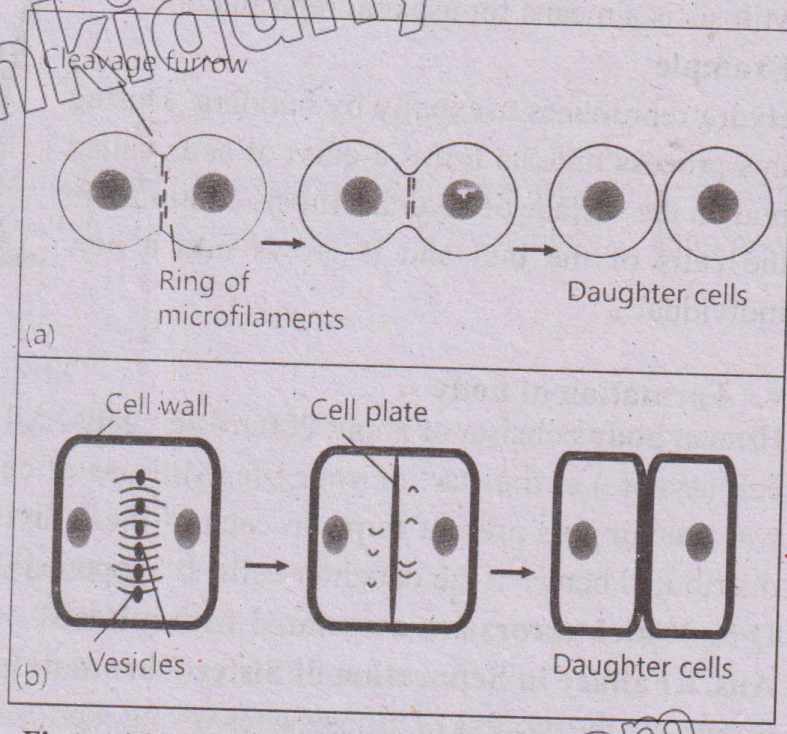


Figure 4.3: Cytokinesis; (a) in animal cell, (b) in plant cell

Q 4. Describe the significance of mitosis. **09404004**

Ans. Following is the significance of mistosis:

i. Growth

Growth in organisms means an increase in size and the number of cells. Mitosis plays a crucial role in growth by producing new cells that are identical to the original cell.

ii. Cell Replacement

Many cells are constantly dying in our bodies. For example, the red blood cells and the cells of the walls of intestine and skin etc. These are replaced by new ones which are exact copies of the older cells. The new cells are formed by mitosis.

iii. Regeneration

Some animals can regenerate parts of the body. For this purpose, they form new cells by carrying out mitosis in the cells of remaining parts.

Example:

Star fish can regenerate its lost arms.

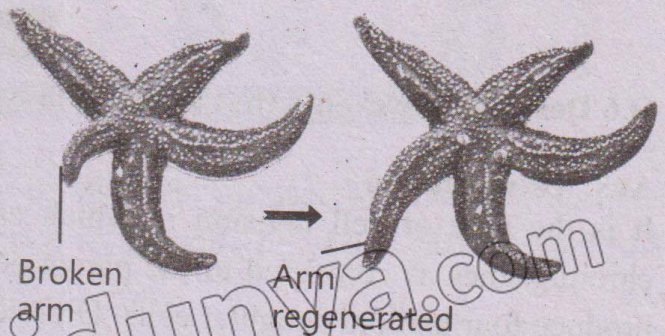


Figure 4.4: Regeneration in Sea Star

iv. Asexual Reproduction

Mitosis is a means for asexual reproduction.

Example

Hydra reproduces asexually by budding. During this process mitosis forms a mass of cells called bud on the surface of Hydra. Mitosis continues in the cells of the bud and it grows into a new individual.

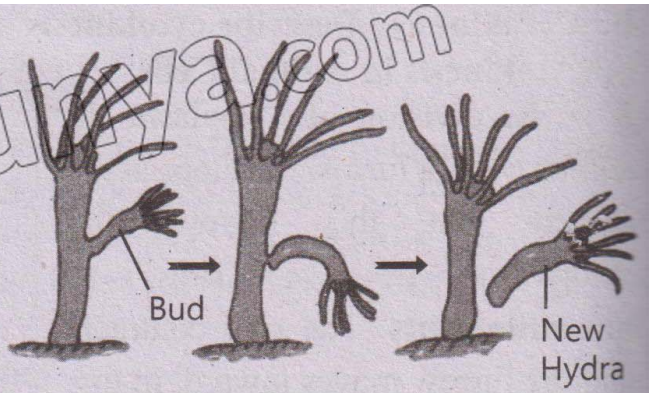


Figure 4.5: Budding in Hydra

v. Formation of body

Human body consists of about 200 trillion cells. All these cells were formed from a single cell (zygote) at the start of your life. Millions of cell divisions occurred while your body was reaching its present form. In each of these divisions the genetic material was equally distributed between the daughter cells. It happened through mitosis.

Q 5. Which errors are associated with mitosis? 09404005

Ans. i. Failure in Separation of Sister Chromatids

Sometime the process of mitosis goes wrong. For example, during the anaphase of mitosis, the sister chromatids of a chromosome may fail to separate. As a result, one daughter cell receives both sister chromosomes and the other will receive none.

ii. Tumor Formation

Introduction

Chromosomes may also be damaged during mitosis. If the genes that regulate mitosis are mutated (changed), the cells continue to divide. Due to this uncontrolled division, masses of cells are formed. These masses are called tumors.

Types

a) **Benign Tumor:** If the tumors remain in their original location, they are called benign.

b) **Malignant Tumor:** If they migrate and invade other tissues, they are called malignant tumors (cancer). It is called **metastasis** (spreading of disease).

Meiosis

Q.6 Describe the events that occur during the phases of meiosis-I and meiosis-II. 09404006

Ans. Introduction

It is the type of cell division in which each daughter cell recives half the number of chromosomes as compared to the parent cell. In meiosis, a diploid parent cell divides to produce four haploid daughter cells. Diploid means the cells in which chromosomes are in pairs (homologous pairs) while haploid means the cell with no pairs of chromosomes. It occurs in germline cells during gamete formation.

Discovery

Meiosis was discovered in 1876 by a German biologist Oscar Hertwig.

Phases of Meiosis

Meiosis consists of two divisions.

1. **Meiosis-I**
2. **Meiosis-II**

1. Meiosis-I

In meiosis-I the homologous chromosomes in a diploid cell separate and so two haploid daughter cells are produced. It is subdivided into prophase-I, metaphase-I, anaphase-I and telophase-I.

i. Prophase-I

a) Condensation of Chromatin

During this stage, chromatin condenses and takes the shape of chromosomes. Each chromosome consists of two sister chromatids, because the DNA has already replicated before meiosis.

b) Synapses and Tetrad Formation

Homologous chromosomes move close together. They pair up in a process called synapsis. Each pair of homologous chromosomes is referred called **tetrad**.

Chiasmata and Crossing Over: Non-sister chromatids of homologous chromosomes become "zipped" together, forming X-shaped structures called chiasmata. Each chiasma is the site for crossing over i.e., exchange of portions of chromosomes between non-sister chromatids. Crossing over leads to recombination of genetic material.

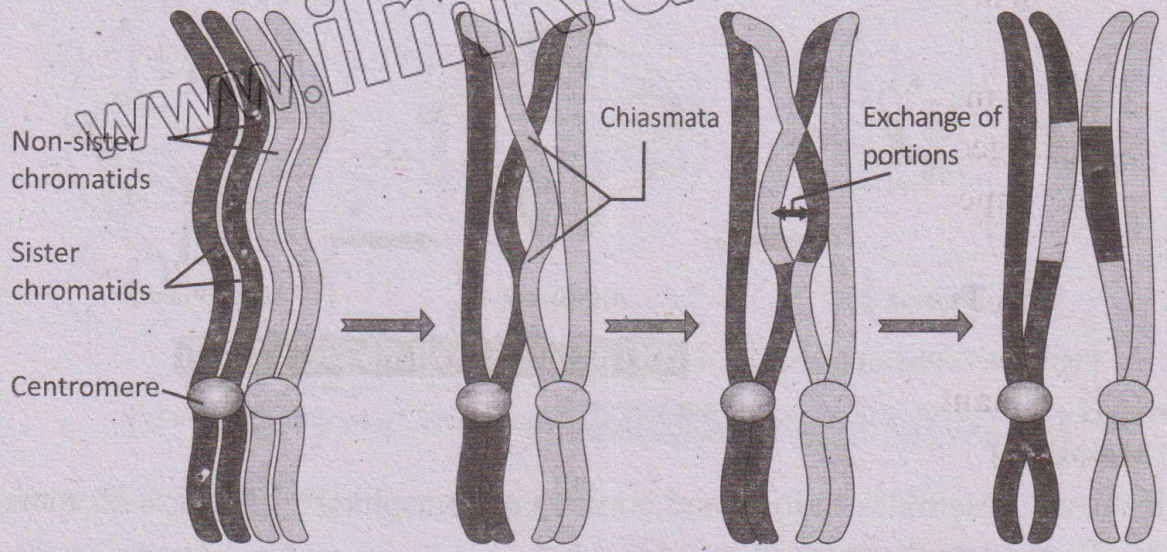


Figure 4.6: Corssing over **(HQ picture is available on Pg # 210)**

Other Events

Other events of prophase-I are similar to prophase of mitosis. The nucleoli disappear and nuclear envelope breaks. Centrioles migrate to opposite poles and make spindle fibres to which chromosomes attach.

ii. Metaphase-I

(i.) The tetrads attached with spindle fibres align along the equator.

(ii.) In this way, they form metaphase plate.

(iii.) Two spindle fibres from both poles attach with one chromosome of the pair.

iii. Anaphase-I

a) Separation of Paired Chromosome

Each spindle fiber attached with kinetochores of a single chromosome pulls towards the pole. In this way the paired chromosomes are separated.

b) Formation of Two Haploid Sets One chromosome is pulled towards one pole and other towards opposite pole. So, two haploid sets of chromosomes are formed. Each chromosome still contains a pair of sister chromatids.

iv. Telophase-I

Spindles disappear and a new nuclear envelope is made around each haploid set. The chromosomes uncoil into chromatin.

Cytokinesis occurs and two daughter cells are made.

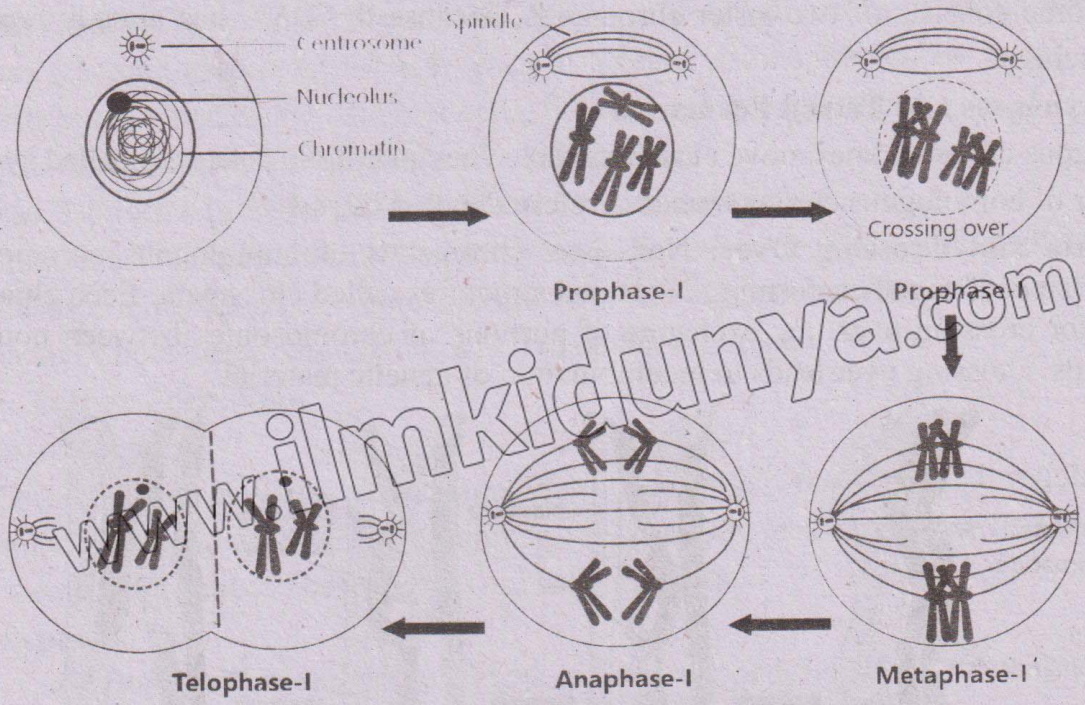


Figure 4.7: Phases of meiosis-I **(HQ picture is available on Pg # 209)**

2. Meiosis-II

Phase of Meiosis-II

Meiosis-II closely resembles mitosis and consists of four phases: prophase-II, metaphase-II, anaphase-II, and telophase-II.

i. Prophase-II

In prophase-II, the nucleoli and nuclear envelope disappear, and the chromatin condenses. Centrioles move to the poles, forming spindle fibres.

ii. Metaphase-II

During metaphase-ll, spindle fibres attach to the kinetochores of chromosomes, aligning them at the cells equator.

iii. Anaphase-II

In anaphase-II, spindle fibres pull sister chromatids apart toward opposite poles.

iv. Telophase-II

Finally, in telophase- II, chromosomes uncoil back into chromatin, nuclear envelopes reform. Cytokinesis occurs which results in the formation of four daughter cells, each with half number of chromosomes.

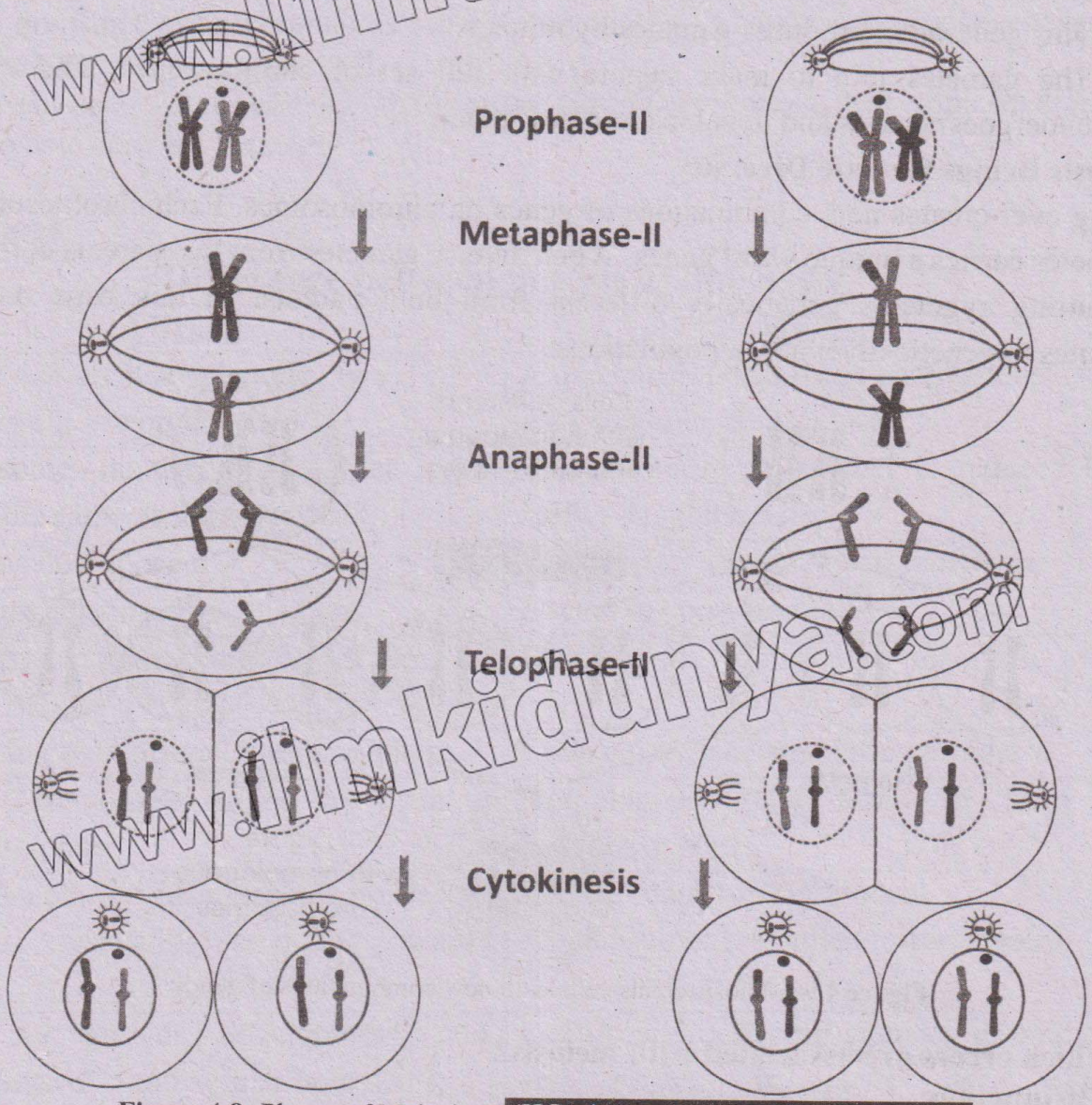


Figure 4.8: Phases of Meiosis-II **(HQ picture is available on Pg # 209)**

Q.7 Describe the significance of Meiosis. **09404007**

Ans. Significance of Meiosis.

1. Meiosis Maintains the Number of Chromosomes

(a) In Animals

i. In Animals, special cells in reproductive organs undergo meiosis. The daughter cells, called gametes, have half the number of chromosomes (with no pairs).

ii. During sexual reproduction, male and female gametes join to make the first cell (zygote) of new generation.

iii. The original number of chromosomes is restored in zygote.

iv. It undergoes mitosis many times and develops into the new animal.

(b) In Flowering Plants

i. In flowering plants, specialized cells in flowers undergo meiosis. The daughter cells, called spores, have half number of chromosomes.
ii. These spores grow into new generation inside the flowers.
iii. This generation produces gametes by mitosis.
iv. The gametes join to make zygote with full set of chromosomes. The zygote undergoes mitosis and develops into new plant.

2. Meiosis Brings Genetic Diversity

Crossing over creates new combinations of genes on chromosomes. Each chromosome in the gametes carries a unique set of genes. When diverse gametes from two parents combine, the resulting zygote is genetically different from both parents. In this way, meiosis contributes to genetic diversity in populations.

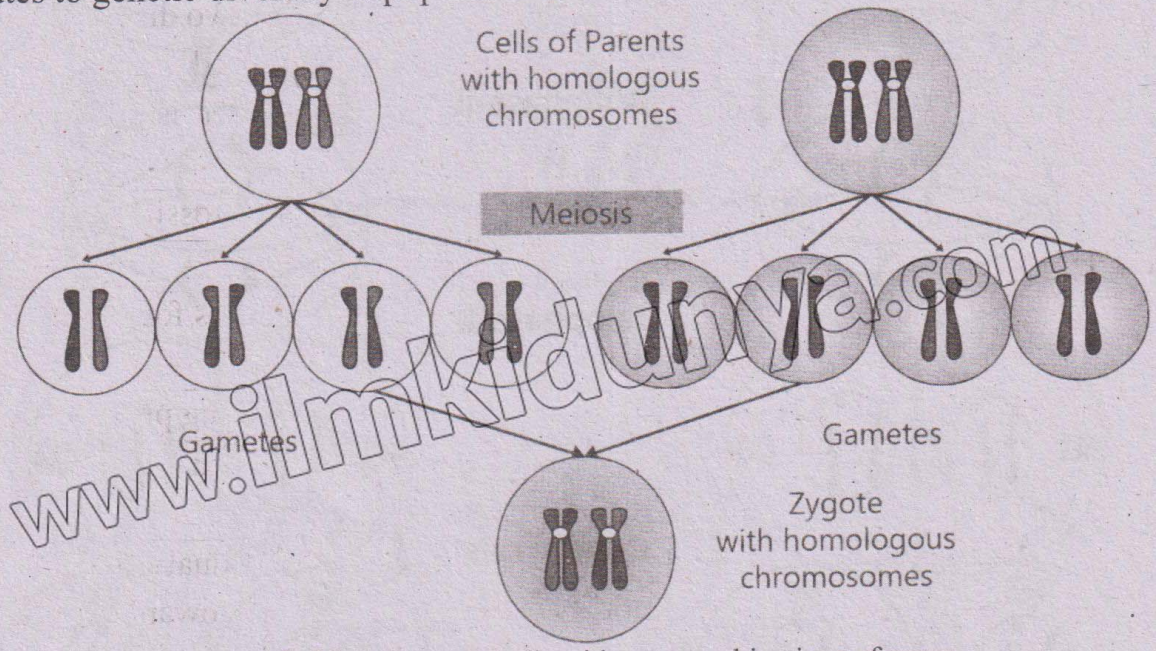


Figure 4.9: Meiosis creats cells with new combinations of genes

Q.8 Which errors are associated with meiosis?

Ans. Disjunction

During meiosis-I, chromosomes separate while during meiosis-II sister chromatids separate. It is called disjunction.

Non-Disjuntion

Sometimes **non-disjunction** occurs. Due to it, the daughter cells (gametes) receive more or less than the normal number of chromosomes. If such gametes fuse to form zygote with abnormal number of chromosomes, the resulting baby suffers from severe medical problems.

Comparison between Meiosis and Mitosis

Q.8 Describe comparison between meiosis and mitosis. **09404008**

Ans. Similarities

1. DNA replication occurs during interphase (S phase) before both divisions.
2. Both divisions begin with a parent cell that has chromosomes in pairs.

3. In both divisions, chromatin condenses and chromosomes become visible during prophase.
4. Both mitosis and meiosis involve the formation of a spindle apparatus.
5. Both involve prophase, metaphase, anaphase, and telophase. However, meiosis has two rounds i.e., meiosis-I and meiosis-II.
6. In both divisions, sister chromatids separate. In mitosis, it happens during anaphase. In meiosis, it happens in anaphase II.
7. Cytokinesis occurs at the end of both divisions. During cytokinesis, the cytoplasm divides and two new cells are formed.

Differences

Difference between mitosis and meiosis	
Mitosis	**Meiosis**
A parent cell divides only once; two daughter cells are produced.	A parent cell undergoes two divisions; four daughter cells are produced.
Chromosome number in-daughter cells remains the same as the parent cell.	The chromosome number is reduced by half in daughter cells.
Variations do not occur.	Variations occur-due to crossing-over.
Occurs in somatic cells.	Occurs in germ line cells.
Homologous chromosomes do not form pairs.	Homologous chromosomes form pair.
No crossing over occurs during prophase.	Crossing over occurs during prophase.
Single chromosome aligns to form a metaphase plate.	Homologous pairs align to form a metaphase plate.
During anaphase, chromosomes break and individual chromatids are pulled towards poles.	During anaphase-I individual chromosomes are pulled towards poles.
Occurs for growth, development, and maintenance of multicellular organisms.	Occurs for producing gametes in animals and spores. in plants for sexual reproduction.

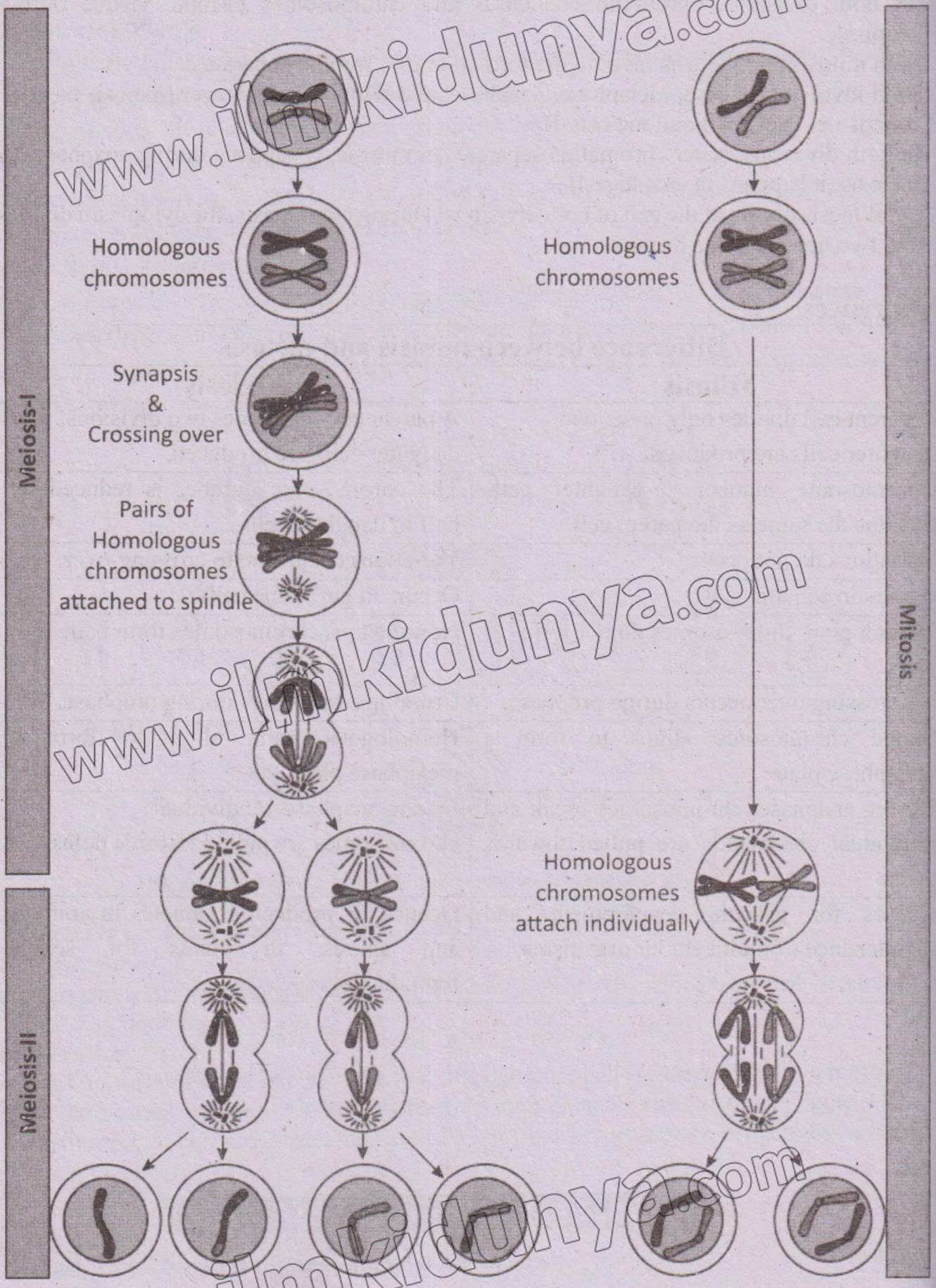


Figure 4.10: Comparison between meiosis and mitosis

Multiple Choice Questions (Exercise)

1. **In which phase of cell cycle, maximum growth occurs in cell?** 09404009
   (a) M phase (b) S phase
   (c) G1 phase (d) G2 phase
2. **In which phase of cell cycle, the chromosomes duplicate?** 09404010
   (a) Mitosis (b) G1 phase
   (c) G2 phase (d) S phase
3. **At which stage of mitosis chromosomes line up in the centre?** 09404011
   (a) Prophase (b) Metaphase
   (c) Anaphase (d) Telophase
4. **If you observe a cell in which nuclear membrane is reforming around two sets of chromosomes, what stage of cell cycle is this?** 09404012
   (a) Anaphase (b) Telophase
   (c) Prophase (d) Metaphase
5. **How does the centrosome contribute to mitosis?** 09404013
   (a) Initiates DNA replication
   (b) Makes mitotic spindle
   (c) Forms the nuclear envelope
   (d) Duplicates organelles
6. **Centrosomes make mitotic spindle in;** 09404014
   (a) Animal cells
   (b) Plant cells
   (c) Prokaryotic cells
   (d) All of these
7. **An organism has 4 pairs of chromosomes. After meiosis-I, how many chromosomes and chromatids will be present in each daughter cell?** 09404015
   (a) 8 chromosomes and 16 chromatids
   (b) 4 chromosomes and 8 chromatids
   (c) 4 chromosomes and 4 chromatids
   (d) 8 chromosomes and 8 chromatids
8. **Which one is the feature of mitosis but not of meiosis II?** 09404016
   (a) Daughter cells with same number of chromosomes
   (b) Separation of homologous chromosomes
   (c) Crossing over
   (d) Separation of sister chromatids
9. **Which event is unique to meiosis but not mitosis?** 09404017
   (a) DNA replication
   (b) Chromosome alignment
   (c) Crossing over
   (d) Nuclear division
10. **Why is meiosis II necessary after meiosis I?** 09404018
    (a) To replicate chromosomes
    (b) To reduce chromosome number
    (c) To separate sister chromatids
    (d) To ensure genetic recombination

Multiple Choice Questions (Additional)

Cell cycle

11. **Substance and energy required for replication for DNA is accumulated in cell during:** 09404019
    (a) G_1
    (b) G_2
    (c) S-Phase
    (d) M-Phase

Mitosis

12. **During cell division spindle fibres attach a chromosome at:** 09404020
    (a) Centromere
    (b) Telomere
    (c) Upper arm of chromosome
    (d) Lower arm of chromosome

13. Some student of SSC observed a thin cross section from root tip of onion plant under the microscope. They found dividing cells at different stages of their life cycle. One of the students found a cell at late prophase and counted 28 chromosomes in it. The number of chromosomes in daughter cells should be: 09404021

(a) 14
(b) 28
(c) 56
(d) 07

14. The spindle apparatus of plants differs from that of animals in not having: 09404022

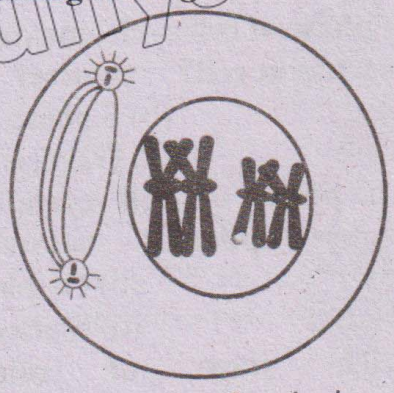
(a) Microtubules
(b) Equator of spindle
(c) Centrioles
(d) Centromere

Meiosis

15. Crossing over results in genetic recombination. It occurs between: 09404023

(a) Two chromatids of the same chromosome.
(b) Two chromatids of any two non-homologous chromosomes
(c) Two chromatids of opposite gametes
(d) Two chromatids of homologous chromosomes

16. The cell shown in this diagram is passing through: 09404024



(a) Prophase I of meiosis
(b) Prophase of mitosis
(c) Telophase of meiosis I
(d) Anaphase of meiosis II

17. The longest phase of meiosis is: 09404025

(a) Interphase I (b) Prophase I
(c) Interphase II (d) Prophase II

18. What causes the number of chromosomes to reduce to half when a cell divides by meiosis? 09404026

(a) Replication of DNA during interphase I
(b) Separation of homologous chromosomes during meiosis I
(c) Separation of sister chromatids of all the chromosomes during meiosis I
(d) Crossing over during meiosis I

19. Chromosomal number of fruit fly is 8. The gametes of fruit fly contain: 09404027

(a) 2 chromosomes
(b) 4 chromosomes
(c) 8 chromosomes
(d) 16 chromosomes

20. All of the following event takes place both in mitosis and meiosis except: 09404028

(a) Condensation of chromatin to form chromosomes
(b) Formation of spindle apparatus
(c) Nuclear envelop and nucleolus disappear
(d) Chromosomes pair for crossing over

Answer Key

1	d	2	d	3	b	4	b	5	b
6	a	7	b	8	a	9	c	10	c
11	b	12	a	13	b	14	c	15	d
16	a	17	b	18	b	19	b	20	d

Short Answers Questions (Exercise)

Q.1 Enlist the events that occur during the G1 phase of interphase? 09404029

Ans. During G1 phase of interphase following events occur:

i. Cell makes proteins and organelles and so grow in size.
ii. Cell also makes enzymes required in S-phase for replication of DNA.

Q.2 What is the main purpose of the S phase in the cell cycle? 09404030

Ans. During this phase, the DNA of each chromosome is replicated (copied). It results in the duplication of chromosomes (each chromosome consists of two sister chromatids). The total number of chromosomes in cell remains the same.

Q.3 During which phase of mitosis sister chromatids separate? 09404031

Ans. During anaphase spindle fibres attached with chromosomes pull towards the poles, making the sister chromatids of chromosomes separated.

Q.4 How does crossing over contribute to genetic variation in meiosis? 09404032

Ans. During crossing over, exchange of segments of non-sister chromatids of homologous chromosomes take place. This process leads to recombination of genetic material and increase genetic diversity.

Q.5 What is the role of spindle fibres in mitosis? 09404033

Ans. During mitosis, spindle fibres ensure the accurate separation of sister chromatids of chromosomes attached with spindle fibres in telophase.

Q.6 How is cytokinesis in animal cell different from plant cell? 09404034

Ans. In animal cells, a furrow develops at the equator. At this furrow, the cytoplasm has a ring of microfilaments. The ring contracts and the furrow moves inward. In this way parent cell is pinched into two.

While in plant cells, Golgi apparatus makes vesicles. These vesicles move to the middle and fuse to form a plate called phragmoplast. The plate grows outward and its membranes fuse with the cell membrane. The result is two daughter cells.

Q.7 What is the difference between prophase of mitosis and prophase-I of meiosis-I? 09404035

Ans.

Prophase of mitosis	Prophase-I of meiosis-I
• Pairing of homologous chromosomes does not take place. • Crossing over is absent.	• During prophase-I, pairing of homologous chromosomes takes place. • Crossing over leads to genetic recombination.

Q.8 How does meiosis differ from mitosis in terms of chromosome number? 09404036

Ans. The number of chromosomes remains the same during mitosis.

Example

A diploid (2n) parent cell will produce two diploid (2n) daughter cells. While during

meiosis the number of chromosomes remain half as compare to parent cell.

Example

A diploid (2n) parent cell produces four haploid (n) daughter cells.

Q.9 What are the key events of anaphase in mitosis? 09404037

Ans.

i. Constriction of spindle fibers towards their respective poles.
ii. Equal separation of sister chromatids of chromosomes.

Q.10 What is the function of the centrosome during cell division? 09404038

Ans. During cell division, the centrosome of cell duplicates into two. Thses two centrosomes migrate to the opposite side of the nucleus and make network of microtubules called spindle fibers. These spindle fibers ensure accurate separation of chromosomes.

Q.11 What are sister chromatids, and when do they separate in meiosis? 09404039

Ans. Sister chromatids are identical copies of a single chromosomes. These sister chromatids are separated during anaphase-II of meiosis.

Q.12 How is mitosis related to the process of regeneration? 09404040

Ans. Some animals can regenerate parts of the body. For this purpose, they form new cells by carrying out mitosis in the cells of remaining parts.

Short Answers Questions (Additional)

Cell cycle

Q.13 What is G_0 Phase? 09404041

Ans. Cells that have stopped dividing are in G_0 phase. In multicellular eukaryotes, cells enter G_0 phase from G 1.

Examples

i. Some cells of liver and kidneys enter the G_0 phase temporarily.
ii. Neurons remain in G_0 phase for indefinite period.
iii. Other cells, such as epithelial cells do not enter into G_0 phase.

Q.14 Describe G_2 Phase. 09404042

Ans. It is last sub-phase before cell division. In this phase increased protein synthesis occurs for the production of spindle fibres.

Q.15 What is M-Phase? 09404043

Ans. In this phase cell is divided into two daughter cells. This phase is called M-phase (mitotic phase).

Mitosis

Q.16 Differentiate between benign and malignant tumours, why does it occur? 09404044

Ans.

i. **Benign Tumours:** Not all tumours are cancerous however, a benign tumour is an abnormal mass of essential normal cells. They always remain at their original site in the body.
ii. **Malignant Tumour:** A malignant tumour is cancerous. It is capable of spreading into neighbouring
iii. Due to uncontrolled division, masses of cells are formed. These masses are called tumors.

Q.17 Can you distinguish between: 09404045

(a) Mitosis and meiosis.
(b) Chromatin and chromosome
(c) Chromosome and chromatids
(d) Centromeres and centrioles
(e) Cytokinesis and karyokinesis
(f) Centromeres and kinetochores
(g) Haploid and diploid number of chromosomes.

Ans. (a) Mitosis and meiosis.

Mitosis	Meiosis
• It takes place in somatic cells.	• It takes place in germ line cells of sex organs.
• It consists of one division.	• It consists of two divisions.

• Crossing over does not take place during prophase.	• Crossing over takes place during prophase-I.
• Chromatids divides at anaphase.	• Chromatids does not divide at anaphase-I.
• Individual duplicated chromosomes align at the metaphase plate during metaphase.	• Paired homologous chromosomes align at metaphase plate during metaphase-I.
• Daughter chromosome move to opposite poles during anaphase.	• Homologous chromosomes with two sister chromatids, separate and move to opposite poles during anaphase-I.
• Two diploid daughter cells are formed.	• Four haploid daughter cells are formed.
• The daughter cells are genetically identical to each other and to the parent cell.	• The daughter cells are not genetically identical to each other and to the parent cell.
• The number of chromosomes remains constant.	• The number of chromosomes becomes half in meiosis.
• Mitotic products are usually capable of undergoing additional mitotic divisions.	• Meiotic products cannot undergo further divisions.

(b) Chromatin and Chromosome

Chromatin	Chromosome
In the beginning of prophase, the chromosomes are not visible as they are in the form of fine thread like structures called chromatin.	During prophase, the chromatin begins to shorten, thicken and coil by a process called condensation. It results in the appearance of chromosomes.

(c) Chromosome and Chromatids

Chromosome	Chromatids
The chromatin begins to shorten, thicken and coil by a process called condensation. It results in the appearance of chromosomes. It consists of two chromatids. Two chromatids of a chromosome is joined by centromere.	Unseparated replica of a chromosome is called chromatids.

(d) Centromeres and Centrioles

Centromeres	Centrioles
The centromere is a constriction in chromosome, where chromatids are joined with each other.	A pair of centrioles located near the anterior surface of the nucleus. It consist of triplet of microtubules arranged to form a hollow cylinder.

(e) Cytokinesis and Karyokinesis

Cytokinesis	Karyokinesis
The process of cytoplasmic division is called cytokinesis.	The process of nuclear division is called karyokinesis.

(f) Centromeres and Kinetochores

Centromeres	Kinetochores
The centromere is a constriction in chromosome.	Kinetochores are proteins that act as attachment site for spindle fibres.

(g) Haploid and Diploid Cells

Diploid Cells	Haploid Cells
• Diploid means cells have full number of chromosomes. • Somatic cells are diploid (2n) cells. • These are responsible for growth and maintenance of the organisms. • These are produced by meiosis. • Diploid number of chromosomes in man is 46.	• Haploid means cells having half number of chromosomes. • Germ line cells are haploid (n) cells. • These are involved in sexual reproduction. • These are produced by mitosis. • The haploid number of chromosomes in man is 23.

Inquisitive Questions

Q1. What role might mistakes in the cell cycle checkpoints play in the emergence of cancer? 09404046

Ans: Mistakes in the cell cycle checkpoints can lead to uncontrolled division of abnormal cells. Checkpoints stop damaged cells from dividing, they ensure chromosomes are correctly copied and distributed during cell division. If they fail, abnormal cellular mass will keep on growing and form tumors, which ultimately may lead to cancer. Checkpoints also detect and repair DNA damage before cell division, failure will increase the risk of mutations that can cause cancer.

Q2. Why do skin cells divide continuously throughout an organism's existence but nerve and muscle cells permanently exit the cell cycle? 09404047

Ans: Skin cells divide continuously to replace old or damaged cells because skin is constantly exposed to wear and tear. While the nerve and muscle cells exist in resting state called the **G0 phase**, where they stop dividing permanently because they are highly specialized and do not need frequent replacement.